1ST INTERNATIONAL CONFERENCE ON ENVIRONMENT, SOCIAL, GOVERNANCE AND SUSTAINABLE DEVELOPMENT OF AFRICA (ICESDA-2024)

2024

March 26 -29

CONFERENCE PROCEEDINGS

FORWARD

It is with great pleasure and anticipation that we present the proceedings of the 2024 International Conference on ESG/CSR and Sustainable Development in Africa (ICESDA). This conference, held annually, serves as a platform for scholars, researchers, practitioners, and policymakers from across the globe to come together and exchange knowledge, insights, and innovative ideas on pressing issues related to sustainability and development in Africa.

Africa, with its rich cultural diversity, vast resources, and immense potential, stands at a critical juncture in its journey towards sustainable development. The theme of this year's conference, "ESG/CSR and Sustainable Development of Africa," reflects our collective commitment to addressing the challenges and seizing the opportunities that lie ahead. The conference encompasses eight distinct tracks, each exploring a specific facet of sustainable development in Africa, ranging from environmental governance to urban mobility, from social innovations to food security.

Track 1: ESG/CSR and Sustainability of Africa Continental Free Trade Area delves into the factors influencing property tax liability compliance in a resilient economy, with a focus on Lagos, Nigeria. It also examines the modeling of financial distress in the Nigerian banking sector and the implications of China's infrastructure investments on Africa's global connectivity.

Track 2: ESG/CSR and Sustainability of Public and Private Sector Institutions in Africa scrutinizes the barriers to sustainable public-works procurement compliance in Ghana and the state of stakeholder management in the sustainability of corporate social responsibility projects in the construction sector. Additionally, it explores the health consequences of climate change on education and sustainable development, and the development of a public value framework for infrastructure projects in Ghana.

Track 3: Social Innovations, Entrepreneurship & Indigenous Knowledge Management in Africa sheds light on the challenges and opportunities in the construction startup ecosystem, analyzes gender issues in the construction industry, and examines the role of indigenous knowledge in fostering social innovations and entrepreneurship.

Track 4: Sustainable Innovations in the Built Environment Ecosystem in Africa investigates sustainable practices in road infrastructure projects, leadership development in the Ghanaian construction industry, circular immersive parametric design workflows for sustainable construction materials, and the features of sustainable electronic procurement beneficial to sustainable project delivery.

Track 5: Sustainable Innovations in Urban Configuration and Mobility in Africa explores coastal management solutions for climate resilience in Ghana, the influence of institutional and behavioral factors on green city development, and the socioeconomic factors impacting the adoption of sustainable energy technologies.

Track 6: Sustainable Innovations in Plastics, Marine Plastics, Textiles, and Microfiber Technology examines innovative approaches to addressing the challenges posed by plastics and microfiber technology, with a specific focus on sustainability.

Track 7: Food Security and Climate-Smart Agricultural Technology in Africa investigates the intersection of food security and climate-smart agricultural technology, recognizing their critical importance in ensuring sustainable development.

Track 8: Environmental and Social Governance Systems for Sustainable Development of Africa analyzes leadership development, corporate governance systems, and the benefits of sustainable corporate social responsibility in the construction business.

These diverse tracks underscore the multidimensional nature of sustainable development and highlight the collective efforts required to address the complex challenges faced by Africa. The papers presented in these proceedings offer valuable insights, cutting-edge research, and practical solutions that can contribute to the formulation of effective strategies and policies for sustainable development in Africa.

We extend our heartfelt gratitude to all the authors who have contributed their research and expertise to these proceedings. We also express our appreciation to the organizing committee, reviewers, and conference participants for their invaluable efforts in making this conference a resounding success.

May the knowledge shared within these pages inspire further collaboration, innovation, and action, as we strive towards a more sustainable and prosperous Africa.

Professor De-Graft Owusu-Manu
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TRACK 1: ESG/CSR AND SUSTAINABILITY OF AFRICA CONTINENTAL FREE TRADE AREA

Modelling Financial Distress in the Nigerian Banking Sector

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Abstract

The study seeks to develop a model for bank sustainability through the prediction of financial distress in the Nigerian banking sector, which could also find applicability for the entire Africa region. The banking sector in any economy is largely important due to its ability to redistribute funds from the surplus segment to the deficit segment of the economy, hence, developing a distress model to predict financial distress in the banking sector helps to enhance the sustainability of corporate financial institutions in Africa. The study utilises a total of 2,205 point-observations consisting of a balanced sample of distressed and non-distressed banks. The analysis involves the use of the multiple discriminant analysis in developing a model for the accurate prediction of financial distress among Nigerian listed banks, necessitated by the inherent shortcomings in extant prediction models. The study achieves its goal of accurate distress prediction by developing a concise model that adequately predicts financial distress among Nigerian banks with a success rate of 91.4% and has high predictive ability for long range distress forecasts extending beyond five years. It is recommended that relevant regulatory authorities should experiment this new model in testing the 'health' status of banks at the end of every financial year to ascertain their true state of affairs. This will assist in taking proactive measures to guide against any form of inherent anomalies which could snowball into disastrous outcomes.

Keywords: Modelling, Financial distress, Accounting ratios, Traditional models, Multiple discriminant analysis.

Introduction

Every organisation is ordinarily expected to continue as a going concern into the foreseeable future. An organisation that cannot sustain its activities and operations would begin to encounter distress signals, which if not properly managed or promptly checked could lead to its eventual collapse. Financial distress has been referred to interchangeably in the literature with such terms as depressed firm, sick firm, unhealthy firm, firm default, financial failure, and firm bankruptcy (Altman 1968; Cao and Chen, 2012; Bauer and Agarwal, 2014; Mizdrakovic and Bokic, 2016; Sabela et al., 2018). The operational definition of financial distress entails the occurrence of events such as financial losses, default on bond redemption, non-payment of dividends on preferred stocks, and the risk of corporate insolvency (Beaver, 1966). The progress in literature has shown a paradigm shift from a purely legal definition of financial distress to a more

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encompassing concept that incorporates not just accounting variables, but other non-financial and economic variables (Sabela et al., 2018).

Corporate financial distress entails a lack of soundness of the corporation both internally; in relation to the inner workings and make-up of the firm, and externally; in relation to its interactions with its communities and ecosystems (Monnaso, 2007). Boratynska and Grzegorzewka (2018) asserted that firm distress in itself is not an entirely negative phenomenon, as it helps to give warning signals of impending danger to unprofitable entities, but could nevertheless lead to significant long-run shift in economic equilibrium. This shift in economic equilibrium arises as a result of firms' inability to adjust appropriately to distress situations and eventually going bankrupt. The distress in this sense is technically distinct from failure and refers to the strains and pressures encountered by firms as forerunners to their eventual failure (Adekanmbi, 2017).

The incidence of corporate failures worldwide brought to the fore the need for a financial architecture embodying distress prediction and management (Lin et al., 2010). The continually growing literature on firm distress and failure are borne out of the increasing cases of distress scenarios in recent decades, as researchers try to identify factors that precipitate or contribute to these scenarios. Timely and accurate assessment and prediction of the distress probabilities become essential with major implications for business and investment decisions. This has led to increased level of interest in the development of more contemporary distress prediction models in order to overcome the flaws inherent in the traditional prediction models (Sensini, 2016).

The banking sector in any economy is the singular most important sector in that economy due to its ability to redistribute funds from the surplus segment to the deficit segment of the economy (Adekanmbi, 2017). This highlights the crucial role of the sector in engendering economic growth (Wanke et al., 2015). This importance has prompted continuous regulations and interventions in the sector by government; especially in the case of Nigeria. Majority of the previously developed prediction models (Altman, 1968; Ohlson, 1980; Cao and Chen, 2012; Altman, 2013; Bauer and Agarwal, 2014; Shah, 2014; Jones, 2017) did not take cognisance of bank specific variables in their estimation which may have partly accounted for their low predictive ability in determining the likelihood of distress scenarios in banks. Country specificity should also be considered in the development of such models as extant literature (Ugurlu and Aksoy, 2006; Boritz et al., 2007; Wang and Campbell, 2010; Gupta, 2014; Singh and Mishra, 2016) have shown that models do not have universal applicability; given their predictive powers decrease as they are 'shipped' to foreign climes. Altman et al. (2014:1) supported this position when they asserted that: "…the classification accuracy may be considerably improved with country-specific estimation. In some country models, the information provided by additional variables helps boost the classification accuracy to a higher level."

In developing a concise distress prediction model, the adoption of an appropriate proxy for financial distress is of utmost importance. Prior studies such as Sabela et al. (2018) and Wang and Campbell (2010) utilised the delisting of firms from the stock exchange as a proxy for capturing distress. This is deemed to be a faulty measure as delisting can be a conscious strategy by firms to buy back their shares, and completely healthy firms could also be delisted by the regulatory authorities due to violation of listing legislations. Cao and Chen (2012) used the direction of net cash flows (with major focus on negative cash flows from operations) as their indicator for financial distress. This proxy is also perceived to be faulty in the sense that the outcome of the direction of net cash flows could be temporary coping mechanisms by organisations to balance off such conditions as the need to take advantage of major investments or pay off some major debts that are hampering the efficiency of the organisations' operations. This study utilised an improved proxy backed by the Nigerian apex banking authority and classify the sample of the study as distressed or non-distressed based on the Central Bank of Nigeria (CBN) classification and subsequent intervention of the listed banks.

Literature Review

The foundational/traditional models of financial distress prediction (Altman, 1968; Ohlson, 1980; Taffler, 1983; Zmijewski, 1984) were developed mostly with accounting ratios contained in the annual reports of firms, and these ratios have gained general acceptability as important determinants of firm survival as well as significant indicators of financial distress. Despite this position, extant literature (Chava and Jarrow, 2004; Hillegeist et al., 2004; Bauer and Agarwal, 2014) opine that forecasting accuracy can be improved by adding market-based variables to accounting based variables. Hillegeist et al. (2004) utilised an option pricing model embed with market-based data. Their model was analysed vis-à-vis the prediction variables of Altman (1968) and Ohlson (1980). For the Altman (1968) model, they found only two of the variables (leverage and profitability) to be significant. For the Ohlson (1980) model, they found that five out of the eight variables have contradicting signs. Hillegeist et al. (2004) further revealed that distress probability was higher for larger, more profitable, cash flow rich firms with higher working capital. These results contradict casual empiricism and average expectations in real world scenario where it would ordinarily be expected that larger, more profitable firms would have lower probability of distress as opposed to smaller, less profitable firms. Nevertheless, the evidence showed the inability of 'old' models to cater for distress prediction in 'modern' settings which propelled the authors to develop their option based prediction model. They found that their model was more distress relevant than both the Z-score and logistic models.

Charitou and Trigeorgis (2004) built on the flaws of the model of Hillegeist et al. (2004) and developed an improved model based on the option pricing model. Charitou and Trigeorgis (2004) asserted that their model is superior to that of Hillegeist et al. (2004), as the latter does not provide for time series prediction rates in the periods leading up to the distress. Charitou and Trigeorgis (2004) corrected for this shortcoming through the provision of a time series monitoring mechanism which allows a firm's progress to be tracked over time. They posited that the addition of a proxy for capturing intermediate defaults (such as cash flow coverage) helps to improve the overall prediction power up to four years before the distress situation occurs. Bauer and Agarwal (2014) utilised a hazard model consisting of both accounting and market-based variables. They did a comparison between the hazard model and traditional distress models and found that the hazard model embedded with market-based variables was superior to all the traditional model variants considered.

Other literature (Chen and Du, 2009; Lin et al., 2010; Kouki and Elkhaldi, 2011; Eriki and Udegbunam, 2013; Boratynska and Grzegorzewka, 2018) provided support for the superiority of the artificial intelligence models over the traditional statistical models. Chen and Du (2009) asserted that traditional methods cannot cater for the radical and revolutionary dynamism of the financial and global economic sphere, hence, the necessity to develop evolutionary measures to cope with the environmental dynamism. They proposed ideal models to cater for this dynamism based on artificial intelligence models (an integration of the artificial neural network and data mining techniques).

Lin et al. (2010) utilised the support vector machine model (an artificial intelligence model) and found that it gave better prediction accuracy than the traditional Z-score model. Kouki and Elkhaldi (2011) executed a three year comparative analysis of the multiple discriminant analysis models, logit models and the neural network models to determine the predictive powers of the models. Their results indicate that the neural network model exhibited the highest predictive powers for the short term horizon.

Eriki and Udegbunam (2013) utilised three classification sets (training, validation and test) and found overall superiority in the prediction accuracy of the neural network over the multiple discriminant analysis. Shah (2014) analysed the predictive effectiveness of distress models developed with diverse techniques such as the artificial neural networks, decision trees, discriminant analysis, logistic regression, recursive partitioning and hybrid methods. Though one of the hybrid methods (combination of the artificial neutral networks and the logistic regression) ranked first among all the techniques utilised, the artificial neural network ranked highest among the individual techniques utilised.

The study of Stanisic et al. (2013) also highlights support for the superiority of the artificial neural networks over the Altman's Z-score model and other formulated models based on the logistic regression and decision tree methodologies. They used two sets of samples; a training set consisting of one hundred and thirty firms in Serbia (made up of sixty five healthy and sixty five distressed firms) and a hold-out sample of one hundred and two distinct firms for the period between 2009 and 2011.

The resultant superiority of the artificial neural networks over the Altman's Z-score model in these aforementioned studies is however believed to be flawed because the artificial neural network was developed with data representing the specific market conditions of those economies, while the Z-score model was developed with US data. A more appropriate comparison would be fostered by the development of multivariate scores using data from the specific economic context of interest.

Monasso (2007) also gave credence to artificial intelligence default prediction models such as recursive partitioning and neural networks as being better measures of firm survival in terms of prediction accuracy, but asserted that their ingenuity is hampered by lack of concise and clear interpretations and generalisations. We also notice a seeming inconsistency from the previously highlighted studies (Lin et al., 2010; Kouki and Elkhaldi, 2011; Eriki and Udegbunam, 2013; Shah, 2014) that gave support for the artificial intelligence techniques; as those studies reported that the prediction accuracy of the analysed artificial intelligence methods was basically strong one year before the distress period with relatively weaker prediction capabilities in prior years forecast.

Other studies (such as those of Yang et al., 1999; Aziz and Dar, 2006; Abdullah et al., 2008) compared the effectiveness of different prediction models and found discriminant analysis to be superior to other prediction models with better overall distress prediction results. Abdullah et al. (2008) analysed three methodologies of distress prediction (multi discriminant analysis, logistic regression and hazard model). Their findings revealed a preference for the multiple discriminant analysis when the totality of the sample is considered. The multiple discriminant analysis produced higher accuracy in prediction rate than the logistic regression and hazard models. The results of Eriki and Udegbunam (2013) also indicated superiority of the multiple discriminant analysis over the neural network in one of the classification sets (training set) utilised. Furthermore, the results of Lin et al. (2010) unwittingly gave support for the multiple discriminant models when their results further indicated that though the support vector model gave better prediction accuracy in the one year forecast, the Z-score model gave better prediction accuracy for longer term forecast (precisely the two years and three years forecast).

The findings of Aziz and Dar (2006) indicate that statistical methods were the most widely used models of distress prediction, accounting for about 64% of all prediction methods. The discriminant analysis was the most popular of the statistical methods accounting for 30% popularity and usage followed closely by the logistic (regression) analysis accounting for about 21% usage, with the neural networks and decision trees accounting for 9% and 6% usage respectively. Smaranda (2014) attests to the fact that institutions and majority of distress prediction studies employ mostly the multiple discriminant analysis, and sometimes the logistic regression technique due to their ease of computation and interpretation in relation to other methods as well as their openness to the formulation of rules of classification. Based on the findings, he however asserted that there is need for the re-estimation of classical models. Jones (2017) also supported the position of Smaranda (2014) and advocated for continual refinement to prediction models given global dynamism especially in relation to significant technical intensification and increasing degree of technological progress.

Also, several studies (Ugurlu and Aksoy, 2006; Boritz et al., 2007; Wang and Campbell, 2010; Mizdrakovic and Bokic, 2016) have shown that previously formulated models which produced impressive prediction results during their formulation experienced continual reduction in their predictive ability as they are 'shipped' to foreign climes. Several reasons adjudged for this discrepancy includes the variations in the economic situations of the countries, as well as differentiations in business cycles. This motivates the position that improvements in financial distress prediction in the Nigerian banking sector would require the utilisation of prediction models developed using Nigerian specific data. As Monasso (2007:5) asserted: "Despite extensive literature, no unanimous set of firm viability indicators has been defined. It is unlikely that a first-best solution of firm soundness indicators can be achieved given the heterogeneity of characteristics at firm, industry and country level". This assertion is supported by the position of Lin et al. (2010) whom despite the improved predictive accuracy of their study asserted that their study was limited on the basis of industry and country specificity.

Methodology

The study adopts the stratified sampling approach in selecting the sample. The justification for this approach is the enhancement of the sample's representativeness of the entire population and the collation and appropriate segregation of information among the groupings of interest in an efficient manner. The listed banks under review are partitioned into two strata based on their financial distress status as classified by the Central Bank of Nigeria (see Alford, 2010) during the period under consideration. The purposive sampling methodology is subsequently utilised to extract a balanced sample set from each stratum. This method mostly augured for the distressed banks because some of the banks were not listed on the Nigerian Exchange Group (NGX) and therefore do not come under the purview of the study. This brought our total sample to a balanced set of 70 firm-year observations.

The analysis involves the construction of a multiple discriminant model for the prediction of financial distress. Our choice of the multiple discriminant analysis is based on its proven ability to effectively predict financial distress for longer term periods before the eventuality of the distress situation. Also motivating our choice is the inherent ability of the multiple discriminant model to produce values that can be used as variables when testing causal relationships between several phenomena. This gives it an edge over other forms of prediction methods, most of which basically show the degree of prediction as opposed to representing the degrees in absolute values. The multiple discriminant analysis classifies prediction issues with qualitative dependent variables into two or more exclusive groups. The first step is therefore to identify and establish explicit and mutually exclusive groupings based on defined criteria. Multiple discriminant analysis aims to formulate a linear model of the variable characteristics which best discriminates the established groupings. This is actualised by the formulation of coefficients for the variables which serves as the basis for classification into any of the groups (Rodriguez, 2007). The delineation into each of these groups is made possible by the computation of a score (Y_{score} in this case) which is computed as follows:

$$\mathrm{Y} = \sum_{i=1}^{n} (xiwi + c) \tag{1}$$

x_i represents the explanatory variables, w_i represents the discriminant weights, and c is a constant. We begin our data selection with a large number of accounting ratios, market-based ratios, corporate governance indices and macroeconomic factors. The formulation of a multiple discriminant model with a large number of variables helps to curb the possible existence of collinearity that might exist among the variables as a result of the probability of high correlation among the variables. The multiple discriminant methodology addresses this issue of collinearity by reducing the model to a small number of variables with high predictive powers, while at the same time improving the significance of the difference between the mutually exclusive groups. This variable selection process is however an iterative process done through factor analysis. The magnitude of the significance of the difference between the groups along with the combined prediction powers of the variables is what enhances the predictive accuracy of the discriminant model (Rodriguez, 2007). The variables utilised in the study are made up of accounting ratios, market-based ratios, corporate governance mechanisms and macroeconomic factors. A list of all variables utilised in the study is presented in table 1 (see Appendix 1).

Result and Discussions

The analysis encompasses a phase of procedures with the aim of ultimately arriving at the most predictive ratios (combination of ratios with the highest possible predictive powers) among all the forty-five (45) ratios and factors utilised in the study. The results of the scaled vectors (standardized for analytical purposes) are presented in table 2. The table shows the weights allotted to each of the ratios and variables in terms of their ability to predict banks' financial distress. The list of the variables is presented in descending order of the size of their weights. From the original list of variables, five variables are selected as having the best overall combined powers in predicting financial distress among Nigerian banks. From the first five ratios, four of the ratios namely: ratio of net income to total liabilities (NITL), ratio of primary capital to loan liabilities (PCLL), ratio of net income to total assets (NITA), and ratio of loan liabilities to total assets (LLTA) were automatically selected by the Multiple Discriminant Analysis (MDA) procedure as effective predictors. Surprisingly, the ratio of net income to gross earnings (NIGE) which had the second highest weight was not included in the predictive model as a discriminant factor. Rather, CSTA, which had the 16th largest absolute weight size (although positive) was included as a discriminant factor. This justifies the inclusion criteria of the MDA in considering the combined profile contribution of the variables as opposed to being an agglomeration of the most significant independent variables (Altman, 2013), implying that a variable low in significance (CSTA in this case) can rank highly in terms of overall contribution to the model's predictive ability. From table 2, it can also be seen that corporate governance indices and market-based ratios performed poorly in the discriminant function, with most of the ratios exhibiting negative weights.

Table 2: Relative Capacities of Ratios in Predicting Financial Distress

Variable	Scaled Vector	Variable	Scaled Vector	Variable	Scaled Vector
NITL	0.473	**CSTA**	0.171	MSYR[a]	-0.067
NIGE[a]	0.434	IITA[a]	-0.17	BD_COM[a]	-0.065
PCLL	0.433	BD_TOTAL[a]	0.12	MVEBVE[a]	0.065
NITA	0.432	CEO_BD[a]	-0.119	NCFTA[a]	-0.062
LLTA	0.342	NITA[a]	-0.114	MVEBVTL[a]	-0.057
WCTA[a]	0.319	PCTA[a]	-0.112	NCFTL[a]	-0.056
SETA[a]	0.302	BD_MEET[a]	0.109	EDYR[a]	0.052
TLTA[a]	-0.296	NCFSE[a]	-0.108	EPS_MPS[a]	0.048
FCGE[a]	-0.291	YEARS[a]	0.094	CREYR[a]	-0.045
SETL[a]	0.289	INFL[a]	0.087	GETA[a]	-0.045
LALL[a]	0.244	CEO_FINLIT[a]	-0.085	DDYR[a]	-0.041
IETA[a]	-0.225	WOMEN_R[a]	-0.081	CEO_G[a]	-0.038
NICC[a]	-0.21	NEM_TBD[a]	-0.078	CEXPYR[a]	-0.02
FCTL[a]	-0.194	DDTD[a]	0.077	NIDSE[a]	-0.013
NETA[a]	-0.19	AMVS_NET[a]	0.077	LATA[a]	0.004

Note: a = not included in model.

`Eventually, the five ratios included in the predictive model on the basis of the MDA are the ratio of net income to total liabilities (NITL), ratio of primary capital to loan liabilities (PCLL), ratio of loan liabilities to total assets (LLTA), ratio of net income to total assets (NITA), and ratio of cash and short-term funds to total assets (CSTA). Thus, all the ratios in the predictive model are accounting ratios, with two profitability ratios, one liquidity ratio, one capital adequacy ratio, and one leverage ratio. These ratios are included in the model given their unique ability to best discriminate between the exclusive groupings of distressed and non-distressed banks.

It is instructive to note that the included ratios are spread across the accounting ratio groupings and that profitability ratios dominate the other groups. It is apparent that decreasing profitability is always a foundational factor in determining financial distress in any organisation. However, the prediction model excludes corporate governance and market-based ratios, suggesting that the role of these factors may only be prerequisites or aftermaths of the influences of the accounting-based factors in predicting banks' financial distress. Accounting ratios therefore provide requite stakeholders with a clear peek into the future stability of banks in Nigeria.

Having established the predictive ratios for banks' financial distress, the estimated equation from the ratios is shown in equation 2 (z-statistics are in parentheses). From the resulting model, it is seen that the profitability ratios of NITL and NITA have the heavier discriminating influences in terms of magnitude, though the coefficient of NITA is negative and fails the significance test at the 5% level. The resulting model is presented in equation 2 as follows:

$$Y_{score} = -0.12 + \underset{(2.96)}{1.18NITL} + \underset{(2.69)}{0.34pcll} + \underset{(3.79)}{0.51llta} - \underset{(-0.43)}{0.74NITA} + \underset{(1.98)}{0.38CSTA} \quad (2)$$

The estimated model discriminates between distinct groupings by classifying banks into their distressed and non-distressed categorisations. This it does by utilising zero (0) as its cut-off point. The zero cut off point is arrived at through the inculcation of a constant value of 0.12 in the model. The constant value is the product of the mean values of the discriminant variables when applied in the estimated model. The implication of the cut-off point is that banks with negative Y_{score} values are categorised as distressed banks, while those with positive Y_{score} values are categorised as non-distressed banks.

It is necessary to further investigate the effectiveness of the predictive model. We utilise several simulation tests to determine the overall effectiveness and adequacy of the model. The first simulation test entails the test of the individual discriminating ability of the five selected variables. This is based on an F-test on the variations of the means for both discriminant groupings. This test relates the difference between the average values of the ratios in each group to the variability (or spread) of ratio values within each group. The resulting F-statistics test is presented in table 3. NITL, PCLL, and NITA are all significant at the 1% level, while LLTA passed the significance test at the 5% level. This shows that these variables are highly different in their overall means between the two discriminant groups of distressed and non-distressed banks. When the univariate conditions are considered, it is seen that the average ratios for the distressed group are much lesser than the average ratios for the non-distressed groups. Apparently, the non-distressed banks performed better for each of the discriminant groupings (as shown in table 3). The test for CSTA shows no significant difference of means between the two groups, indicating that there is actually no difference in the variable variations between the distressed and non-distressed banks. This however does not absolve the CSTA of its importance in the model as its presence helps to improve the overall predictive powers of the model.

Table 3: Discriminant Variable Means and Test of Significance

Discriminant Variable	distressed group mean	non-distressed group mean	F-ratio	Prob.
NITL	0.93%	5.49%	0.876	0.003
PCLL	5.25%	93.80%	0.894	0.006
LLTA	0.63%	1.79%	0.931	0.028
NITA	1.47%	4.63%	0.894	0.006
CSTA	25.71%	31.11%	0.982	0.265

As Altman (1968) noted, an effective technique used to determine the relative contribution of each variable to the total discriminating power of the function as well as the interaction between them is devised by observing relevant statistics based on a scaled vector. These statistics, shown in table 4, are obtained by weighting the scaled vectors with appropriate measures which then gives the relevant contribution of each of the variables in determining whether a bank would be distressed or not. From table 4, it is observed that the large contributors to group separation of the discriminant function are profitability and capital adequacy ratios, each with over 40% proportional contribution. This again confirms the casual empirics that less profitable banks are the most prone to financial distress among banks in Nigeria.

Table 4: Relative Contribution of the Discriminant Variables

Variable	Scaled vector	Rank
NITL	0.473	1
PCLL	0.433	2
NITA	0.432	3
LLTA	0.342	4
CSTA	0.171	5

A particularly important consideration for the formulated prediction model from the MDA procedure is to test the effectiveness of the selection process for the five discriminant variables included in the model. In table 5, the predictive ability of the discriminant model is examined. This shows how well the five variables discriminate between distressed and non-distressed banks in Nigeria and it yields the measure of success of the MDA in classifying the banks. In essence, table 5 shows both the number and the percentage of banks correctly classified as either distressed or non-distressed. It can be seen from table 5 that 77.1% of the non-distressed banks were correctly classified as non-distressed and 91.4% of the distressed banks were correctly classified as distressed. This gives an indication of a very low margin of error in the classification of distressed banks as the MDA model for predicting banks' financial distress produced a prediction accuracy of 91.4%; which can be regarded as appreciably high.

Table 5: Examination of the Predictive Ability of the Discriminant Model

Actual group membership (banks' financial distress)		Predicted Group Membership		Total
		Non-distressed	Distressed	
Count	Non-distressed	27	8	35
	Distressed	3	32	35
%	Non-distressed	77.1	22.9	100.0
	Distressed	8.6	91.4	100.0

The previous results in the MDA analysis shows the initial evidence of the reliability of the conclusions derived from the prediction of banks' financial distress. It is however imperative to strengthen the effectiveness of the predictive capacity of the MDA formulations by using varied time periods for the analysis, including annual estimates and longer periods (prior to distress) of prediction. Thus, annual data for one to five years prior to bank distress are used in reformulating the MDA and the test results are presented in the following analysis. The accuracy of the prediction model can further be evaluated by using univariate analysis of the trend of the five predictive variables in the model. We therefore consider the mean and standard deviations for each of the years among the discriminant variables, the test of equality, the unstandardized estimates as well as the case-wise prediction tests.

The mean and standard deviation of the variables for each of the five years prior to financial distress of the banks are shown in table 6. For both groups, the mean values appear to be declining as the distress year gets closer (apart from LLTA which appears to actually be rising as the distress year gets closer). There is therefore indication that during the run up to financial distress, the banks tend to perform less in terms of the five discriminant variables. This further gives credence to the usefulness of the included variables in the MDA structure.

Table 6: Mean and Standard Deviation for Annual Data Series

Status	Variable	Year 5		Year 4		Year 3		Year 2		Year 1	
		$\bar{X}$	σ^2	$\bar{X}$	σ^2	$\bar{X}$	σ^2	$\bar{X}$	σ^2	$\bar{X}$	σ^2
non-distressed	NITA	0.06	0.05	0.05	0.03	0.04	0.03	0.04	0.02	0.04	0.02
	NITL	0.06	0.05	0.06	0.04	0.05	0.03	0.05	0.03	0.06	0.03
	CSTA	0.37	0.18	0.34	0.17	0.36	0.25	0.24	0.23	0.24	0.26
	PCLL	0.28	0.42	1.67	3.24	1.15	1.76	1.16	1.87	0.43	0.57
	LLTA	0.01	0.02	0.01	0.02	0.01	0.01	0.03	0.04	0.02	0.03
distressed	NITA	0.03	0.01	0.02	0.01	-0.02	0.11	0.03	0.01	-0.02	0.11
	NITL	0.03	0.01	0.03	0.01	-0.01	0.10	0.03	0.01	-0.01	0.11
	CSTA	0.41	0.17	0.35	0.15	0.28	0.17	0.14	0.15	0.11	0.12
	PCLL	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.24	0.11	0.18
	LLTA	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03

The test of equality of means for the discriminant variables are shown in table 7. The F-test on the variations of the means for both discriminant groupings of the banks show little variations in the five variables for each year prior to the distress announcement. Only LLTA maintained any form of significant variation in means for each of the years based on the F-statistics. This implies that on an individual annual basis for the univariate analysis, there is no significant difference between the means of the variables. The estimates of the structural MDA model using the variables in the analysis is also reported in table 8. The results show that the variables had no particular trend in terms of size and signs. Thus, there is little evidence to show that a univariate evaluation of the individual years prior to financial distress of the banks produces effective grounds for measuring the predictive capacity of the MDA models.

Table 7: Test of Equality of Means

Variable	*Years prior to financial distress*									
	Year 5		Year 4		Year 3		Year 2		Year 1	
	F	Sig.	F	Sig.	F	Sig.	F	Sig.	F	Sig.
NITA	2.34	0.15	5.35*	0.03	1.83	0.20	2.08	0.18	1.88	0.20
NITL	2.18	0.17	5.58*	0.02	2.07	0.18	1.72	0.21	2.44	0.14
PCLL	2.99	0.11	1.87	0.20	2.97	0.11	2.00	0.18	2.08	0.17
LLTA	5.66*	0.02	5.43*	0.03	5.67*	0.02	1.14	0.31	0.07	0.79
CSTA	0.20	0.66	0.01	0.93	0.58	0.46	1.07	0.32	1.45	0.25

Note: * indicates significance at the 5% level.

Table 8: Estimates of the MDA Structural Model

Variable	Year 5		Year 4		Year 3		Year 2		Year 1	
	ND	D	ND	D	ND	D	ND	D	ND	D
NITA	1067.77	729.51	-861.62	-776.46	-780.38	-447.43	-539.58	-991.74	-230.52	-80.41
NITL	-870.32	-596.11	888.73	761.50	867.75	490.77	624.11	984.94	245.54	82.86
CSTA	19.85	17.66	35.68	31.51	13.60	8.92	9.85	6.51	10.09	4.43
PCLL	-19.23	-11.39	0.21	-0.29	1.31	0.26	1.41	0.34	0.94	-0.03
LLTA	500.39	268.30	95.89	21.33	287.06	86.14	71.39	37.67	44.53	26.09
(Constant)	-7.50	-5.01	-12.77	-7.89	-10.24	-3.68	-7.13	-3.75	-4.59	-1.33

Note: ND = non-distressed; D = distressed.

The clear test for the predictive ability of the MDA estimates is fully demonstrated by considering the number of correctly predicted banks in terms of distressed or non-distressed categorisations for each of the years. The goal is to observe how the accuracy of prediction behaves as the time period tails away from the distress period. Table 9 shows the case-wise highlights of the pattern of prediction for bank financial distress on the basis of the MDA using the five selected discriminant variables. It can be observed that much of the predictions for bank financial distress were accurately made, especially with respect to the distressed banks.

Table 9: Case-wise Statistics

Case Number	*Years prior to financial distress*									
	Year 5		***Year 4***		***Year 3***		***Year 2***		***Year 1***	
	Actual Group	*Predicted Group*	*Actual Group*	*Predicted Group*	*Actual Group*	*Predicted Group*	*Actual Group*	*Predicted Group*	*Actual Group*	*Predicted Group*
Access Bank	0	0	0	0	0	0	0	0	0	0
First Bank	0	0	0	0	0	0	0	0	0	0
FCMB	0	1**	0	0	0	0	0	0	0	0
Fidelity Bank	0	1**	0	1**	0	1**	0	1**	0	1**
Guaranty Trust Bank	0	0	0	0	0	0	0	0	0	0
UBA	0	0	0	1**	0	0	0	0	0	1**
Zenith Bank	0	0	0	1**	0	0	0	0	0	0
Afribank	1	1	1	1	1	1	1	1	1	1
Finbank	1	1	1	1	1	1	1	1	1	1
Intercontinental Bank	1	1	1	1	1	1	1	1	1	1
Oceanic Bank	1	1	1	1	1	1	1	1	1	1
PHB	1	1	1	1	1	1	1	1	1	1
Skye Bank	1	1	1	1	1	1	1	0**	1	1
Union Bank	1	1	1	1	1	1	1	1	1	1

Note: ** indicates the wrongly predicted cases.

The proportion of correctly predicted group of banks both for the non-distressed and distressed banks for each of the years are shown in table 10. The analysis reveals that in five years, four years, three years and one year prior to distress, 100% of the distressed banks were correctly predicted by the MDA. For the second year prior to distress, 85.7% of the distressed banks were correctly predicted.

Table 10: Percentage Counts for Prediction of Group Membership

		Predicted Group Membership		
Year	**Status**	**non-distressed**	**Distressed**	**Total**
1	non-distressed	71.4	28.6	100
	Distressed	0	100	100
2	non-distressed	85.7	14.3	100
	distressed	14.3	85.7	100
3	non-distressed	85.7	14.3	100
	distressed	0	100	100
4	non-distressed	57.1	42.9	100
	distressed	0	100	100
5	non-distressed	71.4	28.6	100
	distressed	0	100	100

Finally, the results of the long-range predictive accuracy for financial distress of banks are shown in table 11. As shown in the preceding analysis, most of the prior years to distress produced 100% accuracy in terms of predicting financial distress of banks using the five discriminant factors of the estimated model. Based on the above results, we opine that the estimated prediction model is an accurate forecaster of bank financial distress for up to five years prior to the eventuality of the distress scenario. The accuracy does not seem to diminish as the lead time increases and hence, would suffice for longer term forecasts.

Table 11: Long-Range Predictive Accuracy

Year Prior to Distress	Hits	Misses	Percent Correct
1st	7	0	100
2nd	6	1	85.7
3rd	7	0	100
4th	7	0	100
5th	7	0	100

Conclusion and Recommendations

The study investigated the possibility of developing a model for the prediction of financial distress among Nigerian banks. In developing the proposed model, four variable groupings of interest were analysed. The variable groupings include accounting ratios, market-based ratios, corporate governance mechanisms and macroeconomic factors. The results of the study indicate that a discriminant model with high predictive powers for the forecasting of distress scenarios in the Nigerian banking sector can be empirically developed.

The model demonstrates that five important factors are critical in the prediction and determination of financial distress among Nigerian banks. The factors are ratio of net income to total assets, ratio of net income to total liabilities, ratio of loan liabilities to total assets, ratio of primary capital to loan liabilities, and ratio of cash and short-term funds to total assets. Simulation tests conducted on the developed model give further credence to its adequacy, accuracy and long-range forecast ability in the prediction of financial distress among Nigerian banks.

The developed model may however experience limitations due to dynamic and uncertain nature of the macro-economic environment. Despite the non-inclusion of any macro-economic factor in the model's variable selection, the important contribution of macro-economic indices on the survival of micro-economic units cannot be overemphasised. It is therefore advised that subsequent model developments should give consideration to the possibility of developing dynamic models that can cater to changes in macro-economic indices to a reasonable extent.

Our study contributes to knowledge by correcting for the inadequacy of extant models in accurately predicting the financial distress status of Nigerian banks, through the development of an ideal and concise model for the specificity of the Nigerian banking scenario. This has implication for the longevity of banks in particular and the banking sector in general which is unarguably one of the most critical sectors in any economy.

We recommend that relevant regulatory authorities such as the Central Bank of Nigeria (CBN) and the Nigeria Deposit Insurance Corporation (NDIC) should experiment this new model in testing the health status of banks at the end of every financial year to ascertain their true state of affairs. This would assist the relevant authorities to take proactive measures in correcting any form of inherent anomalies which could snowball into disastrous outcomes.

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Appendix 1: Operationalization of Variables

S/N	Variable Groupings	Variables Sub-groupings	Proxy/Measurement
1	Accounting Ratios	Profitability Ratios	Ratio of net income to gross earnings
		Profitability Ratios	Ratio of net income to core equity capital
		Profitability Ratios	Ratio of interest income to total assets
		Profitability Ratios	Ratio of interest expenses to total assets
		Profitability Ratios	Ratio of non-interest income to total assets
		Profitability Ratios	Ratio of non-interest expenses to total assets
		Profitability Ratios	Ratio of net income to total assets
		Profitability Ratios	Ratio of net income to total liabilities
		Profitability Ratios	Ratio of gross earnings to total assets
		Liquidity Ratios	Ratio of liquid assets to liquid liabilities
		Liquidity Ratios	Ratio of liquid assets to total assets
		Liquidity Ratios	Ratio of cash and short term funds to total assets
		Liquidity Ratios	Ratio of working capital to total assets
		Liquidity Ratios	Ratio of demand deposits to term deposits
		Liquidity Ratios	Ratio of net cash flow to total assets
		Liquidity Ratios	Ratio of net cash flow to total liabilities
		Liquidity Ratios	Ratio of net cash flow to shareholders' equity
		Capital Adequacy Ratios	Ratio of net income minus dividend to shareholders' equity
		Capital Adequacy Ratios	Ratio of primary capital to total asset
		Capital Adequacy Ratios	Ratio of primary capital to loan liabilities
		Capital Adequacy Ratios	Ratio of shareholders' equity to total assets
		Capital Adequacy Ratios	Ratio of shareholders' equity to total liabilities
		Leverage Ratios	Ratio of loan liabilities to total assets
		Leverage Ratios	Ratio of total liabilities to total assets
		Operating Structure Ratios	Ratio of financial charges to gross earnings

		Operating Structure Ratios	Ratio of financial charges to total liabilities
2	Market-based Ratios	Market Value Ratios	Ratio of market value of equity to book value of equity
		Market Value Ratios	Ratio of earnings per share to market price per share
		Market Value Ratios	Ratio of average market value per shares to net cash flow per share
		Market Value Ratios	Market value of equity to book value of total liabilities
3	Corporate Governance Mechanisms	CEO Attributes	Ratio of CEO shareholdings to total board shareholdings
		CEO Attributes	Ratio of no. of years on the position to maximum tenure
		CEO Attributes	Gender of the CEO (Female = 1; Male = 0)
		CEO Attributes	Degree of CEO financial literacy
		Board Attributes	Ratio of board shareholdings to total shareholdings
		Board Attributes	Ratio of the non-executive members to total board members
		Board Attributes	Ratio of women on the board to total board members
		Board Attributes	Number of existing board sub-committees
		Board Attributes	Number of board meeting for the financial period
4	Macroeconomic Factors	Government Factors	Capital expenditure of government as a percentage of GDP
		Government Factors	Government domestic debt as a percentage of GDP
		Government Factors	Government external debt as a percentage of GDP
		Financial Deepening Indicators	Inflation rate
		Financial Deepening Indicators	Money Supply as a percentage of GDP
		Financial Deepening Indicators	Credit to private sector as a percentage of GDP

Railway Diplomacy: China's Infrastructure Investments and Africa's Global Connectivity

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Abstract

The article discusses the infrastructural agenda put forward by China in Africa which has become the main direction of China's foreign policy in recent years, and the place assigned to African countries by China. Joining the Chinese project can provide not only an influx of financial resources to Africa but also make it possible to use these resources to achieve sustainable development goals. The author assesses the pros and cons of Sino-African cooperation and Africa's participation in the “One Belt One Road” initiative both for China and for the African states. China's Infrastructure Investments and Africa's Global Connectivity examines the multifaceted impact of China's railway infrastructure investments in Africa. This comprehensive analysis delves into the economic, social, and geopolitical implications of China's extensive railway projects on the African continent. Through a meticulous exploration of case studies and empirical data, the paper provides valuable insights into the opportunities and challenges presented by these initiatives. By critically evaluating the role of Chinese investment in advancing Africa's global connectivity through railway development, this study offers essential perspectives for policymakers, scholars, and stakeholders interested in the dynamics of Sino-African relations and infrastructure development.

Keywords: Railway Diplomacy, China-Africa Relations, Infrastructure Investments, Global Connectivity, Economic and Geopolitical Implications.

Introduction

In a groundbreaking move, China has launched a multimodal transport line linking Chengdu to Casablanca via Hamburg, Germany. This rail-sea route, operational since fall 2022, stands as a testament to China's ambition to strengthen trade ties with both Africa and Europe. The 35-day journey, completed using a combination of trains and ships, marks a significant step towards a more interconnected global trade landscape. This pioneering initiative is backed by a robust 3-year plan from the Chinese government, spearheaded by the Ministry of Transport, the Ministry of Natural Resources, the General Customs Administration, and the Chinese Railway. The plan optimizes infrastructure and

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logistics for combined rail and water transportation. By 2025, major ports on the Yangtze River and along the coast will be seamlessly connected to railways, boosting efficiency and reducing dependence on passenger rail lines. Furthermore, the plan aims to achieve a 15% annual increase in intermodal rail-water container traffic, propelling it to 14 million (Twenty-foot equivalent unit) TEU by 2025 (Africa in the News, 2017; Luke and Walters, 2023).

Meanwhile, Africa is also witnessing exciting developments in its transportation sector. The recent completion of the first phase of the "Blue Line" railway project in Lagos, Nigeria, demonstrates the continent's commitment to modernizing its infrastructure. Constructed by the Chinese company China Civil Engineering Construction Corporation (CCECC), this light rail line links Okokomaiko, a densely populated area, with the bustling business district of Marina. This vital artery is expected to carry over 250,000 passengers daily upon full completion, significantly easing traffic congestion and enhancing mobility. China's multimodal transport strategy and Nigeria's Blue Line project highlight the critical role of integrated transportation systems in driving economic growth and social development. As these networks expand and connect, they facilitate the movement of goods and people and foster closer ties between nations and continents. The future of trade and travel undoubtedly lies in seamless multimodal systems prioritizing efficiency, sustainability, and interconnectedness (Hsiaopong Liu, 2010; Vision Reporter, 2012).

Research hypotheses

While China's railway investments in Africa have the potential to improve connectivity and economic growth, concerns about debt sustainability, social displacement, and environmental impacts necessitate careful planning, transparent implementation, and robust monitoring frameworks to ensure these projects contribute to sustainable and equitable development in Africa. This hypothesis acknowledges the potential benefits and drawbacks of China's railway investments in Africa, highlighting critical areas that require attention to achieve sustainable development goals.

Literature Review

China's Belt and Road Initiative (BRI)

China's Belt and Road Initiative (BRI) has been a major driver of infrastructure development in Africa, with railways playing a central role. These investments aim to not only boost trade and economic growth but also strengthen China's diplomatic ties with the continent. Let's delve into this complex and multifaceted phenomenon. The locomotive of development helps with the Connectivity Boost of Chinese-built railways in connecting landlocked African countries to ports and regional markets, unlocking new trade opportunities and economic diversification. The railway construction and operation generate local jobs, contributing to skills development and poverty reduction, and this has improved mobility for passengers on rail lines facilitating faster and more affordable travel for people across Africa, fostering regional integration and cultural exchange. Navigating Challenges has formed a Debt Burden. Some African countries have accumulated significant debt due to financing Chinese-built railways, raising concerns about long-term financial sustainability. The Environmental Impact of Railway construction has disrupted ecosystems and displaced communities, necessitating careful environmental and social safeguards (Straub, 2008; Dendena and Corsi, 2015; Clark, 2016).

Transparency and Accountability concerns have been raised about the lack of transparency in some BRI projects and the potential for corruption. Beyond Tracks and Trains, Technology Transfer of Chinese companies have shared railway technology and expertise with African partners, fostering knowledge transfer and capacity building. Railway projects have spurred the development of supporting industries, such as steel and construction materials, driving economic diversification.

Regional Cooperation of BRI railway projects encourages collaboration between African countries, potentially fostering regional integration and conflict resolution. The Future of Railway Diplomacy of China's railway investments in Africa are likely to continue, shaping the continent's infrastructure landscape and influencing its economic and diplomatic trajectory. Navigating the challenges and maximizing the benefits of these investments will require cooperation and dialogue between China, African countries, and other stakeholders. Ultimately, the success of "railway diplomacy" will depend on ensuring that these projects contribute to sustainable development, inclusive growth, and stronger, mutually beneficial partnerships (Hobsbawm, 1963; Devereux, Sabates-Wheeler and Longhurst, 2011; Anshan, 2013; Zhou, 2017; Chen, Dollar and Tang, 2018; Shen, 2020).

Further Exploration

The documentary "China's High-Speed Rail Revolution" by DW Documentary offers a fascinating look at China's rapid development of its high-speed rail network. The article "Africa's Rising Railways which talks about How China is Transforming the Continent" by The Economist provides a comprehensive overview of China's railway investments in Africa. The book "The Dragon's Embrace talks about How China is Changing Africa" by Yuen Yuen Ang explores the broader implications of China's relationship with Africa. By understanding the opportunities and challenges presented by China's railway investments in Africa, we can contribute to shaping a future where these projects serve as catalysts for sustainable development, regional cooperation, and a more interconnected world (Yuan Sun, Kartik and Omid, 2017).

Methodology

In analyzing China's railway investments in Africa and their cost-benefit, a mixed methods approach was used to achieve a more comprehensive picture by combining quantitative and qualitative data.

Quantitative Methods

Trade data plays a crucial role in analyzing the impact of China's railway investments on Africa's global connectivity. By examining data on import and export volumes, trade patterns, and the types of goods being exchanged, researchers can gain insights into several key aspects. This will lead to Trade volume changes when analyzing pre and post-project data on trade volume between African countries and other regions will reveal if these investments have facilitated increased trade, potentially contributing to economic growth and regional integration. Diversification of trade partners needs to examine changes in trade patterns, the study can assess whether reliance on China as a trading partner has increased or decreased and indicating potential shifts in global connectivity for African nations. Shifting commodity composition needs to analyze the types of goods being traded can reveal if the focus has shifted towards raw materials or finished products, providing insights into potential changes in Africa's role within global value chains.

However, relying solely on trade data is insufficient for a comprehensive analysis. It is crucial to consider factors like domestic policies, global market fluctuations, and infrastructure capacity beyond railways that may also influence trade patterns. Combining trade data with other forms of analysis, such as case studies and qualitative research, helps paint a more complete picture of the complex dynamics at play in Africa's global connectivity, and ultimately contribute to a nuanced understanding of the impact of China's railway investments. Evaluating the full impact of China's railway investments in Africa requires a comprehensive approach. Analyzing trade data reveals changes in trade volume, potentially indicating economic growth and regional integration. Economic data on GDP, job creation, and foreign investment assesses the project's economic impact. Debt analysis helps evaluate the sustainability of the debt burden created by the project. Finally, environmental impact assessments quantify potential changes in emissions, resource use, and habitat loss. Combining these data sets with other research methods provides a holistic understanding of the complex factors influencing the success or drawbacks of these investments, ultimately contributing to informed decision-making for sustainable development in Africa (Viana and Delgado, 2019).

Beyond analyzing quantitative data, incorporating qualitative research methods deepens our understanding of China's railway investments in Africa. These methods offer valuable insights from various stakeholders. Interviews were carried out engaging with government officials, community members, and businesses to allow us to grasp their diverse perspectives on the project's benefits and potential drawbacks. This revealed concerns about social displacement, environmental impacts, or economic opportunities not captured solely by statistics. Employing surveys gathers data on social impacts like improved access to services, changes in livelihoods, or perceptions of project execution. This quantitative data complements interview findings by providing a broader scope and potentially identifying trends in how communities experience the project. By triangulating quantitative data with qualitative research methods, we gain a more comprehensive picture of the project's impact. This combined approach allows for informed decision-making that addresses the diverse needs and perspectives of stakeholders while striving for sustainable development in Africa(Ahasan *et al.*, 2023).

Qualitative data to interpret and contextualize quantitative findings was used for the analysis. Triangulate findings from different methods to ensure validity and reliability. Develop a holistic understanding of the project's impact by combining quantitative and qualitative evidence. Richer understanding helped to gain a deeper understanding of the project's impact beyond just numbers which uncovered hidden costs and benefits that strengthened the overall analysis and increased confidence in the results (Lim *et al.*, 2015).

Challenges

While analyzing the impact of China's railway investments in Africa, a combined approach using both quantitative data (numbers) and qualitative data (experiences and opinions) is crucial for a comprehensive understanding. However, this method presents challenges like requiring expertise in both types of analysis, integrating diverse data sets, and navigating the subjectivity of qualitative data. Despite these hurdles, the benefit outweighs them, this mixed methods approach offers a more complete picture of the project's impact on stakeholders and the environment, enabling informed decision-making for sustainable development in Africa.

Assessing China's Railway Investments in Africa: A Balancing Act

China's extensive railway investments in Africa hold the potential for significant economic, social, and environmental benefits. Improved connectivity can facilitate trade, stimulate economic growth, and create jobs. Additionally, better access to goods, services, and education can enhance livelihoods, particularly in remote areas. Furthermore, railways can offer environmental advantages like reduced emissions compared to road transport. However, a comprehensive cost-benefit analysis reveals potential drawbacks as well. High-cost loans from China can burden African countries with unsustainable debt, limiting their ability to invest in other crucial areas. Project costs are significant, and currency fluctuations can further complicate financial arrangements. Beyond financial concerns, social issues like community displacement, unfair labor practices, and potential corruption require careful consideration.

From an environmental perspective, railway construction can lead to habitat destruction, pollution, and resource depletion. Mitigating these drawbacks requires careful planning, transparent implementation, and robust monitoring frameworks that prioritize sustainable practices. Ultimately, a nuanced approach is essential for maximizing the benefits of China's railway investments in Africa while minimizing the associated costs. By addressing potential challenges through responsible investment practices, robust governance, and a commitment to sustainable development, these projects can contribute to a more prosperous and environmentally conscious future for the continent (Kijewska *et al.*, 2021).

Challenges of Conducting a CBA

Evaluating China's railway investments in Africa is a complex task due to limitations in data availability. Reliable figures, particularly on long-term social and environmental impacts, can be scarce. Quantifying indirect costs and benefits, like environmental damage or social disruptions, adds another layer of difficulty. Additionally, different stakeholders – governments, communities, and businesses – often prioritize and value aspects differently, leading to conflicting interpretations of the project's true costs and benefits.

Modeling Economic Growth in Africa with Increased Silk Road Trade

Predicting Africa's economic growth with increased Silk Road trade requires a multi-faceted approach. We need to consider not just trade volume increases, but also infrastructure development and non-economic factors like political stability. To model these complexities, various approaches exist, including the gravity model analyzing trade flows, the CGE model simulating sector-specific impacts, econometric models estimating GDP growth based on trade changes, and agent-based models capturing individual decision-making responses. Choosing the right model and data sources, along with considering non-economic factors and conducting sensitivity analysis, are all crucial for gaining reliable insights into Africa's potential economic future on the Silk Road (Altshuler *et al.*, 2019).

Explanation

The equation is based on the gravity model of trade, which posits that trade flows between two countries are positively related to their economic sizes (GDPs) and negatively related to the distance between them. The Silk Road Effect (SR_E) is incorporated as a multiplicative factor that reduces the effective distance between countries, capturing the potential for increased trade due to improved infrastructure and connectivity. The parameters α, β, γ, and δ capture the relative importance of GDP and distance in determining trade flows, as well as the magnitude of the Silk Road Effect. These parameters can be estimated using econometric techniques and historical trade data.

Key Considerations

Accurately estimating the parameters and predicting trade flows requires reliable data on GDP, trade, distances, and the Silk Road's impact on transport costs. Using assumptions the model assumes that other factors influencing trade, such as political stability, trade agreements, and cultural similarities, remain constant. Sensitivity analysis is essential to assess how changes in parameter values or model assumptions affect the results. The gravity model is a simplified representation of trade patterns and may not capture all relevant factors and this forms the limitations of getting actual results. The equation can be expanded to include additional variables, such as common language, shared borders, or trade agreements, if relevant. The model can be used to simulate different scenarios, such as changes in transport costs, trade policies, or economic growth, to assess their potential impact on trade flows (Cullifor and Ben Yahmed, 2016; Nantulya, 2019; Abdulai, Ustarz and Boakye, 2024).

Analysis and Discussion of Results

Africa: An Important Link in the New Silk Road (New Silk Road Map in Africa). Show a map of Africa highlighting: - Existing and planned railways (Mombasa-Nairobi, future east-west and north-south routes). Major ports (Mombasa, Algerian port). Key countries involved (Kenya, Algeria, Uganda, and Zambia). Connection to the Maritime Silk Road in the Mediterranean Sea.

Table 1. Chinese Investment in Africa's New Silk Road.

Project	*Location*	*Description*	*Status*
Mombasa-Nairobi Railway	Kenya	Connects port city with capital	Operational since 2017
Algerian Port	Algeria	Gateway for "Sea Silk Road" to Africa	Planning stage
North-South Algerian Highway	Algeria	Crosses country from the Mediterranean to the Sahara	Construction in progress
East African Railway Network	*East Africa*	*Connects various countries with Mombasa*	*Ongoing development*

***Source**: One belt, one road to tie Asia to Africa and Europe. Africa Report, 28.01.2016*.

Equation

$$T\_ij = A * (GDP\_i)^{(\alpha)} * (GDP\_j)^{(\beta)} * \exp(-\gamma * D\_ij * (1 - \delta * SR\_E)) \quad (1)$$

Where:

T_ij: Bilateral trade flow between countries i and j (2)

A: Constant term

GDP_i: Gross Domestic Product of the country I (3)

GDP_j: Gross Domestic Product of country j (4)

D_ij: Distance between countries i and j (5)

α, β, γ, δ: Parameters to be estimated (6)

SR_E: Silk Road Effect

(A measure of the expected reduction in trade costs due to the Silk Road) (7)

Discussion

Analyzing the true cost-benefit picture of China's railway investments in Africa requires a nuanced discussion. While increased trade and economic growth are potential upsides, critical questions remain. Will these benefits be evenly distributed within African countries? Could local industries be crippled by competition from imported goods? Are the created jobs sustainable and aligned with local skills? Are there concerns about labor exploitation or unfair wages? Finally, does the potential revenue from increased resource access outweigh the environmental and social costs of extraction? This complex cost-benefit analysis necessitates careful consideration of diverse perspectives to ensure sustainable development in Africa.

Social and Environmental Considerations

Managing the displacement and resettlement of communities is a complex issue with both challenges and positive developments. While a lack of qualified professionals and inadequate attention to social concerns can lead to insufficient compensation and livelihood restoration, there's a growing focus on minimizing relocation and involving communities in the decision-making process. On the flip side, fair labor practices and safety regulations often need strengthening, and environmental impact needs to be minimized through sustainable practices and responsible resource management. Overall, achieving positive outcomes requires a multi-faceted approach that prioritizes the well-being of affected communities and the environment alongside project development.

Transparency and Governance

A big question mark hangs over transparency in project selection, contracting, and finances in Africa. To combat potential corruption, African countries need to build their capacity to negotiate loan terms, manage projects, and hold all parties accountable. International organizations and civil society can play a crucial role by shining a light on these issues and advocating for good governance.

Long-Term Sustainability

African countries face the challenge of balancing the debt burden from infrastructure projects with long-term goals. Strategies like economic diversification beyond resource extraction are crucial. The success of these projects hinges on aligning them with community needs and fostering domestic technological and infrastructural expertise, allowing Africa to build its development path.

Beyond Cost-Benefit

While a cost-benefit analysis provides valuable insights, it is crucial to consider the broader geopolitical and strategic dimensions of these investments. How do these projects influence the power dynamics between China and African countries? Are there concerns about China's growing influence on the continent? What role can other international actors play in shaping the development trajectory of Africa and ensuring mutually beneficial partnerships? This discussion is just a starting point, and there are many other nuances and perspectives to explore. The author suggests that by engaging in open and critical dialogue, we can better understand the complex implications of China's railway investments in Africa and work towards ensuring they contribute to sustainable and equitable development for the continent.

Additionally, consider

To deepen our understanding of China's African railway investments, let's explore specific projects and perspectives. Whose voices matter most – local communities, African governments, or Chinese companies? We need solutions! Can alternative funding models or stricter environmental regulations mitigate concerns? By continuing this conversation, we can ensure these railways truly benefit Africa's development. The author encourages future stakeholders to share their thoughts and insights to continue this important discussion. China's railway diplomacy in Africa is a multifaceted strategy aligned with the Belt and Road Initiative, aiming to enhance economic ties, diplomatic relations, and global connectivity. The investment in railway infrastructure is seen as a means to boost economic growth, facilitate trade, and strengthen China's influence. However, concerns exist regarding the associated debt, environmental impact, and the need for local empowerment. The success of these projects depends on addressing these challenges, ensuring sustainability, and promoting regional integration. A comprehensive further discussion should explore the economic, diplomatic, and developmental aspects, potential alternatives, and diversification in funding sources.

Some potential implications across different areas

Economic and Social Impacts

China's railway investments in Africa bring both opportunities and challenges. Increased trade and improved connectivity could boost economic growth and create jobs, but concerns exist about unfair competition and the need for diversified trade partnerships. The study also addresses the debt burden associated with Chinese loans and suggests strategies for managing it. Additionally, the impact on access to resources and potential environmental consequences need to be carefully considered. On the social side, the study explores how railways improve access to goods, services, and markets, potentially enhancing livelihoods in rural areas. However, it also highlights potential problems like displacement, resettlement, and fair compensation for affected communities. The analysis also identifies issues with labor practices and safety standards, leading to calls for improved regulations and ethical treatment of workers. While improved connectivity could facilitate access to education and healthcare, concerns about cultural homogenization and the need for locally-driven development initiatives need to be addressed.

Geopolitical Considerations and Long-Term Goals

The study shed light on the geopolitical implications of China's investments, including concerns about transparency, accountability, and potential power imbalances. It also prompts discussions on diversifying Africa's global partnerships and ensuring mutually beneficial collaborations. Additionally, the analysis informs discussions on achieving the Sustainable Development Goals through these investments, ensuring they are inclusive, environmentally responsible, and contribute to long-term development in Africa.

Further research

The study might necessitate further research into how the impacts of railway diplomacy vary across different regions and countries in Africa, considering their unique economic, social, and political contexts. Alternative models and analysis could pave the way for exploring alternative financing and infrastructure development models that prioritize African ownership, sustainability, and community participation. Long-term impacts could initiate longer-term research to monitor the evolving socio-economic and environmental impacts of railway diplomacy in Africa, ensuring responsible development and addressing potential challenges. Remember, these are just some potential implications, and the actual impact will depend on the specific findings of the study. By critically analyzing the research and its conclusions, stakeholders can engage in informed discussions and contribute to shaping the future of Africa's infrastructure development and global connectivity.

Recommendations

Conduct country-specific CBAs considering the unique context and priorities of each African nation, Adopt a multi-criteria approach incorporating economic, social, and environmental factors, Ensure transparency and stakeholder participation throughout the CBA process, and Develop long-term monitoring and evaluation frameworks to track the actual costs and benefits of railway projects. By carefully considering these factors and challenges, a cost-benefit analysis will provide valuable insights into the potential impact of China's railway investments in Africa. For African Governments: Conduct thorough cost-benefit analyses: Carefully assess the potential economic, social, and environmental impacts of railway projects before entering agreements with China or any other investor. Prioritize transparency and accountability: Ensure open and competitive bidding processes, involve local communities in decision-making, and establish robust monitoring frameworks to track project implementation and outcomes. Negotiate sustainable financing models: Explore alternative financing options like public-private partnerships, blended finance, or grants to reduce reliance on debt and ensure long-term financial sustainability.

Develop robust regulatory frameworks: Implement regulations that ensure fair labor practices, environmental safeguards, and responsible resource management practices for railway projects. Focus on skills development and technology transfer: Collaborate with China and other partners to ensure projects contribute to building local capacity and expertise in infrastructure development and maintenance. For China: Increase transparency and address concerns: Enhance transparency in project selection, contracting, and financial management to address concerns about hidden costs and potential corruption. Adopt responsible financing practices: Offer more flexible financing options with lower interest rates and longer repayment periods to reduce debt burdens on African countries. Prioritize fair labor practices and environmental standards: Implement stringent labor and environmental regulations across all projects in Africa, ensuring fair treatment of workers, environmental protection, and community engagement. Work towards mutually beneficial partnerships: Engage in open dialogue with African governments and communities to understand their needs and priorities, working collaboratively towards achieving sustainable development goals.

For International Organizations and the Global Community: Provide technical assistance and expertise: Offer technical assistance and expertise to African governments to help them conduct thorough cost-benefit analyses, negotiate contracts, and develop robust regulatory frameworks for infrastructure projects. Promote best practices and ethical standards: Encourage China and other investors to adopt best practices in infrastructure development, adhering to international labor and environmental standards. Support alternative financing models: Advocate for and support alternative financing mechanisms for infrastructure development in Africa, promoting diversification of partnerships and reducing reliance on debt-based models. Monitor and assess long-term impacts: Collaborate with African governments and civil society to monitor the long-term social, economic, and environmental impacts of railway projects and advocate for necessary adjustments to ensure sustainable development. These recommendations aim to encourage responsible and sustainable development practices in Africa's infrastructure sector. Remember, achieving these goals requires active participation and collaboration from all stakeholders involved.

Conclusion: A Win-Win Outlook

It is worth mentioning that the role of Chinese private structures in the field of ensuring the security of African states is also causing concern (the number of these structures in Angola, Ethiopia, Nigeria, Sudan, South Sudan, Zimbabwe, and more recently Somalia is increasing). Carrying out large-scale capital investments, Beijing does not count on their quick payback, deliberately taking financial risks (*Embassy of the People's Republic of China in the Republic of South Africa All Rights Reserved*, 2023). In this regard, African experts express doubts about the success of these mega projects. Skeptics are opposed by those who believe that China's provision of loans and credits is the only way to help Africa achieve the Sustainable Development Goals (Cullifor and Ben Yahmed, 2016). For China, even if China and its firms, even if they cannot recoup their investments, they will still have the opportunity to compensate for the costs at the expense of African natural resources. Projects such as the Belt and Road Initiative (BRI) will also result in convenient and modern roads, ports, and other means of communication, ultimately contributing to the development of the PRC's economy (Ramasamy and C. H. Yeung, 2017; *Xinhua*, 2023).

There is no doubt that the China-Africa Cooperation Forum in 2015 and the speech given by Chinese leader Xi Jinping, who put forward a plan for Sino-African cooperation for 2016-2018, were the beginning of the final stage of China's long journey of becoming the main force on the continent. If this happens, China will get a whole continent with all its natural wealth and other resources. Already, about 20% of the crude oil imported by China comes from Africa. In addition, China imports other African minerals, as well as agricultural products. Also, in Africa, China has a huge market for its goods. But that's not all. Africa can become an extremely important link in the trade routes of planetary importance, the creation of which China is so keen on. When all the states of Africa join the New Silk Road, the ports of its eastern coast can be connected by rail to the ports of the western coast. So, the Maritime Silk Road will continue across the Atlantic Ocean and reach both Americas. This will then make the Chinese "economic belt" encircle the whole world.

Africa, of course, needs capital investments, but it is potentially a rich continent in terms of its provision of natural resources. Responding to those who believe that China is driving Africa into a "debt trap", Managing Director of the Chinese-African Project website Eric Olander stated: "You have to ask yourself, why China wants to impose debts on Africa? Africa is not rich in money, but it is a very rich continent, given the 54 votes in the UN and international organizations such as the World Bank, International Monetary Fund, World Health Organization, etc. These voices are vital for the Chinese, who sell many goods to Africans. To crush Africa with debts so that Africans are not able to buy anything that the Chinese produce simply does not make sense". The Governments and business circles of African countries generally positively assess China's role in solving the problems of the continent's economic development (Ben Mbarek, 2024).

The African partners note the high qualification and organization of the management personnel from China, strict discipline, and commitment during the implementation of most projects. Many African States are ready to participate in the BRI project, as it will contribute to increasing the region's economic potential by reducing trade barriers and implementing megaprojects, including the development of ports, the creation of modern railway and road infrastructure, and an industrial base. The BRI project will provide an opportunity for Chinese and African companies to work together during the implementation of projects along the Belt and Road. Such projects promote the activation of integration processes on the continent by expanding regional transport, industrial, cultural, and scientific ties and creating new prospects for cooperation (Foster and Briceño-Garmendia, 2009; Ranganathan and Foster, 2012; Ramasamy and C. H. Yeung, 2017).

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Abbreviations and Acronyms

- PRC: People's Republic of China
- BRI: Belt and Road Initiative
- GDP: Gross Domestic Product
- CGE: Computable General Equilibrium
- SR_E: Silk Road Effect
- (CBA): Cost-Benefit Analysis
- (TEU): Twenty-foot equivalent unit
- (CCECC): China Civil Engineering Construction Corporation

Currency Units

As mentioned, these are units of money used in different countries and economies. Some common examples include:

- USD: US Dollar
- EUR: Euro
- JPY: Japanese Yen
- RMB: Chinese Renminbi
- GBP: British Pound
- CAD: Canadian Dollar
- AUD: Australian Dollar
- NZD: New Zealand Dollar
- INR: Indian Rupee
- BRL: Brazilian Real
- MXN: Mexican Peso

There are countless other currency units worldwide, each with its unique symbol and exchange rate. Understanding currency units is important for international trade, finance, and travel.

Factors Influencing Property Tax Liability Compliance in Resilient Economy, Lagos Nigeria

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Abstract

Property tax liability as an actual burden of tax is assessed on the value of hereditaments within a rating jurisdiction. The study aimed at determining the factors influencing property tax compliance. The study employed descriptive and inferential techniques to analyse the data obtained from the questionnaire. The reliability test conducted indicated that the data used for the analysis were reliable considering that the Kaiser–Mayer–Olkin (KMO) is greater than 0.5 and Bartlett's test of sphericity is significant as indicated by the p-value of 0.000 of the Chi-square statistics. The result mean analysis revealed that level of income, level of education and available community services were ranked first and second factors that influence tax compliance. The result factor analysis identify five factors that constituted about 81.1% variance and these factors include economic, institutional, social, individual and socio-economic factors. the study concludes that attitudes of taxpayers towards compliance tend to be positive and responsive whenever the identified factors are addressed.

Keywords: Property tax, tax liability, tax compliance factors

Introduction

Property tax is synonymous to land tax. Property tax may be calculated annually in the form of a tax, rate, levy or charge. Property taxation, apart from providing a major source of government revenue, also serves various non-fiscal and regulatory functions (Kalu 2011). Property tax is veritable tool for revenue generation and source of finance particularly to local government expenditure (Aluko, 2005) .Property tax is a wealth tax, especially when it is levied annually on the value of property and it is a form of tax confined to land and building, and it is based on estimated market value or rental value for which property could be exchanged in the market (Munro, 2000; Wyam *et al.,* 2011).

Property tax liability is the actual burden of tax and it is assessed on the value of hereditament which may either be rental or capital value and hereditament is simply a property to be assessed for rating purposes. McClucksey *et al*., (2005) and Aluko (2005) have therefore

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classified property taxes in relation to tax base (i.e tax base which is simply the value of the assessed property either on land or building or improvement on land upon which tax rate or liability is applied) into four such as tax on rental value, tax on capital value, tax on income from property and tax on realizable again from the sale of land. The property tax liability is levied on occupier and property owner. It is an object of property tax liability is; land only, building only or land and building. Property tax liability is a tax gap that exists between the expected property revenue and realizable property tax revenue; it is basis for measuring tax collection efficiency and performance (Umar *et al.,* 2012). For tax purpose, the sole objective in defining tax liability is to make the tax collectable and to find a person to whom the taxing authority can apply sufficient leverage to extract the tax. Also compliance theory that is based on equity theory dictates that addressing inequities in the exchange relationship between government and taxpayers would result in improved compliance (McKerchar & Evans, 2009; Gurawa & Mansor, 2015). Citizens may not consider their relationship with the state in a vacuum where both parties are the only actors. Likewise, they may not think about their fellow citizens without considering their own relationship with the state. They may also consider how the state treats them relative to their fellow citizens. This judgment is likely to affect not only their judgment of the state, but also how they view their fellow citizens (D'Arcy, 2011).

Promoting property tax compliance involves the empowering or strengthening key factors such as improving services made to the taxpayers by providing them with clear instructions, understandable forms, and assistance and information as necessary. James and Alley (2004) assert that tax compliance is very important in the whole process of collecting tax revenues. Monitoring tax compliance is very important and requires proper maintenance of taxpayer current accounts and management information systems. Gemmel and Hasseldine (2014), tax compliance is generally concerned with tax evasion, tax avoidance, compliance and non compliance. The proper means of achieving tax compliance need to be designed in such a way that can help to deal with tax evasion and tax avoidance. Lubua (2014) reveals that awareness of tax laws, business experience and the integrity of employees together with training needs are very important in compliance process. The study therefore aimed at examining the factors influencing property tax compliance with a view to improving property tax revenue generation in the state.

Literature Review

Fischer’s tax compliance model provides a framework for understanding the influence of those socio-economic and psychological components on taxpayers’ compliance decision; Chan (2000). Fischer’s model is a single model, which integrated economic, social and psychological factors and a viable conceptual framework for understanding tax compliance behavior. Alm (1999) contended that no single model can account for the enormous factors influencing tax compliance decision and submitted that other factors may well be relevant in explaining tax compliance behavior. The Fischer model suggests major considerations for altering taxpayers’ attitudes and perceptions to tax compliance. These are the fairness of the tax system and peer influence. It is widely believed by tax administrators and the taxpayers that growing dissatisfaction with the fairness of tax system is the major causes for increasing tax noncompliance. Chan and Leung (2009) stated that demographic factors such income, level of education and ethnic composition and religious beliefs influence the taxpayer’s perceptions regarding tax payment. These factors are categorized by Fischer and associates (Fischer *et al.,* 1992) into 4 groups.

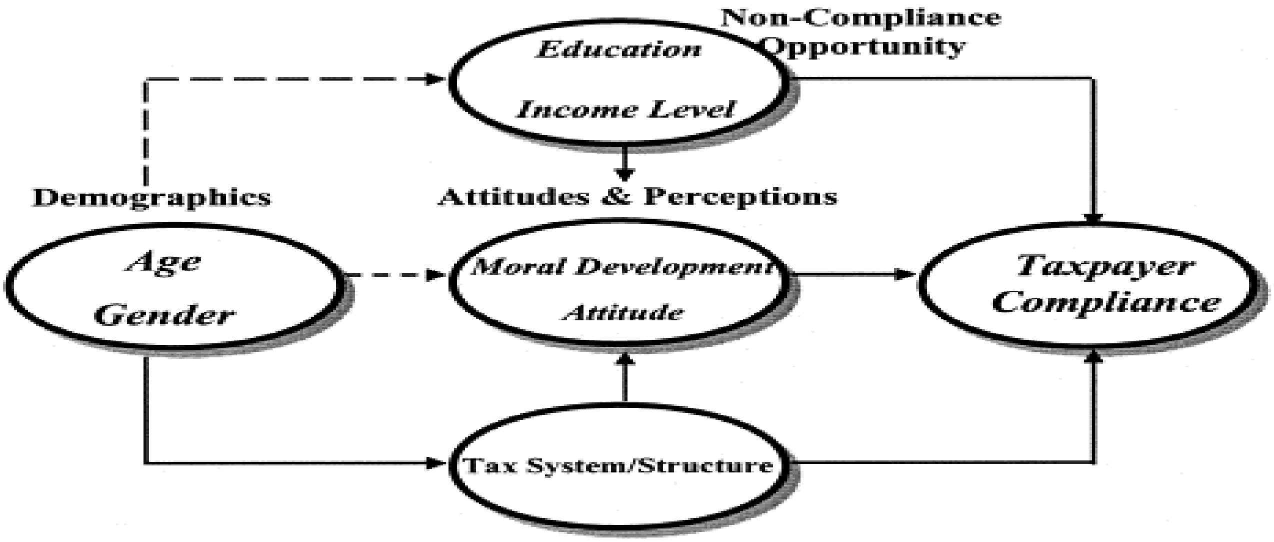

Figure 2.1: Fischer's Model of Tax Compliance Behavior

Source: Fischer *et al.* (1992)

Thiga and Muturi (2015) divulged that tax rate and tax compliance cost are very significant aspects of tax compliance and tax awareness to tax payers. Administrative and compliance cost are very important aspects of tax compliance and should not be ignored when designing efficient and effective compliance strategy. Ariffin and Ichis (2011) reveal further that tax payers' attitude on tax evasion has positive relationship with compliance behavior. In a broad sense, it can be argued that some tax payers do comply with tax laws not only because they want to comply, simply because they understand the importance of tax and tax compliance for the prosperity of the nation.

The division of determinants of property tax liability compliance into these categories is based on Kirchler (2007) and Loo (2006) in which they approached tax compliance from an interdisciplinary perspective which represents a wider perspective of tax compliance determinants compared to other researchers. For example, Kirchler (2007) divided tax compliance determinants into five categories and the study was based on psychological and tax authority-taxpayers' view namely, political perspectives, social psychological perspectives, decision making perspectives, self employment and interaction between tax authorities and taxpayers. Kirchler (2007) also suggests that there was a significant relationship between tax rates and evasion due to tax rates being used as an instrument that can be manipulated for policy goals in particular. McKerchar and Evans (2009) suggested that the degree of trust between taxpayers and the government has a major role in ascertaining the impact of tax rates on compliance. When trust is low, a high tax rate could be perceived as an unfair treatment of taxpayers and when trust is high, the same level of tax rate could be interpreted as contribution to the community (Kirchler *et. al.,* 2007). Adebisi and Gbegi (2013) proper use of public funds has strong influence on enhancing tax morale and compliance for tax payers. Therefore, the efficient and effective provision of quality public goods has embedded effect on lessening tax evasion and tax avoidance.

Kelly (2013) found that property tax reform should be structured as an integral part of broader public sector management reforms, such as fiscal decentralization and governance, public financial management, local government and urban development reform. This would mobilize key stakeholders and resources, minimize political, administrative and taxpayer opposition and generate the synergy needed to design, implement and sustain a successful property tax reform.

Factors Affecting Property Tax Liability

Stucere and Mazure (2012) assessed the peculiarities associated with property tax and factors affecting the amount of property tax liability in Latvia, the study utilized descriptive analytical method to investigate the procedures employed by State land Service to determine the cadastral value as basis for property tax. The study found out that amount of property tax is limited on the condition that after updating the cadastral value, the amount of property tax exceeds the calculated amount of property tax for previous year, the study concludes that system of property tax contradicts basic principles of uniformity and justice and the study recommends for revaluation of procedures for changing in cadastral value. Birskyte (2013) assessed the determinants of the property uniformity in Vilnius, Lithuanian. The study employed regression analysis to test the factors that contribute to the variation in property tax. The result of the analysis revealed that economic structure and condition are the most determinants of property tax assessment. Awunyo-Vitor *et al.,* (2015) examined the determinants of property tax defaults in Ashanti region, Ghana. The study employed multi-stage sampling techniques to sample 540 respondents across the region. The study utilized the descriptive and regression analysis to anaysed the data. the result showed that lack awareness and high tax rate as reasons for default and the study further revealed that income level, property value and property location significantly influenced the rate of default, and raising in awareness of property tax is recommended.

Conclusively, these aforementioned studies have dwelled on the factors that determine the property liability non-compliance or default but there are other factors which the existing studies have not considered which this intends to consider such as socio-economic factors, institutional, physical factors and value of hereditament. In summary, taxpayer's perceptions are potentially important in determining their compliance behaviour. Therefore, from previous literature, tax compliance determinants from an economic perspective, discussing results of previous studies that have suggested that tax rates, tax audits and perceptions of government spending have influenced taxpayers' compliance behaviour.

Methodology

The study randomly selected property owners across Lagos state. The study utilized primary sources of data. The study requires both descriptive and inferential method of analysis. Descriptive analysis for the study featured the use of mean and the use Relative Important Index (RII). Inferential method for the study will comprised principal component analysis.

	Population	**Sample Size**	**Number of Questionnaires Administered**	**Number of Questionnaires Returned**
Lagos Mainland	4105	951	951	725
Lagos Island	3730	1071	1071	810
Apapa	3815	958	958	671
Etio-osa	4750	1100	1100	769
Surulere	2008	759	759	593
Ikeja	4680	1030	1030	737
Total	**23,088**	**5869**	**5869**	**4305**

Factor Analysis: Factor analysis (Principal Component Analysis) is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. Factor analysis aim to reduce the dimensionality of a set of data.

$$y_{ij}= \nu_j+ \lambda_{j1} \eta_{i1}+ \lambda_{j2} \eta_{i2}+ \dots + \lambda_{jk}\eta_{ik}+ \dots + \lambda_{jm}\eta_{im}+ \varepsilon_{ij} \qquad 1$$

where $\nu_j$are intercepts, λ_{jk} are factor loadings η_{ik} are factor values ε_{ij} are residuals with zero means and correlations of zero with the factors

Results

The result of demographic information of respondent presented in Table 4.1 showed the income level, age, occupation and level of education of respondent in Lagos. The result revealed that more than 50% of the respondents earned the income that is more than N100,000. The majority of the respondents fall within the age bracket of 46-60years which is an active population, in other word more 40% of the respondents fall within 46-60years. More than 50% majority of respondents were in private service except in Apapa. More than 50% of the respondents had first degree except Lagos island where majority had master degree. This indicates majority of respondents sample for this study average income earners who fall within the active population with first degree in education.

Table 1 Demographic Information of Respondents in Lagos

Demographic information	Lagos Mainland		Lagos Island		Apapa		Eti-Osa		Surulere		Ikeja	
Income level	N	%	N	%	N	%	N	%	N	%	N	%
18000-30000	90	12.4	-	-	-	-						
31000-50000	91	12.6	-	-	50	7.5	75	9.8				
51000-100000	181	25	350	43.2	200	29.8	254	33.1	183	31	237	32.2
100100 and Above	363	50	460	56.8	421	62.7	440	57.1	410	69	500	67.8
Total	725	100	810	100	671	100	769	100	593	100	737	100
Age												
18-30yrs	-	-	-	-	-	-	51	6.6	-	-	86	12
31-45yrs	184	25.3	212	26.2	150	22.4	130	16.9	-	-	314	42
46-60yrs	360	49.7	498	61.5	446	66.5	450	58.5	387	65.3	300	41
61 and Above	181	25	100	12.3	75	11.1	138	17.9	206	34.7	37	5
Total	725	100	810	100	671	100	769	100	593		737	100
Occupation												
Private	400	55.2	410	51	300	44.7	500	65	350	59	520	71
Public	325	44.8	400	49	371	55.3	269	35	243	41	217	29
Total	725	100	810	100	671	100	769	100	593	100	737	100
Level of Education												
Primary/secondary	-	-	-	-	-	-	-	-	-	-	-	-
ND/NCE	-	-	-	-	-		-	-	--	-	-	--
HND/BSC	425	58.6	390	48	370	55.14	469	61	380	64.1	400	54.3
M.tech/Bsc	300	41.4	420	52	300	44.71	300	39	210	35.4	337	45.7
Phd	-	-		-	1	.15			3	.5		-
Total	725	100	810	100	671	100	769	100	593	100	737	100

Source: Field Survey, 2021

The analysis of the opinion of taxpayers on the determinants of property tax liability is presented in table 2 was conducted on 5-point likert. The benchmark that represents minimum acceptable level of agreement is determined by Ikediashi, Ogunlana, and Boateng, (2014), and is calculated as (5+4+3+2+1= 15/5=3). The cronbach's alpha revealed that there is high level of internal consistent among the variables which suggest that there is high level of reliability in the data employed for the study at 85% in Lagos.
The result revealed that level of education and income level were ranked first as major determinant of property tax liability across the study areas having highest relative important index at 93%. Availability of community services is ranked second the most important determinant of property tax liability across the study areas with relative important index of 92% at 4.60 mean. Age of the property is also found third determinant factor in Lagos with relative important index of 90% equivalent to 4.53 average responses.

Table 2 Factors Influencing Property Tax Compliance

Determinant factors	Lagos(Cronbach alpha @.85)				
	N	Sum	Mean	Rk	RII
Tax Rate	4305	17004	3.9515	9	.79
General economic condition	4305	16359	3.8061	11	.76
Personal financial constraint	4305	18511	4.3394	5	.86
Property Investment Income	4305	12121	3.5636	13	.71
Value of the property	4305	14335	4.3394	5	.86
Efficiency of the tax authority and government	4305	18253	4.2424	6	.84
Equality and fairness	4305	17607	4.0970	7	.82
Level of government spending	4305	19588	4.5576	4	.91
Awareness of Offences and Penalty	4305	14297	3.3212	15	.66
Resident Attitude to Property Tax Payment	4305	17607	4.0970	7	.82
Property market constraint	4305	16574	3.8545	10	.77
Political status	4305	16929	3.7333	12	.74
Availability of community services	4305	19803	4.6061	2	.92
Cultural factor	4305	17090	3.9758	8	.79
Individual Income Level	4305	19932	4.6303	1	.93
Age of the property	4305	19501	4.5333	3	.90
Level of education	4305	19932	4.6303	1	.93
Valid N (listwise)	4305				

KMO (Kaiser-mayer-Olkin measure of sampling adequacy) and Bartlett's test of sphericity are validity and reliability test. It is considered importance to test sampling adequacy for the purpose of further analysis and to test hypothesis of of non- correlation matrix in the factor analysis. Table 3 is the table that precedes factor analysis and it shows the result of KMO (Kaiser-mayer-Olkin measure of sampling adequacy) and Bartlett's test of sphericity. In order to establish the strength of the factor analysis solution, it is therefore essential to establish the reliability and validity of the reduction through KMO and Bartlett's test of sphericity. Bartlett's test of sphericity for the significance of the correlation matrix of the variable indicated that the correlation coefficient matrix is significant as indicated by the p-value of 0.000 corresponding to the chi-square statistics. This suggests a rejection of the hypothesis that correlation matrix of the variables is insignificant. This is because; the p-value of 0.000 is less than the assumed level of significance of 0.05. Also the value KMO is greater than 0.5 which further suggest that factor analysis can used for the given set of data.

Table 3 KMO and Bartlett's Test

Validity and Reliability Tests			
Lagos	Kaiser-mayer-Olkin Measure of Sampling Adequacy		0.725
	Bartlett's test of Spericity	Approx.Chi.q	81.001
		d.f	24
		Sig	.000

The analysis required the first five components to be extracted and the first five components form extracted solution and the most highly emphasized determinant factors of property tax liability. The extraction of sum of the square loadings in the second section explained the variability in original 17 variables. The extracted components explained 81.1% variability in the original variables. Therefore, this study considerably reduce the data by selecting the extracted components as the most emphasized factors or components with the minimum of 18.9% loss of information.

Total Factor Variance Explained in Lagos

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.375	25.735	25.735	4.375	25.735	25.735	2.944	17.318	17.318
2	3.497	20.571	46.306	3.497	20.571	46.306	2.935	17.265	34.583
3	2.580	15.178	61.484	2.580	15.178	61.484	2.806	16.508	51.091
4	1.854	10.907	72.391	1.854	10.907	72.391	2.796	16.450	67.540
5	1.481	8.710	81.100	1.481	8.710	81.100	2.305	13.560	81.100
6	.923	5.430	86.530						
7	.674	3.966	90.496						
8	.476	2.801	93.297						
9	.434	2.554	95.851						
10	.296	1.741	97.592						
11	.189	1.113	98.705						
12	.100	.589	99.293						
13	.058	.338	99.632						
14	.045	.266	99.897						
15	.017	.103	100.000						
16	2.887E-015	1.698E-014	100.000						
17	-8.886E-016	-5.227E-015	100.000						

Extraction Method: Principal Component Analysis.

The result of analysis of determinants of property tax liability presented in table 4.24 revealed that the five factors were loaded constitutes about 81.1% variance in the determination of property tax liability in Lagos. The cut-off point for this study is taken 0.5 and above as general rule of thumb applied. The most important factor is economic factors and it explained 25.735% variance across 17 determinants, this suggests that economic factors such as tax rate, general economic condition, property investment income, level of government spending, and value of property asset contributes majorly the variance in the determinants of property tax liability. Factor two (2) is institutional factors and it explained about 20.571% variance in the determinants of property tax liability and such institution factors comprise of property market constraints and efficiency of tax authority and government. Factor three (3) is named as social factors, and it explained 15.178% variance in the determinants of property tax liability. Such social factor comprises of equity and fairness, resident attitude to property tax payment, cultural belief and availability of community services. Factor four (4) is named as individual factor and it explained 10.907% variance in the determinants of property tax liability. Such individual factors comprises of awareness of offences and penalties, personal financial constraint and political status. Factor five (5) is socio-economic factors, and it explained 8.710% variance in the determinant of property tax liability, such socio-economic comprises of individual income level, age of the property and level of education.

Factor Loading analysis of determinants of Property Tax Liability Compliance in Lagos

Determinants	Factor loadings	Eigen value	% of variance
Factor 1: Economic Factors:		4.375	25.735
Tax rates	.964		
General economic condition	.943		
Property Investment Income	.907		
Level of government spending	.905		
Value of property Asset	.704		
Factor 2: Institutional Factors		3.497	20.571
Property market constraint	.925		
Efficiency of the tax authority and government	.893		
Factor 3: Social factors		2.580	15.178
Equity and Fairness	.932		
Resident Attitude to Property Tax Payment	.916		
Cultural beliefs	.687		
Availability of community services	.749		
Factor 4: Individual Factors		1.854	10.907
Awareness of Offences and Penalties	.871		
Personal financial constraint	.865		
Political status	.851		
Factor 5: socio-economic factors		1.481	8.710
Individual level of Income	.738		
Age of the Property	.672		
Level of Education	.608		

Summary of Findings and Conclusion

The study further analyzed factors influencing property tax liability and found out that level of education, income level, availability of infrastructure and age of the property were among the first-fourth determinants of property tax liability to be reckoned with by the property taxpayers. The level of agreement further revealed a consensus of opinion among the taxpayers that level of education of taxpayers and cultural belief were indispensable factors that need to be addressed. This is because, the level of awareness of benefits and understanding purpose of taxation is important in improving tax compliance. Further it is understood that five factors constituted about 81.1% variance in determining the tax compliance, these five factors include economic, institutional, social, individual and socio-economic factors. Conclusively, it is not doubt that whenever property tax system is made simple with clear process, attitudes of taxpayers towards compliance tend to be positive and responsive. Also transparency and accountability under institutional factor is necessary condition for restoring public confidence, effectiveness of tax authority and government institutional policy on property market have long term effect on compliance to property tax liability, therefore having sustainable and property market-friendly policies tend to encourage compliance toward property tax. Socio-economic status especially income level and education status play significant role in property tax liability compliance, in that, first property market-friendly policies is geared toward protecting property investment for improving income level which in turn encourage compliance.

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TRACK 2: ESG/CSR AND SUSTAINABILITY OF PUBLIC AND PRIVATE SECTOR INSTITUTIONS IN AFRICA

Assessing Barriers to Sustainable Public-Works Procurement Compliance at the Tender Evaluation Stage in Ghana

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Abstract

Existing studies indicate that the construction sector is critical to the integration of sustainable public-works procurement towards the achievement of the Sustainable Development Goals 12.7 (SDGs). However, significant impediments to effective and efficient compliance with sustainable public-works procurement exist. The focus of this study is to identify the specific barriers to compliance with Sustainable Public-works Procurement. Through a scientific literature review and questionnaire survey, seventeen (17) barriers were identified and analyzed using the Principal Component Analysis (PCA) variant of factor analysis to assess the significant barriers to sustainable public-works procurement. Four clusters of factors were concluded as critical barriers to compliance with sustainable public-works procurement at the tender evaluation stage. (1) sustainable adaptability cluster; (2) managerial challenges cluster; (3) knowledge incapacity cluster; and (4) legal, policy, and evaluation cluster. The study presents a basis for experts along with researchers to appreciate the barriers to compliance and the need to improve compliance with sustainable public-works procurement in Ghana. The study adds to the pool of knowledge and provides the first survey on the specific barriers that inhibit compliance with sustainable public works procurement at the tender evaluation stage in Ghana.

Keywords: Public-works; Procurement; Sustainability; Barriers; Compliance

Introduction

Sustainable Development is the adoption of sustainable principles in the built environment to meet the present needs of humankind, without compromising the future generation's ability to meet their own needs (Berry and McCarthy (2011). Contemporary public procurement acts as a catalyst for promoting good governance and sustainable development by optimizing resources, enhancing project delivery, fortifying public procurement systems, and fostering stakeholder

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participation to promote the country's social, environmental, and economic policies (Adjei-Bamfo and Maloreh-Nyamekye, 2019; Adjei, 2010). Governments around the world have relied heavily on public procurement due to the substantial amount of procurement expenditure on the economy and as such must be well handled (Thai, 2009). Mahmood (2010) agreed by indicating that public procurement represents 18.42% of the world GDP. Furthermore, the Ghanaian construction industry generated 14.34 percent of the country's GDP on average, and it is the second highest contributor in terms of jobs created between 2009 and 2013 (Ghana Statistical Service, 2018). However, Construction has an impact on the economy, society, and the environment, and multiple authors have noted that it underperforms in all three main elements of sustainability: social, economic, and environmental (Bratt et al., 2013; Tsai and Chang, 2012). Thus, both industrialized and underdeveloped nations are taking measures toward incorporating sustainable procurement criteria into the country's national procurement (Islam et al., 2016). Despite these endeavors, the primary barriers to the compliance of sustainable public procurement have been identified as the misconduct of procurement officers and non-adherence to procurement policies and procedures (Gelderman et al., 2006). In a study conducted on sustainability standards in public procurement, Montalban-Domingo et al., (2018) argue that the lack of objective evaluation of sustainability compliance during sustainable public-works procurement evaluation is the main obstacle faced in the integration of sustainable public procurement. Also, the lack of empirical studies on the specific barriers that hinder sustainability compliance at the tender evaluation stage of public procurement is a major gap in the scientific literature. In 2016, the Public Procurement Authority of Ghana amended its objective to align with the Sustainable Development Goals, specifically target 12.7 which focuses on sustainable procurement. The amendment seeks to guarantee that public procurement is carried out in a manner that ensures environmentally and socially sustainable procurement (PPA, Act 663 as Amended Act 914, 2016). Despite these enormous efforts and resources invested in this regard, success has been slow and stagnant, especially in sustainable procurement (Montalban-Domingo et al., 2018; Bratt et al., 2013). Against this background, this research seeks to explore the barriers to compliance with Sustainable Public-works Procurement at the Tendering stage.

Literature Review

Sustainable Public Procurement

Public procurement constitutes 18.42 percent of the global Gross Domestic Product (Mahmood, 2010) and is progressively acknowledged as vital in enhancing service delivery in developing countries (Basheka and Bisangabasaija, 2010), representing a substantial proportion of overall expenditures. They further stated that public procurement constitutes 60% of the Kenyan government's expenditures, 58% in Angola, 40% in Malawi, and 70% in Uganda (Government of Uganda, 2006), making it the second-largest expenditure in Tanzania after employee salaries (NPPP, 2012). Several countries have begun to change their procurement systems in recent years to simplify and harmonize their legal and institutional frameworks (Vitor, 2015). In Ghana according to Section 3 of the PPA Act, Act 663 as Amended Act 914, 2016, Procurement is defined as the process where a procurement entity purchases, employs, leases, or otherwise acquires goods, work, or services, and/or a procurement entity that acquires goods, construction, or services. This contains all functions related to procurement such as the specification of requirements, selection, and invitation of tenders, contract drafting, awarding, and management.

In recent years, both the public and private sectors have recognized the need for sustainable procurement as a well-positioned means to aid the commercialization of the built environment. The connection between procurement and sustainability is intricate, necessitating additional research to ascertain effective methods for aligning these two objectives. (Laryea et al. 2013). The notion of sustainable development is commonly categorized into three components: environmental sustainability, economic sustainability, and social sustainability. To improve the link between procurement and sustainability thereby attaining sustainable procurement, it is important to balance economic, environmental, and social considerations in procurement. Mensah and Ameyaw (2012), posited that developing a sustainable procurement strategy necessitates the ability to describe the circumstances under which a procurement process qualifies as sustainable. The Whole Life Cycle approach, they claim, is one means for measuring sustainable procurement. Researchers like Agbesi et al. (2020) and Mensah and Ameyaw (2012) explained sustainable procurement as a process where the client and collaborating organizations meet design and development requirements in a manner that ensures value for money throughout the entire project life cycle. This approach aims to generate benefits for project stakeholders, society, and the economy, while simultaneously minimizing environmental harm.

They also indicated that it involves procedures and measures to ensure value for money throughout the entire life cycle, counting for the profitable, environmental, social, and ecological issues associated with the procurement of goods, works, and services while causing no or little detriment.

Sustainable Public Procurement in the Construction Industry

As stated by Bamgbade et al. (2017), the construction sector significantly contributes to a nation's economic and social advancement, but concurrently imposes substantial environmental harm. Bo et al. (2015) highlight that the construction industry accounts for approximately 10% of the global economy. Xia et al. (2015) emphasize that due to its vast size, extensive resource consumption, and profound impact on the built, natural environment, and society, the construction industry plays a pivotal role in embracing sustainable development principles. The industry contributes to long-term progress by providing human (labor), social (welfare), and environmental capital. Rode et al. (2011) reveal that roughly 10% of global energy consumption is used for producing building materials. Construction and demolition activities generate over 40% of solid waste in developed nations, while construction materials contribute to about 40% of total global greenhouse gas emissions.

In Ghana, the construction sector contributes an average of 14.34% to the country's Gross Domestic Product, as reported by the Ghana Statistical Service (2018), which emerged as the second largest job creator between 2009 and 2013. Despite these insights, the construction industry has struggled to fully integrate sustainable principles into their procurement choices (Islam et al., 2016). Scientific literature indicates that the construction industry lags behind other sectors in the adoption and implementation of sustainability measures, as observed by Brennan and Cotgrave (2014).

Governments at national and international levels are under significant pressure from various organizations to formulate and enact policies and strategies for sustainable procurement (Islam et al., 2016; Wong et al., 2016; Meehan and Bryde, 2015). The growing legal and regulatory concerns are pushing institutions to adopt sustainable procurement strategies for reduced environmental impact (Islam et al., 2016). It is widely acknowledged that clients not only influence the selection of building materials but also impact the choice of stakeholders, including consultants and contractors. Such a decision-making process can largely affect the adoption of sustainable sourcing practices (Wilkinson et al., 2015; Glass et al., 2011). Given this, active participation from government entities in the construction sector is essential for formulating and executing SP policies that prioritize sustainable development principles (Islam et al., 2016).

Barriers to Sustainable Procurement Compliance

Despite Global and national efforts to integrate sustainability in public procurement, there are still obstacles that vitiate these efforts, particularly at the tendering stage of the public-works procurement. Barriers to sustainable procurements encompass challenges in altering procurement practices, a lack of contractors offering sustainable projects, products, or services, complexities in conducting cost/value assessments, challenges in integrating factors beyond environmental considerations, and a perception that the process and outcomes are more expensive or time-consuming (UN, 2016). The most constantly cited barriers to sustainable procurement include the perception that it increases costs, a limited understanding of the necessity for sustainable procurement and its associated processes, insufficient expertise, client risk aversion, regulatory constraints, leadership challenges, and inertia (Sustainable Development Commission, 2004). Also, regular practice of an organization establishes a sense of dependability, making processes habitual. Consequently, changes become more challenging, as it would disrupt the established routine (Meehan and Bryde, 2011; Belfast et al., 2011). Another issue is the provocation of conflict. Procurement professionals may feel compelled to disagree with the sustainable procurement plan. This might indicate a contradiction between the constraints on workers and the more vital driving force prompting them to continue the other conventional approach.

The third hedge is a hollow formality. Though numerous companies validate sustainable procurement strategies in their periodic reports, it would be intriguing to learn how important these programs impact procurement opinions within a company. Ruparathna and Hewage (2015) observed in a study that the absence of sustainability criteria in tender assessment was the most critical debit of sustainable procurement. Other factors include a need for more traditional procurement styles and an understanding of the actual reality. According to McMurray, (2014), the main issues militating against sustainable procurement were a lack of capability, a lack of coffers, a lack of a long-term approach to procurement choices, a lack of assistance, and a lack of political backing. A study by Adham and Siwar (2012), revealed that challenges in measuring SP technologies mainly revolve around criteria at the tender evaluation stage including the choice of metrics and scoring methods. Opoku et al. (2019) also examined obstacles impeding built environment consultants in promoting the environmental sustainability (ES) of construction projects. The main findings from their research encompass perceived initial cost, limited understanding of environmentally sustainable (ES) practices, technological challenges, external influences affecting the adoption of environmental sustainability (ES) approaches, and environmental circumstances in developing countries. Ayarkwa et al. (2020) investigate obstacles to implementing environmentally sustainable procurement in public universities. The study findings indicate that eight primary barriers impede the effective adoption of environmentally sustainable procurement in public universities. These obstacles include inconsistencies in decision-making, centralization/decentralization challenges, resistance to change, challenges in interacting with government agencies, collaboration among stakeholders, deficient planning, insufficient budget allocation, and a lack of training for procurement professionals and suppliers. Using Ghana as an example, Mensah and Ameyaw (2012) contended that to achieve sustainable procurement in a developing nation, the following obstacles need attention: inadequate internal management structures supporting sustainable procurement, insufficient social commitment from key stakeholders, a lack of technical and management capacity, an ineffective stakeholder management approach, high initial costs linked to green products, insufficient stakeholder education, a lack of government interest and political will, corruption among procurement practitioners, and restricted capacity for small-scale suppliers and contractors.

They concluded that the primary barriers to sustainable procurement practice in Ghana were insufficient comprehension of the sustainable procurement concept and higher initial costs associated with sustainable procurement. In the context of another developing country, Ross (2012) identified barriers as a legal framework and guidelines that discourages sustainable public procurement, inadequacies in capacity, guidance materials and practical tools, the complication of sustainable public procurement, perceived increased costs, and rigid budgetary mechanism. Given that the degree of implementation and the hurdles to implementation differ by country, the goal of this study is to examine the specific factors that constitute barriers to compliance with Sustainable Public-works Procurement at the tendering stage in Ghana.

Table 1. List of barriers from previous publications

Item	Barriers	References
1	Lack of knowledge and awareness of sustainability concepts and practice	Oyewobi and Jimoh (2022); Murphy et al. (2021); Dza et al. (2021); Ayarkwa et al. (2020); Oluwabukunmi et al. (2019); Opoku et al. (2019); Sourani and Sohail (2019); Wanner and Probstl-Haider (2019); Iles and Ryall (2016); Djokoto et al. (2014); Mcmurray et al. (2014); Sourani and Sohail (2011)
2	Perception of higher initial associated costs on sustainable projects	Murphy et al. (2021); Opoku et al. (2019); Wanner and Probstl-Haider (2019); Djokoto et al. (2014); Bangdome-Dery et al. (2014); Laryea, et al. (2013); Mensah and Ameyaw, (2012); Sourani and Sohail (2011)
3	Reluctance in embracing new knowledge or Resistance to change	Oyewobi and Jimoh (2022); Dza et al. (2021); Sourani and Sohail (2019); Oluwabukunmi et al. (2019); Iles and Ryall (2016), Sourani and Sohail (2011); Djokoto et al. (2014)
4	Lack of regulatory framework for sustainable public procurement	Oluwabukunmi et al. (2019); Wanner and Probstl-Haider (2019); Murphy et al. (2021); Djokoto et al. (2014); Sourani and Sohail (2019)
5	Insufficient time to address sustainability issues	Oyewobi and Jimoh (2022); Jimoh, (2022); Dza et al. (2021); Sourani and Sohail (2019); Oluwabukunmi et al. (2019); Sourani and Sohail (2011)
6	Inadequate training and education in sustainable procurement	Oyewobi and Jimoh (2022); Opoku et al. (2019); Mensah and Ameyaw (2012); Djokoto et al. (2014)
7	Lack of motivation or incentives for the implementation	Oluwabukunmi et al. (2019); Opoku et al. (2019); Djokoto et al. (2014)
8	Slow uptake on sustainable public procurement concept	Asman et al. (2019); Woodcraft (2012); Boschetti et al. (2012)
9	lack of planning and coordination,	Murphy et al. (2021); Wanner and Probstl-Haider (2019)
10	Corruption among procurement practitioners	Oluwabukunmi et al. (2019); Mensah and Ameyaw (2012)
11	lack of expertise	Murphy et al. (2021); Wanner and Probstl-Haider (2019); Djokoto et al. (2014)
12	Vagueness of sustainability definitions and interpretations	Dza et al. (2021); Sourani and Sohail (2019); Sourani and Sohail (2011)
13	Insufficient research and development on Sustainable Procurement	Dza et al. (2021); Sourani and Sohail (2019); Sourani and Sohail (2011)
14	Lack of government/political will	Oyewobi and Jimoh (2022); Mensah and Ameyaw (2012)
15	Lack of sustainability measurement tools	Oyewobi and Jimoh (2022); Djokoto et al. (2014)
16	Insufficient understanding of the Sustainable Procurement Concept	Mensah and Ameyaw (2012)
17	Lack of sustainable technologies	Opoku et al. (2019); Djokoto et al. (2014)

18	Lack of human resources capacity	Oluwabukunmi et al. (2019)
19	Cognitive abilities	Griessler and Littig (2005)
20	Lack of enforcement of relevant laws	Oluwabukunmi et al. (2019)
21	Lack of demand from stakeholders on sustainability incorporation	Djokoto et al. (2014)
22	Lack of expertise	Djokoto et al. (2014)
23	Lack of government support	Djokoto et al. (2014)
24	Inadequate database and access to information	Djokoto et al. (2014),
25	Less priority on sustainability	Bangdome-Dery et al. (2014)
26	Lack of design and construction team	Opoku et al. (2019),

Source: Author construct, (2023)

Research Method

Approach/Strategy

Mix-method research involving literature review, interviews, and questionnaire survey was adopted. As a result, qualitative and quantitative paradigms were utilised. The first stage was conducted using a qualitative research approach. Based on the comprehensive literature review, semi-structured questions were asked of Nine (9) experts (construction professionals and researchers in procurement and sustainable development from public universities and consultancy firms) possessing a minimum of ten years of experience in the construction industry. These experts were asked to comment on whether the barriers indicated in the literature apply to the Ghanaian construction industry and to aid in the improvement and merging of pertinent barriers to sustainability compliance at the tender evaluation stage of works procurement. The interviews validated the existence of 17 barriers, with nine barriers either rejected or integrated into the identified barriers in the questionnaire.

Sampling technique and sampling size

The selection of respondents for questionnaire administration utilized purposive sampling. (Fellows and Liu, 2015) Professionals who have been involved in the procurement of public-works at the public universities in Ghana. This includes procurement professionals at the universities physical and development offices, consultants on university projects and sustainable construction experts. A total of 96 surveys were administered purposefully online (using Google forms) and in person.

Analysis of data

Quantitative analysis of the survey data was conducted using the IBM Statistical Package for Social Scientists (SPSS) Version 23. As outlined by Dawson (2019), this methodology allows for the quantitative exploration of a diverse range of respondent opinions. Furthermore, utilizing this approach improves the overall applicability of research findings and outcomes (Tezel et al., 2018). Principal Component Factor Analysis (PCFA) was used to examine the fundamental connections between the identified barriers.

Results and discussions

Respondents Biodata

Respondents were requested to submit general information, to better inform the researcher about the reliability and validity of the responses being gathered, such as their greatest degree of education and years of experience in their respective field. They were also asked if they had any experience with sustainable procurement training. Table 2.10 provides an accurate overview of the data gathered.

Table 2.10: Background of the respondents for the questionnaire survey

Respondent Background	Frequency	Percentage
Educational level		
HND.	4	4.2
BSc.	14	14.6
MSc.	52	54.2
Ph.D.	26	27.1
Professional position		
Quantity Surveyor	48	50.0
Engineer	14	14.6
Architect	16	16.7
Procurement Officer	10	10.4
Project Manager	8	8.3
Years of Experience		
Less than 3 yrs	2	2.1
3 - 6 yrs	2	2.1
6 - 9 yrs	20	20.8
10 years and above	72	75.0
Building Projects Undertaken During the Last Six Years		
1-5 projects	25	26.0
5-10 projects	27	28.1
10- 15 projects	35	36.5
15-20projects	9	9.4
Any Training in Sustainable Procurement?		
Yes	32	33.3
No	64	66.7

Source: Field survey, (2023)

4.2 Barriers to Compliance with Sustainable Public Procurement of Works

Barriers are channels and qualities that prevent system development and implementation (Agyekum, 2018). The goal was to use mean score and primary factor analysis to analyze the major impediments to sustainable public-works procurement, as detailed in Chapter Three. A total of twenty-six (26) factors were discovered through literature research to accomplish this. A pilot study was conducted in-which certain factors were eliminated or added to the list. Ten (10) professionals (quantity surveyors, procurement officials, sustainability experts, and academics) with at least ten years of experience were asked to answer semi-structured questions. After the pilot study, seventeen (17) factors were concluded and Professionals in the construction industry were provided with questionnaires utilizing a Likert scale, ranging from Very low to Very high using purposive and snowball sampling techniques. The survey data was analyzed in two distinct ways using the IBMS Statistical Package for Social Scientists (SPSS) Version 23.

The initial step involved ranking the critical obstacles based on their mean scores. Subsequently, the second step entailed examining the fundamental connections among the prominent obstacles through Principal Component Factor Analysis. Principal Component Factor Analysis may reduce data to a readily accessible form. A reliability test was performed to ensure that the consistency of the barriers accurately reflects the construct that was measured statistically (Norusis 1993; Ameyaw 2014). The overall alpha value obtained from the dataset was 0.803, exceeding the recommended threshold of 0.70 (Eybpoosh et al., 2011; Oyedele, 2013). This indicates that the data acquired from the field check had substantial internal consistency and reliability. Based on that, the five-point scale system was reliable.

4.3 Ranking of Critical Barriers to Compliance with Sustainable Public Procurement of Works

The relative applicability of each detected variable was also determined using a mean score ranking. Consistent with the expected risk level, the significance threshold was also set at 95. Moreover, in cases where two or more variables share the same mean, the one with the smallest standard deviation is assigned the highest ranking (Field, 2005). The mean indicators span from 2.69 to 4.39; nevertheless, variables within the range of 3.50 to 4.39 were considered as having lower and maximum inflexibility. Table 4.11 indicates the slow uptake on the conception of sustainable public–works procurement, perceived high costs of adopting sustainable solutions against lower returns on sustainable public-works procurement projects, the vagueness of definitions and variety of interpretations, lack of awareness and knowledge of sustainability concepts, difficulty in embracing new knowledge or change, lack of enforcement of relevant laws was identified as the most severe factor in terms of critical barriers to compliance with Sustainable Public Procurement of works.

On the other hand, inadequate training and education, insufficient research and development on Sustainable Procurement, lack of planning, and unfamiliarity with sustainable technologies was deemed the more severe factors in terms of critical barriers.

Overall, Slow uptake on the concept of sustainable public works procurement was ranked first (1st) with a mean score of 4.39. Perceived higher costs of adopting sustainable solutions against lower returns on sustainable public-works procurement projects was ranked second with a mean of 4.35. This was followed by Vagueness of definitions and variety of interpretations with a mean of 4.16. The least ranked barriers include Lack of motivation for practitioners; corruption; Lack of expressed interest and demand from stakeholders on sustainability incorporation of mean 2.73, 2.71, and 2.69 respectively. These barriers had a mean score of less than 3.0 and hence considered the barriers with the least severity.

Except for the lack of awareness of sustainable public works procurement factors and the absence of appropriate time to address sustainability enterprises during tender, further exploration revealed that the variables had standard diversions lower than 1.0. This shows that respondents are harmonious, and the dataset has a low variation (Field, 2005). The variables with a standard deviation exceeding 1.0, on the other hand, suggest a notable disparity in how respondents scored these factors.

Table 4.1: Mean Score ranking of critical barriers to sustainable procurement

Code	Barriers	Mean	Std. Deviation	Cronbach's Alpha
BSP 1	Slow uptake on the concept of Sustainable Public-works Procurement	4.39	.622	
BSP 2	Perceived higher costs of adopting sustainable solutions against lower returns on Sustainable Public-works Procurement projects	4.35	.632	
BSP 3	Vagueness of definitions and variety of interpretations	4.16	.701	
BSP 4	Lack of awareness and knowledge of sustainability concepts	4.08	.660	
BSP 5	Difficult in embracing new knowledge or change	4.02	.725	.803
BSP 6	Lack of enforcement of relevant laws	4.01	.718	
BSP 7	Inadequate training and education	3.92	.981	
BSP 8	Insufficient research and development on SP	3.91	.769	
BSP 9	Lack of planning	3.90	.852	
BSP 10	Unfamiliarity with sustainable technologies	3.75	.995	
BSP 11	Lack of regulatory framework for Sustainable Public-works Procurement implementation	3.38	.932	
BSP 12	Lack of understanding of Sustainable Public-works Procurement factors	3.33	1.012	
BSP 13	Lack of human resources capacity	3.12	.976	
BSP 14	Insufficient time to address sustainability issues during the tender	3.00	1.170	
BSP 15	Lack of motivation for practitioners	2.73	1.000	
BSP 16	Corruption	2.71	.983	
BSP 17	Lack of expressed interest and demand from stakeholders on sustainability incorporation	2.69	.966	

Source: Researcher's survey (2023)

4.4 Factor Analysis of the Critical Barriers

Barriers are channels and qualities that prevent system development and implementation (Agyekum, 2018). The goal was to use primary factor analysis to assess the significant barriers to sustainable public-works procurement. This method was used to identify the underpinning links between the seventeen (17) essential variables. This approach, as indicated by Ahadzie (2007), Oyedele (2013), and Kissi et al. (2014), aids in statistically reducing variables to an easily understood framework. The Kaiser- Meyer- Olkin (KMO) measure of adequacy and Bartlett's test sphericity are used to assess the applicability of the primary factor analysis. The KMO test result of 0.635 (Table 4.2) indicates that the data set was suitable because it surpassed the required threshold of 0.5 (Norusis, 1993). Likewise, the result of Bartlett's test of sphericity was good, with a value of 633.761 and a significance of (p = 0.000). Ameyaw (2014) and Lattin et al. (2003) conclude that the correlation matrix is not identifiable.

Table 4.2: KMO and Bartlett's Test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.635
Bartlett's Test of Sphericity	Approx. Chi-Square	633.761
	Df	136
	Sig.	.000

Source: Researcher's survey (2023)

Based on principal component factor analysis, four factors with eigenvalues greater than 1.00 were utilized, and Varimax rotation after five duplications were employed to explain 58.97 of the total variance. Further examination of the extracted variable loadings across various factors reveals significant item loadings, with each variable exceeding the recommended threshold of 0.32. (Tabachnick and Fidell, 2001 Ameyaw, 2014). These loadings reflect their contribution to the underpinning factors, with reasonably high factor loadings above 0.60 confirming the acceptability of the sample size.

Table 4.3 depicts the four major components and their related variables, which are interpreted as follows:

- Component 1: Adaptability to Sustainable Public-works Procurement
- Component 2: Managerial Challenges
- Component 3: Knowledge incapacity
- Component 4: Legal, Policy, and Evaluation

Table 4.3: Rotated Component Matrix

	Component			
	1	2	3	4
Slow uptake on the concept of Sustainable Public-works Procurement	.769			
Lack of understanding of Sustainable Public-works Procurement factors	.794			
Perceived higher costs of adopting sustainable solutions against lower returns on Sustainable Public-works Procurement projects	.612			
Lack of planning	.762			
Inadequate training and education	.763			
Unfamiliarity with sustainable technologies	.619			
Vagueness of definitions and variety of interpretations	.557			
Insufficient time to address sustainability issues during the tender		.740		
Lack of expressed interest and demand from stakeholders on sustainability incorporation		.707		
Lack of motivation for practitioners		.716		
Lack of human resources capacity		.708		
Lack of awareness and knowledge of sustainability concepts			.879	
Difficult in embracing new knowledge or change			.759	
Lack of enforcement of relevant laws			.572	
Lack of regulatory framework for Sustainable Public-works Procurement implementation				.779
Insufficient research and development on SP				.612
Corruption				.558
Extraction Method: Principal Component Analysis. **Rotation Method:** Varimax with Kaiser Normalization.				
a. Rotation converged in 5 iterations.				

Source: Researcher's survey (2023)

Component 1 – Adaptability to Sustainable Public Works Procurement

The seven barrier factors identified for component 1 were slow uptake on the concept of sustainable public-works procurement (76.90%), lack of understanding of sustainable public-works procurement factors (79.4%), perceived higher costs of adopting sustainable solutions against returns on sustainable public-works procurement projects (61.20%), Lack of planning (76.2%), Inadequate training and education (76.3%), unfamiliarity with sustainable technologies (61.9%) and vagueness of definitions and variety of interpretations (55.7%). The factor loadings, represented within parentheses, indicate that this cluster contributed to 25.905% of the variance (Table 4.4). Commonalities within this cluster include a general connection to adaptability, knowledge, and awareness of sustainable public-works procurement. Mensah and Ameyaw (2012) argue that a lack of understanding of sustainable procurement is a significant hindrance to sustainable procurement in Ghana. They also concluded that very few procurement practitioners appreciate Sustainable Procurement as an approach that incorporates the environmental, economic, and social aspects of sustainability. This implies that not much difference has been realized before and after the amendment of the Public Procurement Act 2003. United Nations (2016) also highlighted as an impediment to long-term procurement the habit and the difficulties of altering purchasing behavior.

Component 2 – Inadequate Managerial Capacity

The main component accounts for 15.461 percent of total variances and includes four specific variables: insufficient time to address sustainability issues during tender (74.0 percent), lack of expressed interest and demand from stakeholders on sustainability incorporation (70.7 percent), lack of motivation for practitioners (71.6 percent), and insufficient capacity of human resources (70.80 percent) (Table 4.4). This component was named Inadequate managerial capacity. The adoption of Sustainable Public works procurement requires good managerial and planning skills by the Employer, Consultant, and Contractor. The idea that the process and results are time-consuming is one of the major hurdles to sustainable procurement (United Nations, 2016; Renukappa et al., 2015).

Component 3 – Knowledge incapacity

Component three identified barriers were a lack of awareness and knowledge of sustainable principles (87.9 percent), difficulty adopting new information or change (75.9 percent), and a lack of enforcement of appropriate legislation (57.2 percent). The number in parenthesis is the factor loadings. This cluster was responsible for 10.74 percent of the variation (Table 4.4). According to Olanrewaju et al. (2014), the level of knowledge of sustainability in construction among industry practitioners is modest. McCarthy (2011) contends that every project, particularly public infrastructure, should have a well-articulated sustainability objective. Furthermore, where practicable, procurement sustainability criteria should be contractually enforced (Ogunsanya et al., 2022). At the initial stages of the project, standards and measurement criteria should be established to ensure compliance. If this is not done at the procurement stage subsequent implementation of sustainability will be difficult during the execution stage of the project.

Component 4 – Legal, Policy, and Evaluation

The fourth component was labeled as Legal, policy, and evaluation factors collectively accounted for 6.866 of the total variances not explained by the other three factors. (Table 4.4). This assumption agrees with UNODC (2019), which alleges that approximately 20-25% of global procurement funds are siphoned off due to corrupt practices. Eyo (2017) found that deeply rooted corruption diminishes the constrained funds accessible for public expenditures on a macro level and suggests the implementation of stronger regulatory frameworks at the micro or institutional level to tackle the misconduct of public officials in sustainable public procurement in Africa. The research aligns with Elegbe's (2012) assertion that the Public Procurement Authority lacks adherence to international best practices regarding transparency. This deficiency is evident in the absence of specific guidelines for determining the required threshold for performance bonds, granting considerable discretion to procurement authorities, and leaving room for potential abuse in procurement decisions.

Table 4.4: Total Variance Explained Extraction Method: Principal Component Analysis

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.404	25.905	25.905	4.404	25.905	25.905	3.293	19.373	19.373
2	2.628	15.461	41.366	2.628	15.461	41.366	2.692	15.835	35.208
3	1.826	10.740	52.107	1.826	10.740	52.107	2.239	13.172	48.380
4	1.167	6.866	58.973	1.167	6.866	58.973	1.801	10.592	58.973
5	1.139	6.703	65.675						
6	.937	5.510	71.186						
7	.774	4.553	75.739						
8	.731	4.303	80.042						
9	.668	3.928	83.969						
10	.548	3.221	87.190						
11	.527	3.101	90.292						
12	.430	2.528	92.819						
13	.353	2.077	94.896						
14	.312	1.834	96.730						
15	.257	1.513	98.243						
16	.159	.938	99.181						
17	.139	.819	100.000						

Source: Researcher's survey (2023)

Conclusions and Recommendations

Existing research indicates that the construction sector is critical to Implementing sustainable procurement practices in the attainment of the Sustainable Development Goals. However, significant impediments to effective and efficient compliance with sustainable public-works procurement exist. Scientific literature also suggests that these barriers may differ by nation due to socioeconomic, demographic, and cultural factors. However, empirical studies are scarce on the specific barriers to compliance with sustainable public-works procurement at the tender evaluation stage, particularly in developing countries. Hence, this study identifies the specific barriers to compliance with sustainable public-works procurement at the tender evaluation stage. Seventeen (17) barriers were identified through literature review and expert opinion. The data were analyzed and discussed using the Principal Component Analysis (PCA) variant of factor analysis, which classified the variables into four (4) clusters: (1) adaptability to sustainable public-works procurement cluster; (2) managerial challenges cluster; (3) knowledge incapacity cluster; and (4) legal, policy, and evaluation cluster.

This study is one of the few studies that focus on the barriers to sustainable public-works procurement at the tendering stage of building projects. The study offers insight into the specific obstacles that inhibit compliance with sustainable public-works procurement during the tendering stage in Ghana and adds to the body of knowledge. The study also offers a basis for practitioners and scholars to understand the specific barriers that need much attention to improve compliance levels with sustainable public-works procurement in Ghana, as well as the need to strengthen compliance. It is recommended that the benefits of sustainable public-works procurement should be made known to practitioners to improve its adoption within the construction industry and increase research into the field of sustainable procurement to allow for improved knowledge and awareness of the concept.

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Stakeholder Management In The Sustainability Of Corporate Social Responsibility Projects – A Systematic Literature Review

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Abstract

Firms employ corporate social responsibility (CSR) to influence stakeholder perceptions and positively induce desirable business outcomes. The mechanism through which stakeholder management affects the sustainability of CSR projects has been under-explored despite the burgeoning literature on corporate social responsibility. In response, we systematically review empirical studies on stakeholder management in the sustainability of corporate social responsibility (CSR) projects to assess the status quo of literature to inform future direction in this study area. Four databases, including Scopus, Web of Science (WOS), Ebsco Host and Google Scholar, were searched to identify relevant articles published over the last two decades (January 2000 to November 2023). Peer-reviewed journal publications were systematically reviewed to come up with the findings of this study. The findings highlight that firms practice stakeholder management as part of delivering CSR projects. It also revealed the complexity of stakeholder management within the various sectors, with its stakeholder pool affecting CSR project sustainability. However, there is a need for more evidence of this finding since there were only a few relevant empirical publications in the literature to support this position. The study will draw CSR practitioners' attention to the fact that comprehensive stakeholder management is essential for the sustainability of CSR projects. This study used the systematic review based on clearly defined transparent processes and criteria to aggregate knowledge on the status quo of stakeholder management to ensure the sustainability of CSR projects.

Keywords: Corporate social responsibility (CSR), stakeholder management, sustainability, sustainable CSR projects, review.

Introduction

Businesses allocate resources to undertake corporate social responsibility in society to meet stakeholder expectations and gain their trust despite their focus on profit objectives (Foss and Klien, 2018). Corporate Social Responsibility (CSR) is businesses' obligation to society and

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stakeholders who are influenced and affected by corporate policies and practices (Kowalczyk and Kucharska, 2020). This voluntary process involves the interactions between companies and multiple stakeholders, including employees, customers, suppliers, competitors, local communities, and citizens who are impacted or impact the operations of companies (Sachs and Kujala, 2021). Since communities have relief expectations from companies, corporate bodies are mandated to fulfil these expectations. Lewa (2020) has suggested that society tends to reward organisations in different ways when seen as socially responsible.

Pressures from stakeholder groups such as civil society groups and nations have forced several companies to change their policies toward achieving CSR. Also, for businesses to survive and grow within their operating environment, they need to consider stakeholders' expectations and safeguard the sustainability of the environment (Taghian *et al*., 2015). Thus, in addition to profit-making objectives, companies allocate resources for social investments in societies (Ansu-Mensah *et al*., 2021) and also find a balance between profitability and contributing positively to the sustainability of the society in which they operate (Marinina, 2019).

The importance of stakeholder management in organisational activities, including CSR, cannot be overemphasised. This has been amply revealed through numerous research in stakeholder management and other constructs such as value creation (Freudenreich *et al*., 2020), innovation (Alverez and Sachs, 2021), CSR and sustainability (Kulkarni and Aggarwal, 2022). Stakeholder management involves identification, planning, managing, and monitoring stakeholder engagement (PMI, 2023). Globally, managing stakeholders is complex and challenging due to the diverse characteristics of multiple stakeholders, including their expectations, needs, interests, and power (Nguyen and Mohamed, 2020). Many businesses have altered their policies and operations and integrated the idea of CSR backed by stakeholder management to protect their hard-earned reputation and promote business sustainability (Hasan *et al*., 2018). Thus, companies and stakeholders, including their host communities, mutually benefit from companies' operations through CSR and the sustainability of such CSR initiatives. According to Kiesnere and Baumgartner (2019), the sustainability of projects and their outcomes ensure that the gains from such projects are maintained over a long time. This is what justifies the investment, both financially and socially, in a project. The sustainability and success of CSR initiatives are affected by barriers to stakeholder involvement and engagement in CSR formulation initiatives and thus require further research attention (Fatima and Elbanna, 2023).

The individual concepts of stakeholder management and CSR have been widely studied (Dmytriyev and Freeman, 2021). Previous studies have focused on several areas of CSR, including stakeholder management and CSR (Adomako and Trans, 2022) and the relationships between sustainable development and CSR (Shayan *et al.*, 2022). However, research on the linkage between the concepts of stakeholder management and the sustainability of CSR projects is still evolving (Caroll and Brown, 2018). Though there is a relationship between the two concepts, it also involves sacrificing smart business goals since it draws on the business' resources (Caroll and Brown, 2018). For companies to effectively capitalise on stakeholder management to ensure the full benefits of CSR initiatives are reaped through the sustainability of CSR projects, there is a need to undertake studies on stakeholder management within the context of the sustainability of CSR projects. Thus, this study aims at finding the state of stakeholder management in the sustainability of CSR projects. The study will address the following research question: What is the state of knowledge of stakeholder management in the sustainability of CSR projects? Knowledge of the state of stakeholder management in the sustainability of CSR projects will serve as a benchmark for recommendations for improving the sustainability of CSR projects. Also, areas for further studies will be identified. The first part of this study presents a review of extant literature relevant to the subject matter. This is followed by methodology, then a discussion of findings and results. The paper ends with conclusions and recommendations.

Literature Review

Corporate Social Responsibility (CSR)

CSR initiative is one of the strategies firms employ to positively influence stakeholder perceptions and induce desirable business outcomes. CSR activities and their sustainability bring benefits such as skilled workforce, good reputation, and relationships with stakeholders of companies (Guo and Lu, 2021). Although voluntary, many firms have embraced CSR because it offers an avenue for corporate excellence, leading to repeated and sustainable business. Many firms are involved in various categories of philanthropy-related CSR projects, charitable donations to local communities, advocacy, environmental preservation efforts and volunteering programmes (Abdelhalim and Eldin, 2019). This list of CSR projects is not exhaustive. Other CSR projects organisations tend to engage in include the provision of social infrastructure in host communities (for example, provision of schools, boreholes, and health posts), charitable donations to a good cause (example donation of school items), activities that promote sustainable development and anti-poverty initiatives (example advocacy programmes such as awareness programme on HIV/AIDS and breast cancer) among others (Serfontein-Jordaan and Dlungwame, 2022; Hopkin, 2016)

Sustainability in CSR Projects

The term "sustainability" comes from the concept of "sustainable development”. According to the Brundtland Commission (World Commission on Environment and Development), sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (UN, 1987). This involves a process in which resource exploitation, investment direction, the orientation of technological development, and institutional change are congruent with future and present needs. Following the work of the Brundtland Commission, a broader and more acceptable concept of sustainability has emerged based on the triple bottom line (TBL) of environmental, economic, and social dimensions (Elkington, 1998). There is no universal definition of sustainability. There are over one hundred (100) definitions of the concept of sustainability, and they all generally agree that the broader TBL of sustainability needs to be simultaneously balanced. The concept of sustainability thus hinges on the triple bottom line (social, environmental, and economic dimension), necessitating a new perspective for projects (Martens and Carvalho, 2016; Marcelino-Sádaba *et al*., 2015). Rather than focusing solely on economic interest, the concept of sustainability considers the triple bottom line (TBL) as the basis for achieving short and long-term success through rational use of resources, meeting present human needs without harming future generations (Silvius and Schipper, 2014; Elkington, 1998). There has been a continuous drive to incorporate sustainability effectively in all fields since the 1970s (Marcelino-Sadaba *et al.*, 2015; Elkington, 1998; UN, 1987). Stakeholder management is critical to the sustainability of projects and organisations (Schaltegger and Burritt, 2018).

The concept of sustainability can be looked at from the project level, organisational level and global level (for example, the sustainable development goals level), among others. According to Silvius and Schipper, 2014), incorporating sustainability into projects can be referred to as project sustainability management. Project sustainability can be defined as the planning, monitoring and controlling of project delivery and support processes with due consideration for social, environmental and economic aspects of the life-cycle of the project resources, processes, deliverables and effects aimed at realising benefits for stakeholders and performed in a transparent, fair and ethical way that includes proactive stakeholder participation (Silvius and Schnipper, 2014). Sustainability studies in projects are still evolving (Khalifeh *et al*., 2020). In the context of CSR projects, there are two different but related perspectives on incorporating sustainability into projects, that is, project process sustainability and product or outcome sustainability (Khalifeh *et al*., 2020; Aarseth *et al*., 2017). Whereas project process sustainability relates to the sustainability of the project processes and interrelated activities, project product sustainability is related to the sustainability of the project outcomes or deliverables (Carvallho and Rabechini, 2017; Kivila *et al*., 2017). Identifying and formulating CSR initiatives, among others, falls under CSR project process sustainability, whilst outcomes such as enhancing corporate reputation fall under product outcome sustainability. Incorporating sustainability into projects is still emerging with many unanswered questions, particularly the relationship between sustainability and other constructs, such as stakeholder management, which still lacks empirical evaluation (Martinez-Perales et al., 2018; Marcelino-Sadaba *et a*l., 2015).

Stakeholder Management and Sustainability of CSR Projects

According to PMI (2023), a stakeholder is an individual, group, or organisation that may affect, be affected by, or perceive itself to be affected by a project, programme, or portfolio's decision, activity, or outcome. One of the main reasons stakeholders are taken into account in organisational practices is because an organisation's capacity to generate value and become sustainable relies on its capacity to effectively manage and balance the interests and expectations of its stakeholders (Freeman *et al.*, 2010). However, the past twenty years have seen a change in emphasis from meeting the demands of all stakeholders to interactively working together to generate value and address sustainability challenges (Freudenreich *et al*., 2020; Freeman *et al.*, 2017). Owners, customers, employees, indigenous communities, suppliers, distributors, academics, NGOs, the state, and media companies are just a few of the essential groups of stakeholders (Freeman and Dmytriyev, 2017).

Project stakeholder management includes processes required to identify stakeholders, analyse their needs, expectations, wants, interests, power, influence, and impact on the project, and develop appropriate management strategies for effectively engaging stakeholders in the project decisions and execution (PMI, 2023). The key processes for stakeholder management include identifying stakeholders and planning, managing, and monitoring their engagement. Thus, one of the cardinal processes of stakeholder management is stakeholder engagement (Clevenger and MacGregor, 2019). Stakeholder engagement involves an organisation's efforts to actively involve interested parties in its operations for the benefit of all parties involved (Amoako, 2017). Communicating and passing on information to stakeholders is not enough; proactively engaging stakeholders is crucial to sustainability (Aggarwal and Singh, 2019). Instead of enhancing the organisation’s impact, discretionary CSR and stakeholder involvement reduce its strategic impact and sustainability (Asante *et al*., 2019). Literature clarifies that stakeholder management is vital to CSR (Park *et al*., 2014). Effective stakeholder management is essential for the implementation and sustainability of CSR projects (Asu-Mensah *et al*., 2021), and inconsistent stakeholder management reduces the sustainability of CSR initiatives (Ihugba, 2012).

Research Methodology

The research question was addressed using systematic literature review (SLR) method as this method is replicable, robust, rigorous, and transparent in accessing relevant articles from a vast number of publications, screening and appraising them (Linnenluecke et al., 2020; Aarseth *et al.*, 2017). The choice of SLR was to assist in identifying existing patterns, themes and future directions in the subject area (Fink, 2019; Snyder, 2019). From a literature review on SLR of stakeholder management and CSR (Damoah et al., 2019; Olanipekun et al.,2020) and, to the authors' knowledge, none focused on stakeholder management in the sustainability of CSR.

There are several ways of carrying out SLR (Higgins *et al.*, 2023; Xiao and Watson, 2019; Tranfield *et al.*, 2003). The SLR was carried out by identifying, screening, selecting, extracting and appraising relevant literature based on guidelines outlined by Linnelucke *et al.* (2020) and

Tranfield *et al.* (2003). These guidelines follow three main stages, viz planning the review, conducting the review, and reporting and disseminating the review.

Planning the Review

The scope of the study is to review relevant articles on stakeholder management in the sustainability of CSR projects to assess the status quo of literature to inform future direction in this study area. Thus, the study aims to synthesise and summarise relevant literature to understand the state of knowledge in this subject area and provide insight for future research direction.

The inclusion and exclusion criteria adopted for the study are summarised in Table 1. These criteria were derived from the research question and objective (Linnenluecke *et al.*, 2020). Regardless of their impact factor, peer-reviewed journals were adopted for the study to ensure all relevant data were included (Khalifeh *et al.*, 2020). Books and book chapters were also included in the study, as Transfield et al. (2003) and Shannon (2002) have stated that SLRs should not just focus on journals because they do not contain all published relevant materials. Only English content or studies were considered to avoid misinterpretation of other languages (Qazi and Appolloni, 2022). The study was opened to CSR in all sectors, including mining, banking, manufacturing, and construction, to ensure adequate data was obtained. The study period was limited to 2000 to November 2023. The early 2000s marked a significant and focal point in the emphasis on the need to understand CSR from stakeholders' perspective, and thus, the year 2000 was adopted as the starting point of the SLR (Chaturvedi *et al.*,2022; Morgeson *et al.*, 2013). Also, Homer and Gill (2022), in their study on “How CSR is described in keywords”, found that CSR search became mainstream in the early 2000s.

Table 1: Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
1. Journal/Document Type	Peer-reviewed journals (articles, book chapters, books and conference papers)	All documents that fall outside those in the inclusion criteria (for example, magazines, dissertations, research reports)
2. Language	English	Any other language
3. Time of Publication	2000 – November 2023	Any other outside 2000 - November 2023
4. Focus	Stakeholder management and sustainability and corporate social responsibility (CSR)	Documents not relevant to addressing the research question

Four leading multidisciplinary academic databases were chosen for the literature search since no single database includes all published materials (Fobbe and Hilleftofth, 2021; Linnenluecke et al., 2019; Xiao and Watson, 2019). These include Scopus, Web of Science (WOS), EBSCO Host (Academic Search Complete and Business Source Complete) and Google Scholar (using Publish and Perish interface). This was done to ensure reliability and rigour in searching for relevant articles on stakeholder management and sustainability in CSR. Those databases were selected for their comprehensive coverage and indexing of relevant journals (Damoah *et al.*, 2019). Also, Scopus and WOS have been recognised as one of the largest databases of peer-reviewed literature with high-quality journals and providing advanced search functions (Fobbe and Hilleftofth, 2021; Gusenbauser and Haddaway, 2020).

The keywords for the study were selected based on the research question and the literature review of relevant studies on stakeholder management, CSR and sustainability of CSR in Section 2 above. Three keyword themes and related words were combined using boolean operators "OR", "AND", and wildcard (asterisk sign - *) in developing the search strings shown in Table 2 below. This search string was used in operationalising the search. The Preferred Reporting Item for Systematic Review and Meta-Analyses (PRISMA) guidelines were adopted for the search and reporting.

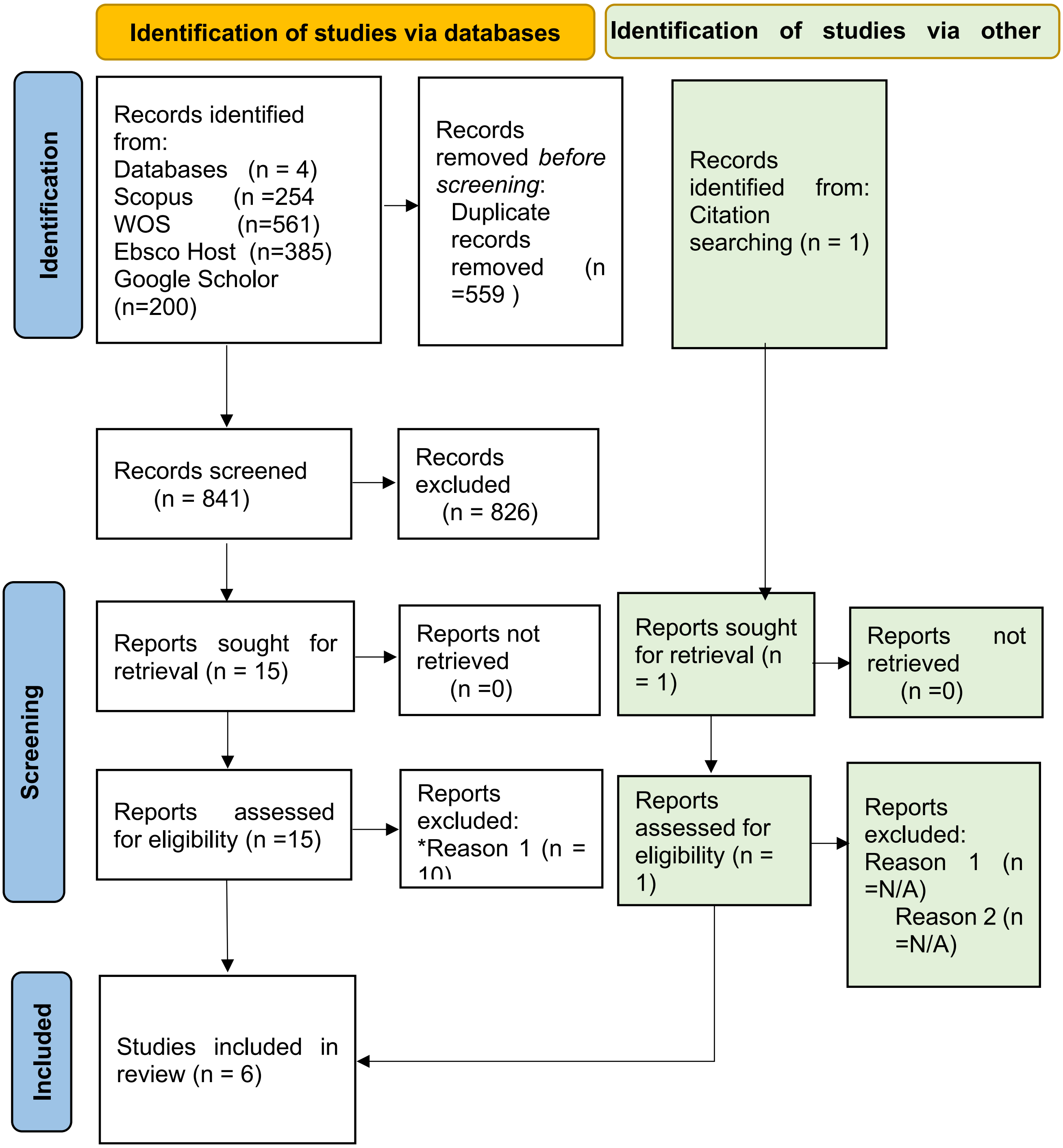
Table 2: Search String

Keyword Theme	Related Words	Search String
Stakeholder Management	Stakeholder Engagement	"stakeholder management" OR "stakeholder engagement"
Corporate Social Responsibility (CSR)		"corporate social responsibility" OR csr
Sustainability		sustainability OR sustain*
Final Search String: ("stakeholder management" OR "stakeholder engagement") AND ("corporate social responsibility" OR csr) AND (Sustainability OR sustain*)		

Conducting the Review

This review stage involves identifying and selecting relevant studies, conducting quality assessment, data extraction, analysis and synthesis (Tranfield *et al*., 2003; Linnenluecke *et al*., 2020). The final string generated in the planning stage was customised for each database and used to operationalise the search and identification of relevant studies in each database using the PRISMA guidelines. The search results are shown in Figure 1. The search across the four databases was carried out in November 2023. The initial search of the four databases yielded a total of 1533 documents. Refining the initial database results using the relevant inclusion and exclusion criteria (publication period – 2000 to November 2023, peer-reviewed document type and English language) resulted in 1400 documents. This is shown in Figure 1, together with the breakdown for each database. Combining the results from the four databases created some duplicates, which were removed.

The removal of these duplicates, the title/abstract screening and full-text screening to determine which documents to include in the study are all shown in the PRISMA flow diagram in Figure 1. This process was carried out with the assistance of the Rayyan software (Qatar Computing Research Institute - QCRI). Also, Mendeley Desktop software was used to manage all the references. Five hundred and fifty-nine (559) duplicate documents were removed, leaving 841 publications for screening. Title/abstract screening was carried out on the remaining 841 publications. Following the title/abstract screening, 826 documents were removed largely because they referred to topics on stakeholder management, sustainability, and corporate social responsibility (CSR) that were not within the study's scope and will thus not assist in addressing the research question. A few of the documents were also review papers and conceptual. The remaining 15 documents were read in full to make a determination on the inclusion in the study. Also, a forward and backward search (Webster and Watson, 2002) was conducted on the relevant articles among the 15 publications, and this yielded one additional relevant article (Ihugba, 2012) from the Serfontein-Jordaan (2022) reference list. The decision to include or exclude was made based on the publication's relevance in addressing the research question (Linnenluecke *et al*., 2020; Majd *et al*., 2015). This resulted in the final sample of six (6) publications (5 peer-reviewed articles and a book chapter) included in the study. These six selected publications focused on stakeholder management, sustainability and CSR or sustainability of CSR projects. The fact that six (6) relevant publications were included in the study shows that the subject area of stakeholder management in the sustainability of CSR projects is under-researched. This final sample included in the study is similar to a sample size of less than ten (10) in SLR study on sustainability and project success (Khalifeh *et al.*, 2020 – 5 samples). It is also akin to the numbers of publications included in the following SLR studies: Al-Abdouh *et al.* (2021) – 4 studies, Wilt *et al.* (2021) – 4 studies, and Piscoya *et al.* (2020) - 6 studies.



Note :	*Reason 1(n=10):	False positives – publications focused on one or more of the constructs but not within the study scope and were irrelevant to addressing the research question.

Figure 1: PRISMA Flow Diagram for SLR Study

Source: Page *et al.*(2021)

Synthesising and Reporting the Review

The research question was addressed by conducting descriptive and content analysis to synthesise, summarise and report the review's findings (Linnenluecke *et al.*, 2020). The content analysis adopted the methodology of Bauer (2007) and Hsieh and Shannon (2005). Each article was read and classified under relevant classification themes to address the research question. The following classifications were adapted to aid in synthesising the publications included in the study: type of article; research strategy and focus of the studies; industries studied or discussed; sample of respondents and main findings on the stakeholder management in the context of sustainability of CSR projects including any relationships (Damoah *et al.*,2019; Khalifeh et al. 2020; Silvius and Schipper, 2014).

Results

Results of Descriptive Analysis

Though the publication's search covered a period of twenty-three (23) years, only six (6) publications covering a time frame of ten (10) years from 2012 to 2022 were finally included in this study. The earliest publication was done in 2012, and the six (6) publications were published in different years. No year has more than one publication. The final sample comprised six (6) publications, made up of five (5) peer-reviewed journal papers and a book chapter published in six (6) different journals. The five (5) journal publications covered developing countries in Africa, and the book chapter covered developed and developing countries. Though the publication's search was not limited to any sector, most of the publications unearthed covered stakeholder management in the context of sustainability of CSR projects in the mining sector. A summary of the descriptive analysis is shown in Table 3.

Table 3: Description of Studies

S/No.	Study	Year	Study Type	Country	Source and Number of Citations
1	Ihugba (2012)	2012	Academic Paper	Developing Country (Nigeria)	African Journal of Economics and Management Studies (21 citations)
2	Sarfo *et al.* (2016)	2016	Academic Paper	Developing Country (Ghana)	Environment and Natural Resources Research (4 citations)
3	Mbirigenda (2017)	2017	Academic Paper	Developing Country (Tanzania)	Utafiti (1 citation)
4	Rendtorff (2019)	2019	Book Chapter	Developed and developing countries	Philosophy of Management and Sustainability (21 Citations)
5	Ansu-Mensah *et al.* (2021)	2021	Academic Paper	Developing Country (Ghana)	International Journal of Corporate Social Responsibility (69 citations)
6	Serfontein-Jordaan (2022)	2022	Academic Paper	Developing Country (South Africa)	Communitas (3 Citations)

Results of Content Analysis (Classification of Literature)

Strategy and Focus of Studies

The final sample and results showed that the subject matter of stakeholder management in the sustainability of CSR projects is inadequately addressed in the literature. This area is under-researched. Only five (5) empirical studies and one (1) book chapter were found to have covered the subject matter under consideration within ten years from 2012 to 2022. Five (5) studies adopted a qualitative research strategy with a case study research design. One of the studies adopted the multiple case study, whilst four (4) used the single case study. Interviews were used as the primary method for data collection. Also, the main sampling technique was purposive with thematic analysis as the main analytical technique. Studies focused on the mining and manufacturing industries. Out of the six publications included in the study, only the study by Serfontein-Jordaan (2022) proposed a conceptual framework between stakeholder engagement and sustainable CSR outcomes. The main issues explored in the publications include the nature of CSR projects; stakeholder management – stakeholder identification, stakeholder engagement through dialogues/consultative, post dialogues/consultation, stakeholder management in achieving CSR outcomes; Sustainability of CSR projects – TBL, form of project sustainability. Table 4 summarises the research strategy and focus of the five studies.

Table 4: Study Strategy and Focus

S/N	Study	Industry Focus	Study Strategy	Research Design	Sampling Technique	Data Collection Method	Analytical Techniques
1	Ihugba (2012)	Manufacturing	Qualitative	Single case study			Thematic & content analysis
2	Sarfo *et al.* (2016)	Mining	Qualitative	Single case study	Purposive	Interview & questionnaire survey	Thematic analysis
3	Mbirigenda (2017)	Mining	Qualitative	Single case study	Purposive	Interview questionnaire survey & focus group discussion	Thematic analysis
4	Rendtorff (2019)	Multiple Industries					
5	Ansu-Mensah *et al.* (2021)	Mining	Qualitative	Single case study	Purposive & snowball	Interview	Thematic analysis
6	Serfontein-Jordaan (2022)	Mining	Qualitative	Multiple case study	Homogenous	Interview	Thematic analysis

Sustainability of CSR Projects and Study Respondents

This section of the studies reviews the nature of CSR projects considered in each publication, the sought of sustainability of CSR projects the publications focused on and also identifies the respondents in each study. All the CSR projects generally focused on social infrastructure, including the provision of potable water and sanitation projects, agricultural development, poverty reduction, environmental protection, healthcare and immunisation delivery, quality of life projects, education and disaster relief. From the review of literature, the sustainability of CSR projects can be looked at from two different perspectives viz CSR project process sustainability and CSR project product sustainability. Thus, in reviewing the selected publications to understand the stakeholder management within the sustainability of CSR projects, which form of sustainability was considered and how stakeholder management interfaced with the sustainability of CSR projects. This was necessary to aid in comprehensively addressing the research question. All the studies focused on both CSR project process sustainability and CSR project product sustainability. All the studies indicated the sustainability of CSR project outcomes being affected by CSR project processes. Asu-Mensah et al. (2021) and Serfontein-Jordaan (2022) found that effective stakeholder management is one of the main ways stakeholders can contribute to sustainable CSR projects. Thus, stakeholder management have an impact on the triple bottom line of social, environmental and economic sustainability paramenters of CSR projects. For Rendtorff (2019), the focus was not on process or product sustainability, but the emphasis was on some of the principles considered in CSR sustainability. Ihugba (2012) found that reactive CSR projects instead of proactive and stakeholder-led CSR projects lead to unsustainable or ill-advised CSR projects.

The respondents' backgrounds in each study were also examined since the views of different stakeholders affect how stakeholder management may influence the sustainability of CSR projects. The book chapter (Rendtorff, 2019) and studies by Ihugba (2012) did not involve any respondents because they were based on secondary data and social reports. Sarfo *et al.* (2016) collected data collected via questionnaire surveys and interviews with senior staff of the mining company studied (AngloGold Ashanti), members of some communities in the catchment area of the mining company and heads of government institutions also within the catchment area of the mining company. In Mbirigenda (2017), focus group discussions comprising nine to eleven (9 to 11) people were held in 4 villages with village leaders, local communities' business groups and the youth. Also, interviews were conducted with twelve (12) interview respondents - Manager and CSR officer of the mining company, head teacher of a local school, leaders within the four (4) villages and business people. Ansu-Mensah (2021) used multiple stakeholders as respondents. These respondents included management and employees of mining company, chiefs, local government representatives, community representatives and heads of governmental and non-government institutions. Serfontein-Jordaan (2022) obtained data from sustainability specialists from three (3) mining companies.

A summary of various perspectives on the sustainability of CSR projects, study respondents and the nature of CSR projects are shown in Table 5.

Table 5: Sustainability of CSR Projects and Study Respondents

S/No.	Study	Nature of CSR Projects	Sustainability of CSR Projects	Study Respondents
1	Ihugba (2012)	Provision of potable water (boreholes), agricultural development (fish farming centre), poverty reduction(vocational training centres), environmental protection(tree planting), healthcare and immunisation delivery (HIV/AIDS vaccines), education (scholarship) and disaster relief.	Project process and project product sustainability	No respondent, based on the company's 5 years social reports and newspaper reports of corporate activities.
2	Sarfo *et al.* (2016)	Community health and malaria control programme, social infrastructure programme, education programme and sports/arts programme.	Project process and project product sustainability	12 respondents - senior staff of mining company, members of communities and heads of government institutions.
3	Mbirigenda (2017)	CSR projects in water supply, education, health and agroforestry.	Project process and project product sustainability	Focus group discussions comprising of 9 to 11 people from 4 villages: 12 interview respondents
4	Rendtorff (2019)	Generic CSR Initiatives	Project process sustainability	No respondent
5	Ansu-Mensah *et al.* (2021)	Community Health projects, Education, Water and Sanitation, Quality of life projects - in the form of safety and protection, production of human capital, improvement of livelihoods and rural development; Agriculture improvement and land access projects/programs; Environmental projects through afforestation program	Project process and project product sustainability	21 respondents
6	Serfontein-Jordaan (2022)	CSR projects implemented include education projects (donations of school items and infrastructure developments), health projects (Donating ambulances, building and refurbishing hospitals, advocacy programmes - hosting awareness programmes for HIV/Aids and cancer), community/social infrastructure	Project process and project product sustainability	Sustainability specialist from 3 mining companies.

Stakeholder Management and Sustainability of CSR Projects

Understanding the background of respondents and the type of stakeholders considered in each study also assistsed in understanding how stakeholder management contributes to the sustainability of CSR projects. Thus, this section covered the stakeholders (single or multiple) considered in each study and how stakeholder management is related to the sustainability of the CSR projects. All studies showed that relevant stakeholders were carefully identified and engaged. The stakeholders' involvement in the formulation and implementation of the CSR projects through consultative committee meetings and community/public engagements is essential for the sustainability of CSR projects. Ihugaba (2012) identified multiple stakeholders, including representatives from government establishments, suppliers, and local communities. This stakeholder participation impacted the sustainability of the CSR projects. Studies by Sarfo *et al.* (2016), Mbirigenda (2017), Ansu-Mensah *et al.* (2021) and Serfontein-Jordaan (2022) all considered multiple stakeholders and showed some significant impact on the sustainability of CSR projects. Mbirigenda (2017) found that ineffective stakeholder participation undermines the sustainability of CSR projects. Stakeholder and relationship of stakeholder management and sustainability of CSR projects are summarised in Table 6.

Table 6: Stakeholder Management and Sustainability of CSR Projects

S/No.	Study	Stakeholders	Relationship of Stakeholder Management and Sustainability of CSR Projects
1	Ihugba (2012)	Multiple Stakeholders were considered (26 government establishments - federal, state and local agencies; 12 suppliers and 4 local communities.)	Stakeholder participation impact on the sustainability of CSR projects
2	Sarfo *et al.* (2016)	Multi-stakeholder groups, including traditional leaders, youth leaders, local government representatives – assemblymen, senior staff and directors of Obuasi Municipal Assembly, Auditor General Department and Municipal Health Directorate were considered.	Stakeholder participation impact on the sustainability of CSR projects
3	Mbirigenda (2017)	Multi-stakeholder groups include 4 villages, district commissioner, head teacher of a school, 4 village chairpersons and business people.	Stakeholders' involvement affects the sustainability of CSR projects.
4	Rendtorff (2019)	Multi-stakeholder	Uncertain
5	Ansu-Mensah *et al.* (2021)	Multi-stakeholder groups, including management, employees, chiefs, assemblymen, community representatives, governmental agencies and non-governmental institutions	Stakeholders' management affects the sustainability of CSR projects.
6	Serfontein-Jordaan (2022)	Multi-stakeholder group involving three mining companies	Stakeholders' management affects the sustainability of CSR projects

Discussion

This study addressed the following research question: What is the state of knowledge of stakeholder management in the sustainability of CSR projects? To address the research question, literature was systematically reviewed, and content analysis was carried out based on the following considerations clarified under sections 3 and 4: the strategy and focus of the studies; sustainability of CSR projects and study respondents; and stakeholder management and the sustainability of CSR projects.

The study results showed that out of an initial 1400 publications searched in four databases, only six (6) publications qualified to be included in the study. Thus, stakeholder management in the sustainability of CSR projects is under-researched, with interest in the subject emerging in 2012. The research strategy for all the publications except that in the book chapter used qualitative research with a case study design. The data collection technique was primarily interviews. Purposive sampling technique was also mainly used.

The findings also showed that the studies focused on both CSR project process and product sustainability and that Stakeholder management impacts the sustainability of CSR projects. The emphasis was on effective stakeholder management impacting the sustainability of CSR projects. All the publications included in this SLR study were based on qualitative research strategy, thus, the impact of stakeholder management in the sustainability of CSR projects was not quantitatively assessed to determine the type and the level of impact. The finding may also be criticised because of the number of publications (six) included in the study and the few authors involved.

Limitation of Selected Studies

There are some limitations on the publications included in this study that may impact the results of these publications. The study by Ihugaba (2012) was limited to social reports and not respondents. It was also limited to one developing country and thus may suffer from geographical bias. Studies by Sarfo *et al*. (2016), Mbirigenda (2017) and Ansu-Mensah *et al.* (2021) were also limited to one developing country. All these studies used non-probability sampling techniques (maninly purposive sampling technique) to access respondents and study data. Additionally, Ansu-Mensah *et al.* (2021) used snowballing technique. Serfontein-Jordaan (2022) used homogenous sampling technique. Thus, all the results have limited generalizability. The limitations of publications included in this study are summarised in Table 7.

Table 7: Limitations of Selected Studies

S/No.	Study	Study Limitation
1	Ihugba (2012)	Research relied primarily on documentary analysis of company social reports and new paper reports of corporate activities. No respondents. The study was limited to one developing country (Nigeria), thus subject to geographical bias.
2	Sarfo *et al.* (2016)	The study was limited to Ghana, a developing country. Non-probabilistic sampling technique used, thus limiting the generalizability of study findings.
3	Mbirigenda (2017)	The study was limited to Tanzania, a developing country. Non-probabilistic sample bias limited the generalisability of study findings.
4	Rendtorff (2019)	-
5	Ansu-Mensah *et al.* (2021)	The study was limited to Ghana, a developing country. Non-probabilistic sample bias and limited the generalisability of study findings.
6	Serfontein-Jordaan (2022)	The study was limited to South Africa, a developing country, with a with non-probabilistic sample bias and limited the generalisability of study findings.

Conclusions and Further Research

The study revealed the state of knowledge or research in stakeholder management in the sustainability of CSR projects. The findings revealed a dearth of empirical research and, thus, contributions from authors. These provide a basis for further research on this subject matter in developed and developing countries. The study also revealed that stakeholder management may impact the sustainability of CSR projects. The study's findings also showed that all the empirical studies included in this research used qualitative research strategy with case study research design, thus limiting the generalisability of the findings. Further studies should consider quantitative research strategy with survey research design rather than the case study to explore this subject matter. This will allow advanced statistical methods such as structural equational modelling, among others, to be used for analysis. Also, only one publication in the study produced a conceptual framework of stakeholder engagement and sustainable CSR outcomes. Future studies can address this gap by empirically exploring a suitable, effective and efficient framework for stakeholder management in the sustainability of CSR projects.

Most of the studies were focused on the mining sector, with only one focusing on the manufacturing sector. This imply the need for more research in other industries such as the construction, banking, hospitality, telecommunication, forestry, oil industry, tourism and hospitality as identified in CSR studies (Olanipekun *et al*.,2020; Damoah *et al*., 2019) which were not examined in the empirical publications included in this study. Most of the studies were carried out in developing countries and thus subject to some level of geographical bias. Future studies covering developed countries are also advocated. All the included publications in this study used non-probabilistic sampling techniques in accessing respondents and study data thus limiting the generalisability of the findings. This is a critical knowledge and methodological gap which should be considered in future research to enhance the generalisability of research findings. Further research is thus required based on the limitations identified in the selected empirical publications.

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Health Consequences of Climate Change on Education and Sustainable Development

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Abstract

Education is a catalyst for the development of every country hence the need for quality education of the youths who shall become leaders of tomorrow. When students' health is threatened by the immediate and long term impacts of climate change, their education is undermined, as such the sustainable development strides of the nation becomes compromised. Nations are vulnerable to climate change impacts given the vagaries of climate conditions they experience. The present study investigated the health consequences of climate change on secondary school students in Ebonyi State. Following a descriptive survey design, 400 Senior Secondary School two (SS11) students were randomly sampled out of 8,376 students in Onueke Educational Zone, Ebonyi State, South-Eastern Nigeria. An adapted instrument with a reliability coefficient of 0.87 was used for this study. Responses were tabulated and categorized using descriptive statistics while hypotheses were tested at $p < 0.05$ level of significance. Findings from the study revealed that changing rainfall patterns, drought and high temperature impact negatively on their health causing serious health challenges like lack of concentration in the class, sleeping disorder and sicknesses resulting from bacterial infection, etc. Based on the findings, it is recommended that school authorities should organize workshops on effective coping strategies to address climate change. Tree planting and other environmental programmes should be instituted to involve students in practical community-based response to climate change

Keywords: Climate change, Climate impact, Ebonyi state, secondary school students, health consequences, coping strategies

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Introduction

The increase in industrial revolution has resulted to significant anthropogenic contribution towards climate change (Sulistyawati et al, 2018, Murshed et al. 2022). This includes activities such as fossil fuel burning, agricultural residues burning, deforestation and transportation among others (Haines, 2006; Huang et al. 2016). The changing climate is gradually becoming one of the most overwhelming threats in the environment (Pandve and Raut, 2011) with traceable effects such as flooding, deforestation, reduced crop yield, increased disease incidence and increased drought among others (Žurovec and Vedeld, 2019; Echendu, 2020).

Much concern is raised in the minds of people given the direct and indirect impacts of climate change on the environment and human health (Romanello, et al 2022; Sulistyawati et al, 2018; Crowley, 2016). Human health is adversely affected in a number of ways. Respiratory diseases like asthma become exacerbated as a result of rising global temperature. Agricultural production and food availability have been negatively impacted resulting to food insecurity and under-nutrition (Mank et al., 2021)

Adverse weather conditions impede smooth educational process for students across all age through its direct and indirect impacts. This is observed in countries which have experienced extreme climate disasters. In the face of climate disasters, stakeholders including teachers, students, parents and government are affected (UNICEF, 2019). It is reported that increase in the regularity and severity of climate-related disasters is common among low-income and developing countries (Leal et al., 2023). In Nigeria for instance, one of the prevalent threat of climate change is hydroelectric power generation (Ekpoh and Ekpoh, 2011). The country is experiencing seasonal reduction in her annual electricity generation due to drought conditions and this is getting worse. Above authors posited that electricity is major to a good studying environment thus its reduction has implications on the country's educational sector as students' health and comfort are affected especially the secondary school students.

Indirect impact of climate change on education could be seen in the form of migration by affected families, teachers inconsistency at school due to illness caused by climate disaster, teachers inadequate knowledge of how to educate school children who were absent as a result of climate disaster, absenteeism, impaired learning and relocation on the part of the students. Such displacement is reported to have instant impact on children's education. For instance, migration intensifies school dropout rates because of the involvement of those children in their families' recovery activities (Baez, 2021). The school buildings suffer reduced availability of safe water and meals, increased need for cooling or heating systems (UNICEF, 2019).

UNICEF (2023) defines education for sustainable development as the process of giving learners of all ages the knowledge, skills, values and agency to address interconnected global challenges including climate change, loss of biodiversity, unsustainable use of resources, and inequality. Secondary school students can be described as children between the ages of 12 years-16 years and specifically the senior secondary students range between 14 years – 16 years. They are early adolescents and part of the curricular processes which compliment learning in a school environment (Edikpa et al., 2016).

Unfortunately, climate change impacts have brought about increased frequency of heavy rainfall, strong winds, and storms. These constantly cause damage to school buildings and property posing possible harms to students' and teachers' health. Once the health of teachers and students are affected it will deprive them from attending school. Thus education for sustainable development will be undermined. Consequent upon these existing conditions, the present study was guided by the following research questions;

1. What is the impact of Rainfall Pattern on secondary school students' health in Ebonyi?
2. What is the impact of Drought on secondary school students' health in Ebonyi State?
3. What is the impact of High Temperature on secondary school students' health in Ebonyi State?

The following hypothesis were formulated and tested at $p < 0.05$ level of significance;

H_{01}: There is no significant difference in the mean response of male and female students on the impact of rainfall pattern on secondary school students' health in Ebonyi State

H_{02}: There is no significant difference in the mean response of male and female students on the impact of Drought on secondary school students' health in Ebonyi State.

H_{03}: There is no significant difference in the mean response of male and female students on the impact of High Temperature on secondary school students' health in Ebonyi State

Literature Review

Climate Change and Health

The single biggest global health challenge in this 21st century which affects the physical environment, ecosystem and their contacts with human beings has been identified as climate change (Vicedo-Cabrera et al, 2021; Romanello et al 2021). Thus, its adverse impact on human health is evidenced across literature (Hathaway and Maibach, 2018), ranging from untimely deaths resulting from natural hazards to transmissible ailments as a result of declined hygiene and excessive increase of pathogens (Lemery et al, 2021). This is more obvious among the vulnerable group; pregnant women, orphans, older adults and children. Their cases are worsened given their incapacitation for resiliency. For instance, children's more fluid intake, more air inhalation, greater food consumption coupled with involvement in several outdoor activities expose them to lately evolving environmental hazards (Zhiwei et al., 2012)

The consequences of climate change on human health are clearly evident in various countries of the world. Recent reviews on the impacts of climate change on health for instance in Ethiopia reveal child under-nutrition as a result of climate change all through the three agro-ecologies of Ethiopia (Hagos et al, 2014). The authors argued that climate change also influence the prevalence of infectious diseases. Another study by Birhane et al., (2014) revealed an overall average occurrence rate of under-nutrition as unconquerable by stunting (55.2%), underweight (42.5%) and wasting (10.1%) in Ethiopia. Rieckmann et al., (2018) reported an increase in cholera outbreak during periods of drought. By implication, droughts are associated with greater risk of diseases such as diarrhea and cholera, as a result of declined water source for hygiene purposes.

Research studies in few other countries have reported that very young children are particularly vulnerable to heat waves (Nitschke, et al., 2011) with associated related disasters like respiratory diseases, high rates of sleep disturbance, sadness, and other mental health impairments (Ahern, et al 2005). The report by Knowlton et al (2008) revealed an increase in heat-related illness among children between the ages of 0–4 years in California during the 2006 heat incident. Exposure to natural disasters has been reported to aggravate the situation of hopelessness, apprehension and pressure.

Omoruyi and Onafalujo, (2011) has reported some direct consequences of climate change in Nigeria as cerebra-spinal meningitis, cardiovascular respiratory disorder of the elderly people, skin cancer, high blood pressure, malaria, cholera and child and maternal health issues. From an empirical analysis of Brenda et al. (2018), 14,280 suspected meningitis cases were reported across 23 of the 36 states in Nigeria with 1145 deaths (8% case fatality rate) amid the suspected cases between December 2016 and May 2017. High temperature is a major cause of meningitis among children.

In addition to above, other direct consequences of climate change can be found in the agricultural sector with severe negative consequences on agricultural production and food availability leading to food insecurity and under-nutrition (Belesova, et al., 2019). The high dependence of West African countries on rainfall for their agricultural practices are adversely affected as evidenced in low farm yields and hiked food prices (Saronga et al., 2016). This situation is reported to lead families into adjusting their food sources and diets. Under such family conditions, children within the age bracket of 0-5years, with particular need for sufficient nutrients and food for their development and growth would suffer some insufficiencies which would manifest in a complex risk for impeded cognitive development, stunted growth and followed by death (Belesova, et al., 2018). Infants and children among few others have been identified as populations at higher risk to climate change health impacts with reports of their susceptibility to heat stress, vector-borne diseases, air pollution, food-borne diseases and malnutrition and drought-related water-borne diseases (Ebi et al., 2012).

Mortality occurs during floods and its recovery period as a result of drowning, non-fatal injuries like cuts and acute physical trauma (Clayton et al., 2014). Floods contaminate freshwater supplies, thus heightening the risk of water-borne diseases which creates safe breeding grounds for insects like mosquitoes with resultant effects of malaria and other water borne diseases (Factsheet, Climate Change and Health, 2016). With attendant increased risk of disease, more deaths of school children and reduced school attendance will occur because of their vulnerability to health hazards (BNRCC, 2011).

Climate change and Education

Adverse weather conditions impede smooth educational process for students across all age through its direct and indirect impacts. This is observed in countries which have experienced extreme climate disasters. In the face of climate disasters, stakeholders including teachers, students, parents and government are affected (UNICEF, 2019). It is reported that increase in the regularity and severity of climate-related disasters is common among low-income and developing countries (Leal et al., 2023). This has further denied the susceptible families and children access to education. In some cases school buildings and facilities like roads and bridges which connect rural communities have been ruined due to repeated climate-related events, ultimately affecting the quality of education and access to school premises (Kousky, 2016; Arndt et al., 2015). The inability of repairing or re-building destroyed school buildings results to further delay of access to education (Luetz, 2020). Direct impacts of climate change disasters like flood and cyclone include injury and mortality on the parents and inability to cover school expenses. In addition to afore-mentioned is inability to access the school premises by the teachers coupled with psychological stress on the students (UNICEF, 2019).

Indirect impact of climate change on education could be seen in the form of migration by affected families, teachers inconsistency at school due to illness caused by climate disaster, teachers inadequate knowledge of how to educate school children who were absent as a result of climate disaster, absenteeism, impaired learning and relocation on the part of the students. Such displacement is reported to have instant impact on children's education. For instance, migration intensifies school dropout rates because of the involvement of those children in their families' recovery activities (Baez, 2021).

Save the children, (2015) reported of 351 schools which were sub-merged by flood and consequently closed for three to fourteen days in Indonesia. Similarly, 803 schools were reported to have shut down for fourteen days as a result of heavy damage after Typhoon Koppu in Philippines. One can easily conclude that such closure would have automatically affected even the curriculum coverage of different school subjects in the affected towns. This ultimately would affect the quality of education offered to the children

Methodology

Study Area and population

This study was conducted in Onueke Education Zone of Ebonyi State. Ebonyi State is located in the South of Eastern Nigeria. It is one out of the six states created in 1996 and is located on the latitudes 5°40′ and 6°45′ north of the Equator and longitudes 7°30′ and 8°46′ east of the Greenwich Meridian. Tropical rainforest and derived savannah describe the climate of the state which is favorable for rice cultivation as the inhabitants are mainly farmers. As at 2023, Ebonyi state has been estimated to have a population of 3,046,287 persons (Nigerian Investment Promotion Commission, 2024). It is been reported that approximately 80% of the inhabitants live in poverty (National Bureau of Statistics, 2012) thus, validating the susceptibility of the state is to climate risks (Onyeneke, 2020).

Sampling procedure and Data collection

A research instrument titled “climate change impact and students’ health questionnaire (CCISHQ)” was adapted and used for data collection. The instrument was made up of four sections; A, B, C and D. Section A consists of questions requesting demographic information from each of the respondents, while section B, C and D were four point Likert scale items designed to elicit responses about impacts of rainfall, drought and high temperature on secondary school students health. The reliability of the instrument was determined using Cronbach Alpha after they were administered to another group of students different from the targeted sample. A reliability coefficient of 0.87 was realized which was suggestive of the instrument’s reliability (Benson and Ttitlayo, 2016)

Sample and Procedure

The study population comprised of eight thousand, three hundred and seventy six (8,376) senior secondary 11 students of public secondary schools in Onueke Education Zone of Ebonyi State. The study employed descriptive survey design which adopted a multi-stage random sampling technique. The first stage involved the selection of 5 schools from each of the four local government areas of the education zone totaling 20 schools. The second stage involved a random selection of twenty senior secondary 11 students from each of the 20 selected schools. This gave a total of four hundred (400) students who participated in the study. The study followed the research ethical guideline of Alex-Ekwueme Federal University as contained in her research policy. Thus, the purpose of the study was explained to the students by the research team, and the re-assurance of treating their responses anonymously was given. In this way, their consents to participate in the study were obtained. The research instrument was administered on senior secondary 11 students by the researchers in the twenty sampled schools. The instruments were retrieved from them afterwards and data collected was analyzed using descriptive statistics and t-test

Results

Data Presentation and Analysis

Research Question 1
What is the impact of rainfall pattern on secondary school students' health in Ebonyi?

Hypothesis
H01: There is no significant difference in the mean response of male and female students on the impact of rainfall pattern on secondary school students' health in Ebonyi.

The data that answered research question one is presented in the table below;

Table 1: Analysis of the responses of respondents on the impact of Rainfall Pattern on secondary school students' health in Ebonyi - n=400

S/N	Item statement	Mean	S	P-Value	Decision
1.	Heavy rains make my environment to become damp causing bacterial infections	2.65	.48	.13	Agreed, NS
2.	Flooding causes drowning of school children leading to death	2.54	.50	.55	Agreed, NS
3.	Excessive rains make me ill always due to prolonged cold	2.97	.85	.01	Agreed, NS
4.	Flooding contaminates our drinking water	2.60	.49	.38	Agreed, NS
5.	Heavy rains causes slippery roads leading to fall	2.62	.57	.07	Agreed, NS
6.	Heavy rains destroy our farms causing food shortage	3.20	.82	.26	Agreed, NS
7.	More rainfall causes more mosquito bites leading to Malaria	3.16	.76	.22	Agreed, NS

Source: Field study, 2023.

Key: SD-standard Deviation, N- Number of respondents, S= Significant, NS= Not Significant and Sig ≥.05

The data presented in table 1 showed that the mean rating of the respondents on the 7 items had their range from 2.54 – 3.16 and were all above the cut-off value of 2.50 on a 4-point rating scale. These however indicated agreed. Therefore, the mean of 2.54 – 3.16 showed that the respondents agreed that rainfall pattern negatively affect secondary school students' health in Ebonyi. The standard deviation of all the 7 items ranged from .01 to .55 which showed that the respondents were not too far from the mean and the opinion of one another in their responses on the impact of rainfall pattern on secondary school students' health in the state. The p-values on all the items were all greater than the alpha-value of 0.05. With the forgoing, we therefore accept the null hypothesis for the items and reject the alternate hypothesis. This means there is no significant difference in the mean response of male and female students on the impact of rainfall pattern on secondary school students' health in Ebonyi state.

Research Question 2

What is the impact of Drought on secondary school students' health in Ebonyi State?

Hypothesis

H_{02}: There is no significant difference in the mean response of male and female students on the impact of Drought on secondary school students' health in Ebonyi State.

The data that answered research question one were presented on table below;

Table 2: Analysis of the responses of the respondents on the impact of Drought on secondary school students' health in Ebonyi State - n=400

S/N	Item statement	Mean	S	P-Value	Decision
1.	Drought leads to crop failures resulting to food shortage in our house	3.25	.82	.02	Agreed, NS
2.	I get sick sometimes due to poor water quality from drought	3.21	.82	.05	Agreed, NS
3.	Drought has resulted to higher food prices leading to my parents inability to provide a balance diet for me	3.21	.85	.22	Agreed, NS
4.	We suffer water shortage in the beginning of every year because of dried water wells	3.25	.82	.05	Agreed, NS
5.	Drought impacts on the quality of air causing me respiratory allergies	3.12	.80	.07	Agreed, NS
6.	We suffer lack of water in the beginning of every year because of delayed rainfall	3.07	.81	.68	Agreed, NS
7.	A lot of children around my environment suffer Cholera as a result of delayed rainfall and drought	3.08	.82	.13	Agreed, NS
8.	Sometimes I have developed skin infections because I bath once a day since there is no water	2.99	.78	.88	Agreed, NS
9.	We suffer water-borne diseases within the first four months of the year due to drought	3.13	.77	.20	Agreed, NS

Source: Field study, 2023.

Key: SD-standard Deviation, N- Number of respondents, S= Significant, NS= Not Significant and Sig ≥.05

The data presented in table 2 showed the mean rating of students on the 9 items had their ranged from 2.99 – 3.25 and were all above the cut-off value of 2.50 on a 4-point rating scale. These however indicated agreed. Therefore, the mean of 2.99 – 3.25 showed that the respondents agreed that drought negatively affect secondary school students' health in Ebonyi. The standard deviation of all the 7 items ranged from .77 to .85 which showed that the respondents were not too far from the mean and the opinion of one another in their responses on the impact of drought on secondary school students' health in Ebonyi State. The p-values on all items were greater than the alpha-value of 0.05. With the forgoing, we therefore accept the null hypothesis for the items and reject the alternate hypothesis which means there is no significant difference in the mean response of male and female students on the impact of Drought on secondary school students' health in Ebonyi State

Research Question 3
What is the impact of High Temperature on secondary school students' health in Ebonyi State?

Hypothesis
H_{03}: There is no significant difference in the mean response of male and female students on the impact of High Temperature on secondary school students' health in Ebonyi State

The data that answered research question one were presented on table below;

Table 3: Analysis of the responses of the respondents on the impact of High Temperature on secondary school students' health in Ebonyi State n=400

S/N	Item statement	Mean	S	P-Value	Decision
1.	Extreme heat causes me poor concentration in the class	3.07	.79	.01	Agreed, NS
2.	High temperature causes sleep disorder for me	3.17	.81	.39	Agreed, NS
3.	High temperature makes me sweat profusely	2.94	.79	.93	Agreed, NS
4.	High temperature has influenced my mental health resulting to issues such as stress	3.20	.83	.26	Agreed, NS
5.	I drink so much water due to dehydration caused by extreme heat	2.65	.48	.13	Agreed, NS
6.	The smoke from bush burning causes respiratory health problems for me	2.54	.50	.55	Agreed, NS

Source: Field study, 2023.

Key: SD-standard Deviation, N- Number of respondents, S= Significant, NS= Not Significant and Sig ≥.05

The data presented in table 3 showed the mean rating of students on the 6 items had their ranged from 2.54 – 3.17 and were all above the cut-off value of 2.50 on a 4-point rating scale. These however indicated agreed. Therefore, the mean of 2.54 – 3.17 showed that the respondents agreed that High temperature negatively affect secondary school students' health in Ebonyi. The standard deviation of the 6 items ranged from .48 to .83 which showed that the respondents were not too far from the mean and the opinion of one another in their responses on the impact of High temperature on secondary school students' health in Ebonyi State. The p-values on the items were all greater than the alpha-value of 0.05. Going forward, we therefore accept the null hypothesis for the items and reject the alternate hypothesis. This means there is no significant difference in the mean response of male and female students on the impact of High temperature on secondary school students' health in Ebonyi State

Discussion

Data presented in table 1 showed that rainfall pattern negatively affect secondary school students' health in Ebonyi State. The finding of this study is in tandem with Edikpa et al., (2016) who reported that rainfall/flooding exacerbate diseases like malaria, pneumonia, ashma, diarrhea etc. Dimitrova, et al., (2022) reported that wet conditions increase the risk of cough and fever in humid, subtropical regions. It can also cause an increased effect on transmission of infectious disease by affecting pathogen survival and transport. Similarly, Nübler et al., (2020), posited that the negative impacts of rainfall shocks on education are as a result of numerous basic mechanisms including persistent effects on the health of children and the wealth of their households. Floods pose threats to human health by exposing individuals to debris and toxic materials, vector-borne illnesses and water-borne diseases which occur as a result of flood water (Clayton et al., 2014; Factsheet, Climate Change and Health, 2016).

Respondents as presented in table 2 accepted that drought negatively affects the health of secondary school students in Ebonyi State. This is aligns with the findings of Singh, et al., (2006) who reported higher malnutrition and mortality rates among infants and young children when compared with the older children and adults as a result of drought. Similarly, Rieckmann et al. (2018) reported an increase in cholera outbreak during periods of drought and drought-related water-borne diseases (Pe'er *et al*. 2017). By implication, droughts are associated with greater risk of diseases such as diarrhea and cholera, as a result of declined water source for hygiene purposes. Similarly, Ojala and Lakew (2022) reported that the devastating impact of climate change are felt on school's materials and human resources especially secondary school students' health which are considered vital to the achievement of educational goals and objectives

Results on table 3 showed that the respondents agreed to negative impacts of high temperature on the health secondary school students in Ebonyi State. This is in agreement with Omoruyi and Onafalujo, (2011) who reported that high temperature is a major cause of cerebra-spinal meningitis among Nigerian children, skin cancer, high blood pressure, malaria, cholera and child and maternal health issues. In congruence with above, infants and children have been identified as the population at higher risk to climate change health impacts with reports of their susceptibility to heat stress, vector borne diseases, air pollution, food-borne diseases and malnutrition (Ebi et al., 2012). Research studies in few other countries have equally reported that very young children are particularly vulnerable to heat waves (Nitschke, et al., 2011) with associated related disasters like respiratory diseases, high rates of sleep disturbance, sadness, and other mental health impairments (Ahern, et al 2005). Knowlton et al (2008) revealed an increase in heat-related illness among children between the ages of 0–4 year in California during the 2006 heat incident.

From the hypotheses results, no significant difference was found in the mean response of male and female students on the impact of rainfall pattern on secondary school students' health in Ebonyi State. There was no significant difference in the mean response of male and female students on the impact of drought on secondary school students' health in Ebonyi State. Finally, there was no significant difference in the mean response of male and female students on the impact of High temperature on secondary school students' health in Ebonyi State.

Conclusion, Implications & Recommendation

It is concluded that the health of secondary school students in Ebonyi State is adversely impacted by rainfall patterns, drought and high temperature. This study has educational implications in teaching and the general well- being of students. Climate change impacts cut across every sphere of life including the educational sector. Its ravaging effects are so enormous on students' health. If no action is taken by the government and schools to avert or mitigate these impacts, the future of our young children would be compromised as some may lose access to quality education due to poor health conditions. There is then the need to educate the schools and homes on simple coping strategies which could be adopted by children in and out of school.

The following are therefore recommended:

- Advance warning management systems should be provided for schools to monitor climate conditions and can support the disaster risk reduction process which will reduce the amount of drought effect on human health
- There should be more awareness creation and climate trainings for teachers and students on how best to manage the health challenges posed to them by climate change
- Cooling systems can be provided for schools by the government for use during intense heat periods

- Planting of trees in school premises should be revived by the government and school authorities. This would improve the ecosystem of such environments
- Further Studies

Further studies should be conducted to find out the coping strategies developed and adopted by secondary school students in the face of climate change impact on their health. Such study would unravel how equipped these students are with the necessary skills and knowledge to tackle this monstrous challenge.

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Developing A Public Value Framework for Infrastructure Projects in Ghana

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Abstract

Empirical evidence has shown the significance of public value implementation to the realization of the Sustainable Development Goals (SDGs). Hence, assessing public value in infrastructure projects has become popular in recent years. However, the assessment of public value is a long way from being translated into practice due to the lack of a framework for the implementation of public value infrastructure projects. Therefore, this study aimed at developing a public value implementation framework for infrastructure projects in Ghana. The study adopted a mixed research method using data from 82 survey questionnaires and 9 interview responses. The findings of the study showed an adequate awareness of public value by the practitioners but a scanty understanding of its implementation. Additionally, they acknowledge some critical challenges that could hinder the implementation of public value including political interferences, conflicting stakeholder perceptions of value, resistance to change and poor stakeholder engagement. Based on the theoretical and empirical findings of the study, an implementation framework for public value in infrastructure projects was developed and subsequently validated to assess the adequacy of the framework in terms of its overall content and completeness. This framework will guide practitioners in ensuring the implementation of public value in infrastructure projects. With the lack of an implementation framework, the outcome of this study provides a solid basis for ensuring public value implementation in infrastructure projects.

Keywords: Public value, Infrastructure projects, Ghana.

Introduction

The United Nations general assembly (Leaders from 193 countries of the world) adopted seventeen (17) Sustainable Development Goals (SDGs) to be achieved by the year 2030 (United Nation-UN, 2015). These goals comprise of several economic, environmental, and social concerns; hence a lot of work is required to realize the agenda in the rest of the coming years (Moratis and Melissen, 2019;

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Globescan, 2017). Empirical evidence has shown the significance of public value implementation to the realization of the SDGs. For instance, in Van Gestel et al. (2023), study, they acknowledged public value as a strategy for the achievement of SDGs. Additionally, Sami et al. (2021), noted that, public organizations in the quest to achieve public value drive towards the achievement of SDGs. Consequently, research on Public Value in the public sector has greatly increased providing a distinct pathway from new public management (NPM) paradigm (Bryson et al., 2014; O'Flynn, 2007). According to Moore (2003), public value can be described as principles that guide the operations of public organizations to create value for citizens through the delivery of quality public services. The Public Value approach is a new post- competitive paradigm that signals a shift from the primary focus on results and efficiency towards the achievement of a broader governmental goal of public value creation. The objective of public value is to offer public managers a simple instrument to articulate the goals of their organization. This theory shifts the focus of public sector management from within the organizational boundaries to society; from how to better produce public services to how to deliver public services that better satisfy those who will consume them (Panagiotopoulos et al., 2019). Therefore, public value has a strong association with what people believe in and value or consider valuable (Khanifah and Nurmandi, 2019). Consequently, public managers in addition to the achievement of performance targets, must create and maintain trust and respond to the collective preferences of the citizens as well as clients.

The public sector is typically the largest purchaser of infrastructure projects, however, due to the socio-political responsibility of public organizations, they have a special role in ensuring the realization of all public values (Kuitert et al., 2020). Public organizations are expected to contribute to social innovation, safety, protection of weaker population and built environment to create public value. However, the achievement of public value is a challenge that public managers and administrators face. Therefore, there is the need for a framework that will guide the implementation of public value in infrastructure projects. Studies on public value have mostly focused on its assessment (*see* Kuitert et al., 2020; Bryson et al., 2014; Cordella and Bonina 2012). The assessment of public value is a long way from being translated into practice due to the lack of a framework for the implementation of public value infrastructure projects. Hence this study aims at developing a framework to facilitate the creation of public value in public infrastructure projects in Ghana.

Literature Review

This section focuses on the review of pertinent literature on public value and infrastructure projects and existing public value framework. This led to the development of a conceptual framework for study.

Public value and infrastructure projects

With construction projects in the public sector, the client's organization is primarily the steering agent for the public value creation (Farrel, 2016). However, the collaborative nature required for value creation challenges public construction clients to create a balance between the different kinds of competing values whiles honoring the structures of authority and regime values within which they operate (Bao et al., 2013). In European countries, public value creation manifests itself within their Procurement Principles. In addition to these principles, product values such as sustainability, cultural heritage, quality of the public space, and performance values, effectivity and efficiency are also essential in the context of performing and completing construction related tasks (de Graaf and Paanakker 2015). Using mere principles poses a challenge as the government cannot determine on its own what public values represent. Public value is a reflection of what is expected by society of facilities and government (Bruiju and Dicke, 2006). In this context it is crucial to identify how public values can be achieved at different phases of the construction lifecycle.

According to Hughes et al. (2006), the ability to safeguard public values in construction projects depends on decisions made in the initial phases as there is the upmost flexibility at that stage. Within this phase, decisions are made on suitability and whether public values are safe in private hands. Public value principles demand there is an understanding of the vision and goals for the initiation of the project as well as an effective engagement of stakeholders (Treasury, 2019). It is expected that different value conflicts will arise during different phases of public service delivery and that trade-offs between performance values, procedural values, and product-related values in the construction context, will need to be made (De Graaf and Paanakker 2014). Clients will be called to account for the process as well as the outcome, and for individual incidents as well as aggregate patterns observed at each step along the way to public value creation (Moore 2000). It is important for the project team to also forecast resource requirements and acquire approval and legitimacy from the public by involving them in the planning and implementation process. Hence, the relationship between the client, users and the contractor are crucial for the effective achievement of public value for infrastructure projects.

Existing Public value frameworks

The concept of public value is perceived a new way of managing the public administration of institutions, However, Guarini (2014) indicated that, developing managerial tools faced with public value paradigm is still at its infancy and thus, there is the need to examine an elaborated approach towards public value measurement. There are existing frameworks on public value summarized in ***Table 1***. All these frameworks provide an ex-post approach to public value management. It is crucial to develop a proactive framework that seeks to focus on the implementation phase rather than diagnostics.

Table 1: Existing public value frameworks

Framework	Description
Generic public value framework	The public value concept can be attributed to Mark H. Moore's publication "Creating Public Value: Strategic Management in Governance" published in 1995 (Moore, 1995). According to Moore (1995), public managers must consider three issues simultaneously when expected to deliver value to citizens. These are: (1) Legitimacy and support from an authorization environment, (2) Operational capabilities of the managed agenda, and (3) Public value rooted in a task environment. This is popularly known as the triangle of public value. Legitimacy and support seek to provide a guarantee of development using public funds whiles operational capabilities allow the provision of certain services and goods through the limited resources that institutions have at their disposal. A public value strategy that is widely supported but without operational capacity, or with capacity and support but without a clear mission, will not produce public value. The three dimensions are interdependent, hence a failure in one area will undermine the creation of public value (O'Flynn, 2021).

Competing values framework (CVF)	The Competing Values Framework (CVF) was created by Quinn and Rohrbaugh (1983) and it combined the dimension of scope of control and the orientation of direction. The scope of control describes a rational model and organizational structure emphasizing stability and flexibility. The second dimension is associated with the shift of organizational focus from people within the organization to the entire organization. This leads to the creation of four management models known as control, compete, create, and collaborate. Each model describes the culture, leadership, effectiveness, and value drivers for the management. The CVF may be used in the assessment of performance and Talbot (2006) opined that it is possible to combine an appropriate set of measures for assessing them. Talbot (2006) combined these four competing values with the public value concept and developed a five dimensioned approach of assessing public value.
Public value scorecard	The Public value scorecard originated from the Balanced Scorecard (BSC) management tool. The authors of the BSC acknowledged the weakness of the model and proposed a modification of the model for non-governmental organizations (Kaplan and Norton, 2001). This modification was since the traditional BSC model was not appropriate for non- profit organizations. Moore (2003) made modifications to the model by adding the concept of strategic triangle of public value. This was aimed at developing a structure that shows how input is converted into value. The authors stressed the fact that value is not only created within an organization, but it stretches beyond the boundaries of the organization.
Performance management system	This system was proposed by Spano (2009) based on a business management perspective where public value created by a single organization can be measured through the achievement of the organization's desired outcomes and impacts Based on this approach, the general notion of Public Management System is executed as the basis for Public Value measurement (Bracci et al., 2014). This is based on four dimensions including intangible economic value, tangible economic value, social value, and public value. These four dimensions of the model must be connected to the planning and control instruments of the public organization through Key Performance Indicators creating an operational alignment (Bracci et al., 2014). In order to measure value, four dimensions are examined to which a normalized scale is applied for the evaluation of sacrifices and benefits. Metrics are related to the main dimensions. The Performance Management System plays an integrating role between creating and measuring public value.

Source: Author's construct, (2023)

Conceptual framework

The conceptual framework shown in ***Figure 1*** was adapted from the generic public value framework by Moore (1995). Moore (1995), opined that, in other to achieve public value, legitimacy and support from an authorization environment, operational capabilities of the managed agenda and public value rooted in a task environment must be considered simultaneously and kept in balance by public managers. However, inferring from Principal Agent Theory (PAT), it is also crucial to consider the interactions between principals and agents in the creation of public value. The conceptual framework depicts that ensuring public value in public infrastructure projects must encompass (2) pillars, legitimacy and support and operational capabilities. Legitimacy and support seek to provide a guarantee of development using public funds whiles operational capabilities allow the provision of certain services and goods through the limited resources that institutions have at their disposal. Public value focuses on what is most wanted by the citizen, and it depends on their perception. Thus, the implementation of public values must satisfy all these parameters. This is fully achievable when there is a complete comprehension of the issues that arise because of principles and agents associated with the task.

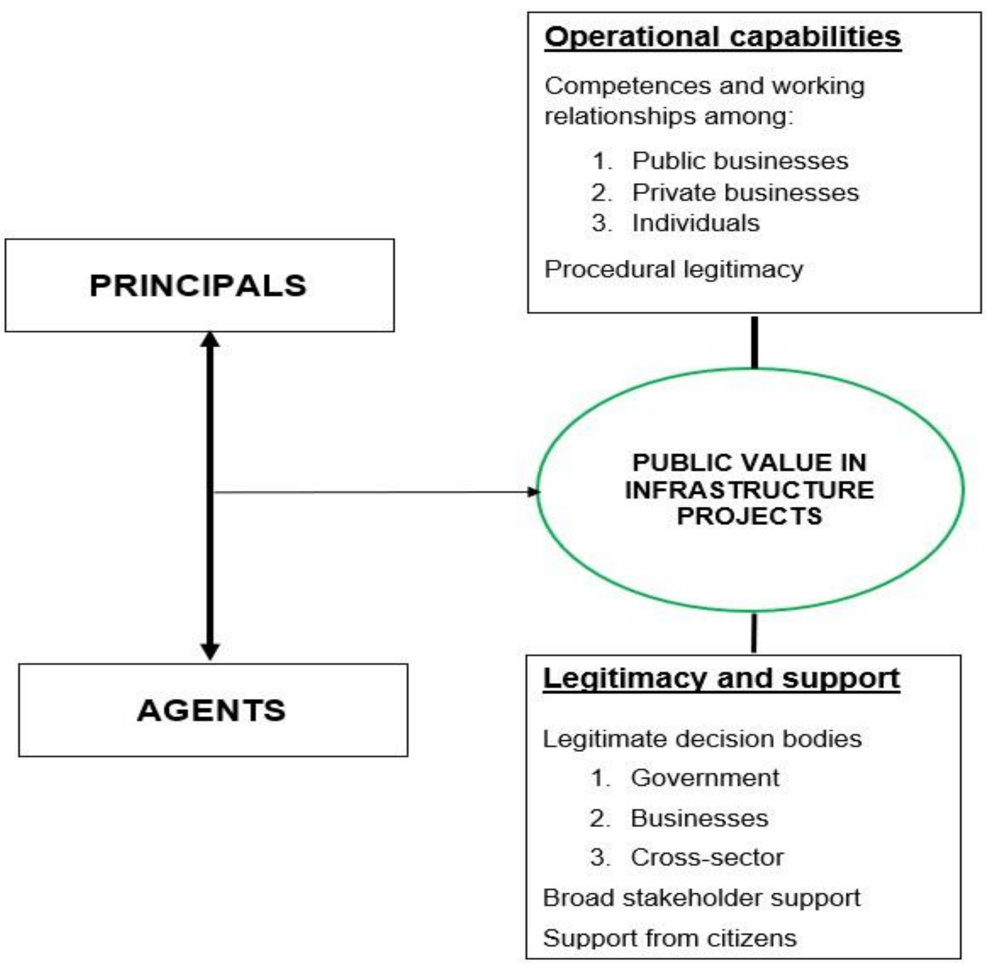

Figure 1: Conceptual framework

Source: Author's construct, (2023)

Methodology

The study sought to develop a framework to facilitate the creation of public value in public infrastructure projects in Ghana. In achieving this aim, it was crucial to seek the perception of expert procurement professionals on public value practices in infrastructure development and the challenges that may present themselves in public value creation. Quantitative data was collected on the public value practices whiles qualitative data was collected on the public value creation challenges. With the quantitative data, 82 valid responses were used out of 260 distributed and for the qualitative data, 9 interviewees were purposively selected based on their experience. Thus, an interviewee must be a Works procurement professional with more than five (5) years of experience. For the quantitative data, the respondents depicted a satisfactory educational level as 53.70% had postgraduate qualification, 36.60% indicated bachelor's degree and 9.80% indicated diploma qualifications. In terms of experiences, 52.13% had above 5 years of experience and 47.60% had 5 years and below. With the qualitative data, 77.78% of the respondents had postgraduate qualifications and 22.22% had bachelor's qualification. In terms of experience, all the respondents indicated have above 5 years of experience.

The quantitative data was analyzed with one-sample t-test whiles the qualitative data employed the use of content analysis. Using one-sample t-test at a 95% confidence level, one-tailed, a test value (μo) of 3.50 was set. This test value ensures that only practices with at least a moderate level of use are deemed significant. Hence, the following hypothesis were made:

- Ho: $\mu o = \mu 1$; Mean values are not statistical different from test value
- H1: $\mu o \neq \mu 1$; Mean values are statistical different from test value.

At one tailed, rejecting the null hypothesis implies that the mean value is significantly higher than the test-value hence the respondents significantly used the public value practice.

The public value framework development involved the review of relevant theories and inference from the discussed results to aid in the determination of appropriate parameters for the framework. Subsequently, the developed framework was validated. In other to ensure internal and external validation, individuals who were involved in the initial interview process and new participants were used.

Results

The results on the level of use of public value practices are shown in ***Table 2***. The inferences made from the results are as follows:

1. None of the statements had p-values < 0.05 hence we fail to reject the null hypothesis (Ho) and conclude that all the mean values are not statistically different from the test value.
2. Some of the statements had negative t-values depicting that, the statistical difference was negative values. Thus, some statements had mean values less than 3.50.
3. The responses indicated that public value practices are not adequately implemented in the public sector.
4. All the standard deviations were greater than 1.00 depicting variations among the responses.
5. The public value practice that had the highest level of use was "Implementation of cost control practices" [t-value = 1.818] followed by "Implementation and monitoring the achievement of project goals" [t-value = 1.583].

Table 2: Level of use of public value practices in infrastructure projects

Statements	SD	T-value	P-value
Understanding the vision and goals that warranted the project initiation	1.238	0.535	0.594
Ascertaining the extent required for the achievement of the project goal	1.354	(1.794)	0.077
Implementation and monitoring the achievement of project goals	1.395	1.583	0.117
Development of processes for managing resources	1.421	(0.700)	0.486
Forecasting resource requirement	1.256	0.704	0.484
Project objectives benchmarking	1.392	(0.872)	0.386
Implementation of cost control practices	1.397	1.818	0.073
Acquiring approval and legitimacy from the public and taxpayers	1.476	(2.544)	0.013
Involvement of client and users in project planning and implementation	1.441	0.306	0.760
Development of project team capacity to manage delivery	1.340	0.742	0.461
Effective stakeholder management	1.533	(0.288)	0.774

Source: Author's construct, (2023)

The purposively selected expects were interviewed on the potential challenges that may hinder the creation of public value. Some excepts on the responses from the interviews conducted on the challenges are as follows:

"In the quest to implement public value, the major challenge is getting what exactly value is from the various and key stakeholders. Their perception of value may conflict on interfere with other stakeholders' perception of value."

"In my opinion, stakeholder consultation has always been inadequate as the project scope is determined at the high level governed by politicians and leaders of civil society organizations."

"Measuring the impact of public initiatives can be challenging as it is often difficult to quantify the value created for the public. This can make it difficult to evaluate the success of initiatives and make informed decisions about resource allocation."

General inferences from the results showed that, the challenges to the creation of public value included political interferences, conflicting stakeholder perceptions on value, resistance to change and poor stakeholder engagement.

Discussion

The results showed that public value practices are not adequately implemented in the public sector. This could be attributed to the lack of awareness of knowledge in the application of the concept. Public values reflect the beliefs of a society in terms of what is important in the production of certain products or services and the responsibility of the government (De Bruijn and Dicke, 2006). For a value to be called public, there must be a collective benefit. Hence Van Der Wal et al. (2008), indicated that public values focus on meeting shared expectations. Public value reflects what is expected by society of facilities and government (Bruijn and Dicke, 2006). In this context it is crucial to identify how public values can be achieved at different phases of the construction lifecycle. With the lack of implementation within the public sector, it was important to further explore the challenges that hinder its implementation and develop a framework to facilitate public value implementation.

With regards to the results on the challenges to public value creation the emanating factors were political interferences, conflicting stakeholder perceptions on value, resistance to change and poor stakeholder engagement. After a contract is awarded, the client must shift its focus to managing the contract. At this phase resources must be deployed towards monitoring to oversee the implementation of the contract. It is expected that different value conflicts will arise during different phases of public service delivery and that trade-offs between performance values, procedural values, and product-related values in the construction context, will need to be made (De Graaf and Paanakker 2014). This was a critical challenge identified by the interviewees pertaining to crucial issues stakeholder value conflicts. Additionally, Bruiijn and Dicke, (2006), indicated that public value reflects what is expected by society of facilities and government. Hence, the government alone cannot determine on its own what public values represent. However, in many situations, project scope decisions are taken by the government officials. This interference hinders the achievement of public value.

The public value framework

The developed framework was based on the conceptual framework as the creation of public value in public infrastructure projects must focus on legitimacy and support, operational capabilities, and the task environment. Hence each step within the process falls within a category within the public value triangle. The validated framework is shown in Figure 2 and Table 3 provides a vivid description its implementation.

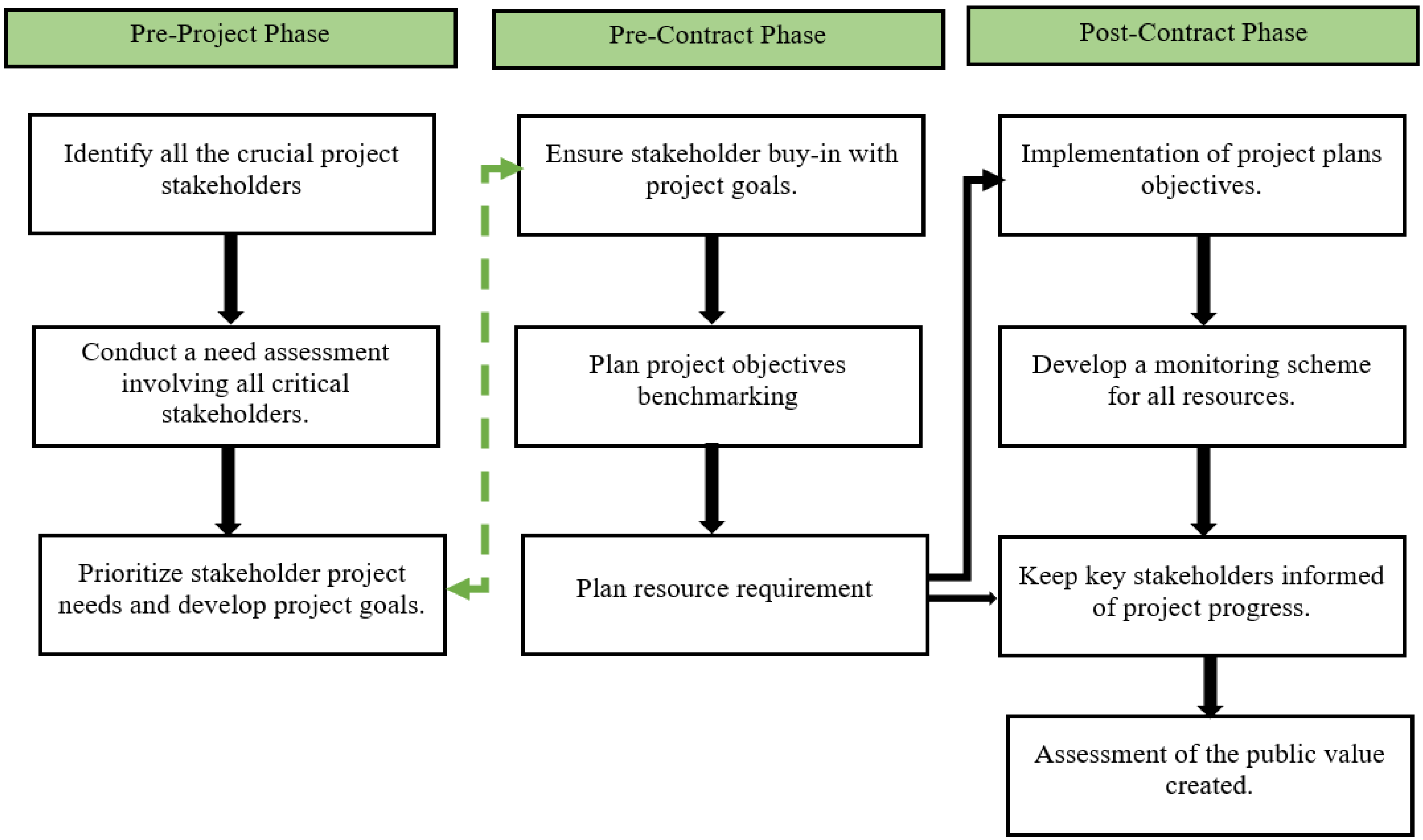

Figure 2: Validated public value framework.

Source: Author's construct, (2023)

Table 3: Description of the validated framework

Public value triangle	Description
Task environment	**Identify all crucial stakeholders.** The identification of crucial stakeholders falls under the task environment theme as the criticality of the stakeholder depends on the nature of the project and the community within which it is been executed. The identification of stakeholders is a first crucial step for public sector projects as it facilitates the overall process of stakeholder engagement. The identification process can be done for each project or as a one-off process and the outcome subsequently adopted for specific projects. The assessment of the criticality of the stakeholders can be facilitated with the power interest matrix which classifies stakeholders in relation to the power they hold and their level of interest in the project (Newcombe, 2003).
Task environment	**Conduct a need assessment involving all critical stakeholders.** Needs assessment involves the investigation of the situation of a community to determine, prioritize and satisfy their project needs. This is done to ensure that the scarce resources are put to good use. Needs assessment was also categorized under the task environment theme as the process will only be comprehensive if critical stakeholders within the community are involved. Needs assessment is a pre-project activity that helps to identify the projects requirement of the community and decide on the one that is more critical.
Legitimacy and support	**Prioritize stakeholder project needs and develop project goals.** The aim of prioritizing project needs is to ensure that only the most critical project for the community is implemented. Thus, scarce resources can be put to good use. After a decision is made on the most critical project for the community, the project team must develop goals that must be met by the selected project. The goals are crucial to the development of an appropriate scope for the project. An effective prioritization of project goals will facilitate an effective development of project goals as the overall vision for the area will be captured through the process. Additionally, prioritizing stakeholder needs leads to an increase of the legitimacy and support from the stakeholders.
Legitimacy and support	**Ensure stakeholder buy-in with project goals.** In as much as the stakeholders are involved in the process of prioritization, it is important to leverage the legitimacy and support by ensuring that, the goals that are developed for the project are understood and accepted by the stakeholders. This may be an iterative process as a total stakeholder buy-in on the project goals is very critical. This is also the first step in public value implementation in the pre-contract phase. The vision and goals of the project must be well understood by the stakeholders in other to ensure their unequivocal support.

Operational capabilities	**Plan project objectives benchmarking** The developed goals provide the foundation for planning the objectives that need to be achieved by the project. The objectives may include benchmarks on scope, budget, schedule among others. Benchmarking the project objectives also gives an indication of the required capabilities to effectively execute the project. Hence it forms part of the operational capabilities theme which allow the provision of certain services and goods through the limited resources that institutions have at their disposal.
Operational capabilities	**Implementation of project plans** Project implementation is typically the responsibility of external firms deemed capable of meeting the goals and benchmarked objectives of the project. The public institution's role are mostly limited to the monitoring of the implementation process to ensure the goals and benchmarked objectives are met.
Operational capabilities	**Develop a monitoring scheme for all resources**. This is crucial step to ensuring public value as it ensures all activities are implemented as planned. Monitoring must be done with a pre-developed scheme which seeks to keep an eye on all the benchmarked objectives and progress to its achievement.
Legitimacy and support	**Keep key stakeholders informed of project progress.** Throughout the entire implementation process, the public institution must monitor the project progress in-terms of the objectives. Additionally, it is highly crucial to keep information flow between stakeholders to continually keep their support. The legitimacy and support of stakeholders is crucial to public value, hence throughout the entire project, crucial stakeholders must be kept informed on the project progress.
Task environment	**Assessment of the public value created.** After the entire process, it is crucial to assess if public value has been successfully created. This can be done using any of the public value assessment frameworks. For instance, the public value scorecard.

Conclusion

Public value is regarded as a potential concept to the achievement of the SDGs. Hence, there is a growing significance of achieving public value in infrastructure development. With the lack of a typical guideline for facilitating the creation of public value in infrastructure project the study sought to develop a public value framework for Ghanaian infrastructure projects. The study showed that public value practices are not adequately implemented in the public sector, cementing the need for a framework to aid in public value creation. However, the study took note of challenges that hinder the implementation of public value practices to include political interferences, conflicting stakeholder perceptions on value, resistance to change and poor stakeholder engagement. These outcomes facilitated the development of the public value framework. The frameworkwas validated as a means of assessing the adequacy of the framework in terms of its overall content and completeness.

The study contributed to knowledge by highlighting the challenges that limit public value creation in infrastructure projects. Prior to this, studies on public value creation challenges were lacking. Further to this, the study developed a framework for public value in infrastructure projects. This is regarded as a significant contribution to knowledge as none exists for infrastructure development. This framework can be readily adopted in practice by public project professionals to facilitate the implementation of public value in infrastructure projects. This study showed the wide acceptance of public value leading to the realization of SDGs. However, empirical evidence to support this assertion is lacking. This creates an avenue for researchers to investigate the extent to which public value leads to the achievement of the SDGs.

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TRACK 3: SOCIAL INNOVATIONS, ENTREPRENEURSHIP & INDIGENOUS KNOWLEDGE MANAGEMENT IN AFRICA

Analysing the Construction Startup Ecosystem: Challenges, Opportunities, and Future Prospect

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Abstract

The construction industry is a cornerstone for economic growth and quality of life. However, it has lagged behind other industries when it comes to technological transformation. As a result, it has failed to yield benefits like process improvements and product innovation that come with technological advances that other industries have enjoyed in the last few decades. However, in the last few years, we have seen a surge of innovative startups that aim to address the challenges the construction industry faces. Thus, this paper seeks to explore the construction technology startup ecosystem by examining its challenges, opportunities, and what the future looks like for the ecosystem. A review of relevant literature was conducted from conference articles and journals from databases like ResearchGate, Emerald, etc. The selection of literature reveals that startups play an essential role in driving innovation, sustainability, and efficiency. The fragmented nature of the construction industry makes it difficult for stakeholders to adopt innovation. Lastly, the industry needs to invest in talent and collaborate more to yield results that come with innovation. This paper is essential because it gives an overview of the construction startup ecosystem. Thus, it will help investors, founders, policymakers, and various construction stakeholders with the necessary insights that will help them foster innovation and digitalization within the sector.

Keywords: Built Environment Startups, Construction, Ecosystem, Innovations, Technology.

Introduction

The phenomena of rising startups have contributed immensely towards global economic growth (Oyewole, 2020). Furthermore, Agenda et al. (2016) suggest that the construction industry is obligated to adopt technological advances due to two global megatrends: Rising population and green gas emissions. The construction industry has gone through decades of under-digitalisation thus the future needs to be led by an entrepreneurial ecosystem. Entrepreneurial ecosystems are combinations of social, political, economic, and cultural elements within a region that support the development and growth of innovative startups (Spigel, 2017).

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This connectivity is also embedded within the Built Environment (Johnson et al., 2019). According to Blanco et al. (2018), the construction industry is making a bold move, with more than $60 Billion in investment toward construction technology startups, in less than a decade, resulting in over 2400 technology solutions. These startups span across 3-D Printing, Modularisation, and Robotics; digital twin technology; Artificial Intelligence (AI); Analytics; Supply Chain Optimisation; and Marketplaces (Blanco, 2019). Therefore, the objective of this paper is to look at the growth factors of construction startups, explore challenges, and discuss growth opportunities.

The word startups perforate around mainstream and non-mainstream environments, from boardrooms, media, and parliaments to academia. Besides, being a popular Buzzword, the word startup doesn't have a clear academic definition. As a result, it has multiple definitions. These are some of the definitions found in the literature: Startup is a promise to a new, better, and modern kind of work (Marwick, 2013), Startups are organized around the love of work (Gill, 2002), and new urban environments and ways of living (Florida, 2005). Therefore, this article will attempt to define startups as a company that is innovative and based on new ideas. As a result, startups build completely new products or services that are not based on any existing product.

Research Methodology

This paper is based on extant literature published in journal articles, conference papers, and industry reports to highlight the construction startup ecosystem. Specifically, the majority of the relevant literature was taken from the ResearchGate and Emerald databases. Literature was extracted using the following search criteria that included the following combination of keywords: Construction AND Startup, Construction AND Innovation, Ecosystem AND Startups, Built Environment AND Innovation, Technology AND Construction, and Built Environment AND Startups. The searches were restricted to the keywords in the title, abstract, and keyword combinations in retrieved articles. From the shortlisted articles, the works of Gill (2002), Lam et al. (2019), Johnson et al. (2019), Oyewole (2020), Agenda et al. (2016), Spigiel (2017), Blanco et al. (2018), Szarek and Piecuch (2018), and Marwick (2013) were considered.

Challenges

The challenges are not ranked in any particular order in Table 1 below.

Table 1: Challenges of Construction Technology Startups

Challenges	Explanation
Customer Fragmentation	An average construction company employs 10 people at the back office; and has over 100 employees and suppliers dedicated to a specific project. This means a startup has to sell to a huge number of people which can make sales labour intensive.
Multiple Customer Personas	It's hard for startups to identify real customers since a buyer might not be the end-user, and the user might not be the one responsible for payments. For example, a customer could be a project manager, IT Manager, or Procurement Manager. This has the potential to raise customer acquisition costs.
Low Margins and Economic Headwinds	The construction industry is a low-margin industry and faces a lot of economic headwinds like labour, and material price inflation. This makes it difficult for startups to convince construction firms to spend money on software
Finding Talent	Finding people with industry knowledge and software engineering is a major problem for startup founders

Source: Blanco et al. (2018) and Blanco et al. (2023)

Opportunities

The opportunities in Table 2 are not ranked in any particular order.

Table 2: Opportunities for Construction Technology Startups

Opportunities	Explanation
Digital Transformation and Automation	The COVID-19 pandemic has altered the way construction companies do business from scheduling to meetings. This has accelerated the demand for digital solutions in the construction industry (Taher, 2021)
Green and Sustainable Construction	The construction industry contributes immensely to global pollution. To honour the Paris Agreement, it needs to take a new direction of emitting less CO2. Thus, there is a demand for solutions that will help the industry to go green Agenda et al. (2016)
Modular and Prefabricated Construction	The population of the world's urban areas is increasing by 200 000 per day. This means there is a need for affordable housing built with speed to address this rising population.
Internet of Things and the Building of Smart Cities	The Internet has moved beyond powering electrical appliances. It is the engine behind the development of cities and smart factories. IoT will be crucial in developing sensors that will capture data in real time, throughout the lifecycle of a building (Taher, 2021)

Source: Taher (2021) and Agenda et al. (2016)

Future Prospects

The future prospects are not ranked in any particular order in Table 3.

Table 3: Future Prospects for Construction Technology Startups

Future Prospects	Explanation
Artificial Intelligence and Analytics	AI and Data Analytics have boundless future use cases in the construction industry.
3-D Printing, Modularisation, and Robotics	The construction industry is moving towards being like the manufacturing industry. Where dome of the parts are produced offsite. This growing further with the development of 3-D Printing, Modularisation, and Robotics. This will increase the industry's productivity by 2X.
Digital-Twin Technology	Digital twin technologies provide real-time transparency of the project's progress. All of the projects with 3-d models replica of the real site activity.
Investments	Between 2020 and 2022 about $50 Billion was invested in construction technology startups. This shows that investors have an appetite for construction startups. This trend will continue to grow in the future since the industry is waking up to digitalisation.

Source: Blanco et al. (2018) and Blanco et al. (2023)

Lesson Learned and Conclusion

Through literature review, this paper gave an overview of the startup ecosystem: highlighted the challenges, showcased opportunities, and presented growth opportunities within the sector. The literature review results showed that customer fragmentation; multiple customer personas; low margins and economic headwinds; and finding talent are among the challenges faced by construction startups. In light of these challenges, these are the opportunities within the sector: transformation and automation; green and sustainable construction; modular and prefabricated construction; Internet of Things (IoT), and the building of smart cities. Furthermore, literature revealed that the future growth prospects of construction startups will come from the following: Artificial Intelligence (AI) and Analytics, 3-D Printing, Modularisation, and Robotics, digital-twin technology, and investments. As a result of this paper, further research can be conducted in different countries and regions across the world. Highlighting construction technology startup trends, challenges, and opportunities. Comparison studies of different geographical regions need to be done.

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Gender Issues in the Construction Industry: An Analysis of Research Trends

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Abstract

Gender issues persist as significant concerns, particularly within male-dominated working environments. Despite the growing volume of scholarly literature addressing gender challenges in construction, there remains a notable absence of comprehensive evaluations synthesizing this extensive body of work. The study examines global research trends concerning gender issues within the construction industry. Employing a bibliometric analysis facilitated by VOSviewer, the study utilized key search terms including "gender," "construction," and "industry." At the outset, 1,030 papers were identified using these keywords. Following refinement of the dataset by language, document type, and keywords, a total of 679 papers were considered suitable for analysis. The most influential studies on gender issues in construction have predominantly originated from the United States of America, the United Kingdom, and Australia. These studies have primarily addressed topics such as women's employment, gender disparities, status, and discrimination. Current research trends in gender within construction are shifting towards themes such as work-life balance, workplace policies, and mental and occupational health. This shift signifies a transition from solely focusing on gender challenges to emphasizing gender empowerment through initiatives aimed at improving work-life balance, implementing pro-women workplace policies, and prioritizing their mental health and well-being in the workplace. This shifting research focus is positioned to draw in and maintain a greater number of women within the construction sector.

Keywords - built environment, mental wellbeing, occupational health, pro-women workplace policies, women, work-life balance

Introduction

An increasing volume of literature acknowledges the significance of women professionals in their careers and delves into the challenges they encounter, especially within male-dominated sectors (Amaratunga et al., 2020; Ofori, 2024). Recognizing and leveraging the valuable contributions

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that women offer to the construction industry, and increasing their representation as construction professionals, will significantly contribute to alleviating the widespread skills shortage experienced by the global construction sector. In the construction industry globally, the issue of gender has become topical because of the hope that women can fill in the skill shortages that have risen (Kwauk & Wyss, 2023).

Nevertheless, the presence of women within the construction industry remains notably sparse. Women constitute only about 9–13% of the workforce (Navarro-Astor et al., 2017). Several obstacles impede women from entering and staying in the construction sector, such as its predominantly male-oriented work culture (Powell & Sang, 2015), discrimination (Amaratunga et al., 2015) low retention (Hasan & Kamardeen, 2022) poor career progression (Starks, 2021), lack of role models role models (Amaratunga et al., 2008), hostility and sexual harassment (Watts 2009), gender stereotyping (O'Connor, 2021), poor work life balance (Ola-tunji et al., 2021).

Increasing females' participation is advantageous to the sector. Firstly, womenfolk will make up for the current skills shortages in the industry thereby increasing the productivity and performance of the industry. Secondly, it will improve the gender diversity of the industry leading to better problem-solving capabilities of the workforce, better risk management and increased profitability.

What is more, studies on the trend on gender issues research in the construction industry can provide awareness of future areas of research focus which is scarce. This study fills this gap by assessing the global research trends on gender issues in the construction industry. This study assesses global research trends on gender issues in the construction industry.

The objectives are:

1. Identify the continent and nation having the highest volume of journals concerning gender in the construction industry.
2. Determine the most frequently cited publication in this area of study
3. Evaluate primary document sources with the greatest number of articles discussing gender in the construction industry.
4. Analyze the most commonly explored keywords or themes in research focusing on gender within the construction industry.

Data was collected from Scopus database. One of the most important databases covering a variety of scientific subjects is Scopus, which is utilized most commonly by researchers. Published journal articles and conference proceedings in construction-related academic fields, including manufacturing, the energy sector, material sciences, and environmental sciences, were the main sources of pertinent literature found during the search. The rationale behind the selection of journal articles was that they are seen as more dependable sources of information and are perceived to be more succinct and comprehensive than other sources."Gender," "construction," AND "industry" were the three main search terms that were used. Data collected was then analyzed using VOSviewer software.

The positive role that women's participation plays in solving the skills shortage problem is one that the global construction industry has yet to fully understand, accept, and embrace. This work will generate fresh insight into how the construction sector can capitalize on the benefits of employing a more diverse workforce. Only one database- Scopus database was used for this research study. The first section of the paper examines the construction industry and the female gender within the context of the industry. It highlights the rationale for selecting this topic. It then proceeds to discuss the research method. The last section analyses and discusses the findings while providing areas for future research.

Literature Review

Evidence suggests that masculine culture, long working hours, discrimination, unequal pay, unsafe working environment and poor conditions of work are among the most important factors affecting female professionals who work in the construction industry. Discrimination in the workplace has long been an issue of great interest in a wide range of sectors. Research by Shrestha et al. (2020); Norberg & Johansson (2021); Ho (2023) and Pamidimukkala, A., & Kermanshachi, S. (2023), revealed that women have being facing discrimination in the construction workplace. Their work was not valued as much as the work done by men and this resulted in them being paid less than men. Abdulmalik and Tabibi (2023). argued that construction organizations which are proactive in providing fair and equal treatment to their male and female employees stand a greater chance of retaining the female employees they have recruited (Abdulmalik & Tabibi, 2023). More so, in 1999, Dainty et al., (1999) interviewed 40 matched pairs of male and female construction professionals to find out the impact of gender on career progression within the industry. Their findings revealed that the hostile and discriminatory work environment in addition to the pressures created by the demanding work environment, compounded by overt resentment from male managers and colleagues posed a major challenge for women. They further argued that women's careers are unlikely to progress in parity with men's until the masculine culture of the industry has undergone reformation. Gale (2003) and George & Loosemore (2019) further opined that the image of the construction industry was affecting how the industry is viewed and that this played a great role in how women are viewed in the industry.

Similarly, Akinlolu et al., (2021) and Abdelwahed & Soomro (2023) argued that workers in this sector continue to face occupational hazards which have put their lives at risk. These traditional and multifaceted dangerous workplace environments serve as a major barrier to women who choose to work within the construction industry. Pamidimukkala and Kermanshachi, (2023) further asserted that women continue to be under-represented in this sector as a result of the management structure, masculine culture and the dangerous environment in which construction workers are expected to work on a daily basis. The construction industry has been identified as being notorious for having a high number of accidental deaths and constantly failing to comply with health and safety legislation on construction sites. In addition, Akinlolu and Haupt (2020) opined that the nonchalant attitude of construction project managers/contractors to providing a safe and conducive environment including safety gear for its workers continues to be a serious concern for women who want to work in this field.

Research Method

This study assessed the research trends on gender issues within the construction industry. It made use of bibliometric analysis to achieve its aim. Bibliometric analysis is used to assess trends in a specific domain from a large volume of scientific data (Visser, Van Eck and Waltman, 2021). The study used data from Scopus being a large data base with a relatively more comprehensive journal coverage (Olawumi, Chan and Wong, 2017). Scopus was used in this study also because it was the only data base accessible to the authors.

The objectives are:

1. Identify the continent and nation having the highest volume of journals concerning gender in the construction industry.
2. Determine the most frequently cited publication in this area of study
3. Evaluate primary document sources with the greatest number of articles discussing gender in the construction industry.
4. Analyze the most commonly explored keywords or themes in research focusing on gender within the construction industry.

The search for relevant and suitable journal articles and conference proceedings centered primarily on carefully examining published journal articles and conference proceedings. The selection of journal articles was grounded in their reputation for reliability as a source of knowledge and their comprehensive nature compared to other sources, as discussed by Zhang, Rousseau, and Glänzel (2016) and Webster and Watson (2002). Likewise, He and Cha (2022) highlighted seminar proceedings as reliable sources for literature reviews, thus justifying their use for this study.

The key words used were “Gender”, “Construction”, AND “Industry”. Publications with these key words appearing in their title, abstract and keywords were selected. During the first search attempt, 1030 documents were mined. These papers were filtered and refined to ensure that the papers were construction-related and relevant to the aim of the study. After cleansing, 678 documents remained. Figure 1 shows the steps used to carry out this study.

The findings were presented by placing the country/region with the highest publication count first, followed by the publications per document sources, then top-cited documents, and lastly the most frequently researched keywords. Co-occurrence network maps were generated using VOSviewer software. VOSviewer software is widely utilized in literature reviews for visualizing bibliometric networks. VOSviewer boasts a user-friendly interface and is particularly adept at representing larger networks due to its utilization of distance-based visualizations rather than graph-based ones (Van Eck and Waltman, 2014).

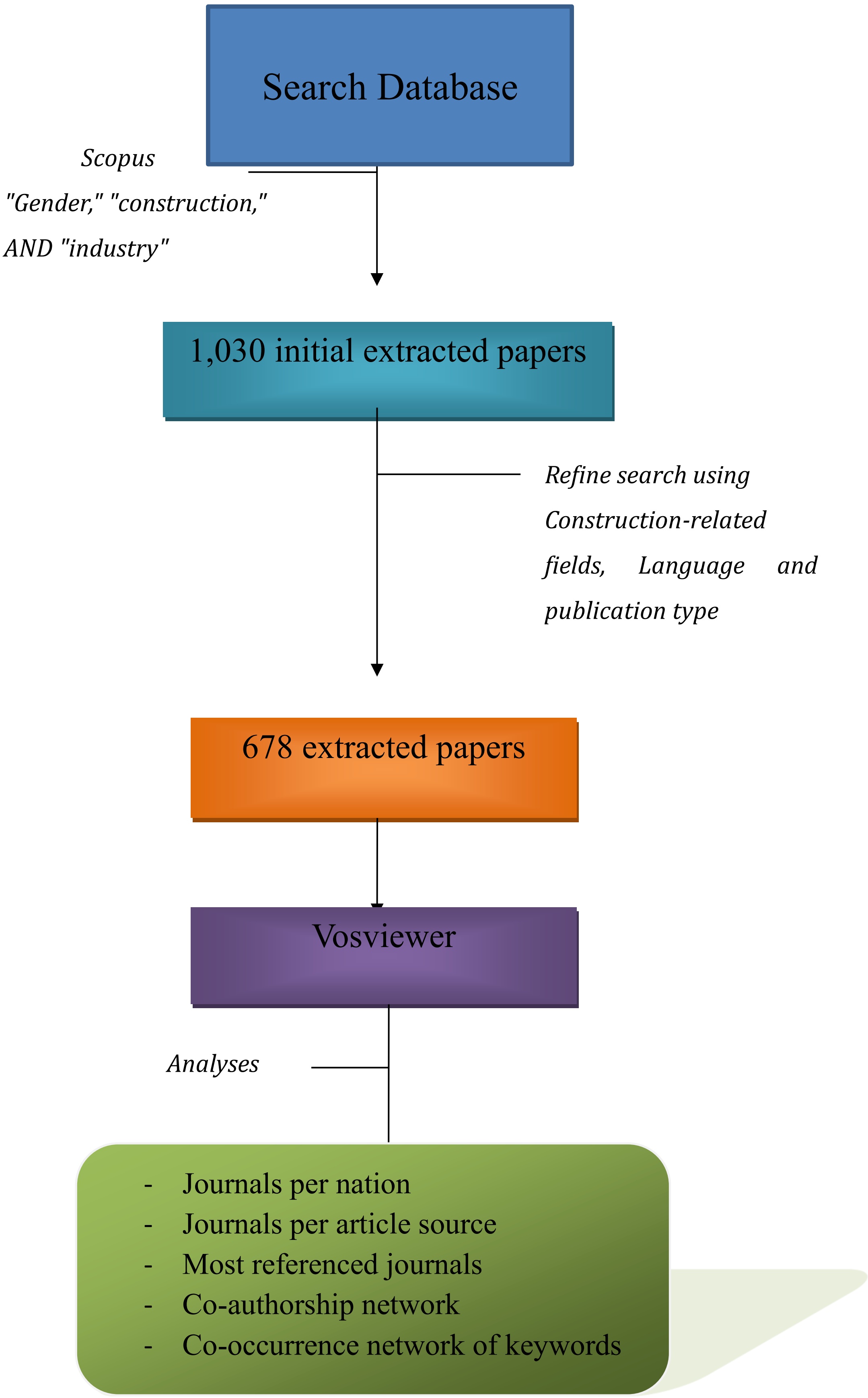

Figure 1: Research Framework

Result and discussion

The continent and the nation having the highest number of journals on gender issues in the construction industry

Any nation having at least one published manuscript even without a citation were taken into consideration when ranking the nations that have contributed to research in this area of study. The global distribution of research studies on issues pertaining to gender difficulties in the construction industry is depicted in the map in Figure 2. Europe leads across the globe in the number of published research on gender issues in the construction industry, with 243 documents. The Americas, with 184 papers, comes next. After that, there are 113 documents from Asia, 110 documents from Australia/Oceania, and 51 documents from Africa. Europe also leads in terms of references with 3,836 references, followed by Oceania (2500 references), Asia (1,649 references), North America (430 references), Africa (424 references) and South America (11 references).

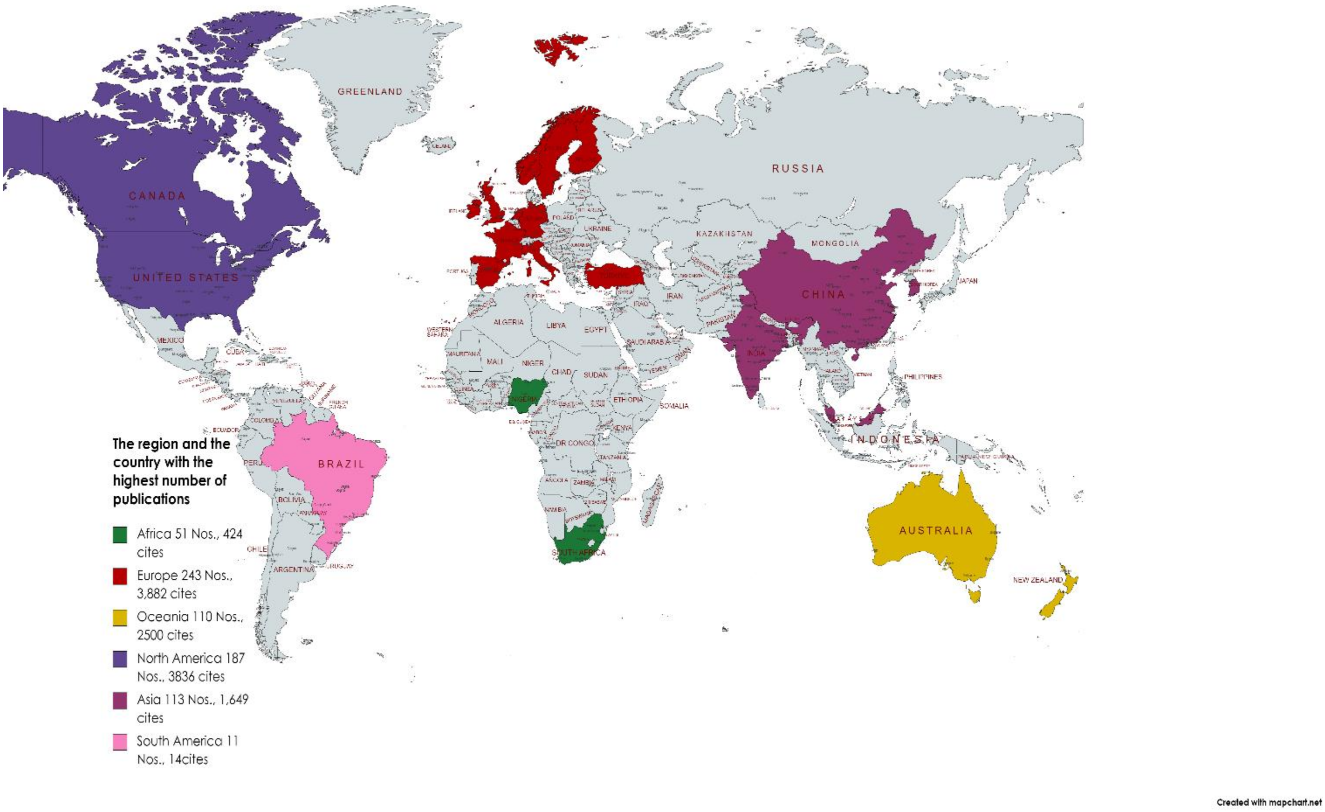

Figure 2: The continent and the nation having the highest number of journals on gender issues in the built environment

Table 1 shows countries that have contributed to research on gender issues in construction by continent and worldwide. In Africa, South Africa has 41 published documents and 300 citations. In Asia, China tops the list with 28 documents but Taiwan 742 citations. In Oceania, Australia leads with 102 papers and 2189 citations. In Europe, the United Kingdom has 105 papers and 2702 citations. United States of America leads in North America with 151 papers and 3359 citations while Brazil top the list in South America with 11 papers and 48 citations.

Table 1 also depicts the major countries that have contributed most to research on gender in construction worldwide. They are United States (151 papers), United Kingdom (105 papers), Australia (102 papers), Spain (42 papers), and South Africa (41 papers). Based on the highest number of citations we have United States (3359 citations), the United Kingdom (2702 citations), Australia (2189 citations), Taiwan (742 citations) and China (621 citations).

United States, United Kingdom, and Australia were identified as some of the top contributors to gender issues in the built environment, which is consistent with the findings of (Huppatz & Goodwin, 2013; Powell & Sang, 2015; Galea, 2018; Galea, et al., 2023). The findings of this bibliometric research is a clear indication that more countries throughout the world need to conduct more research into gender issues related to their own construction industry.

Table 1: Major nations that have contributed to gender issues in the construction industry research globally

Continent	Country	Number of Documents	Citations
Africa	Nigeria	10	124
	South Africa	41	300
Asia	Hong Kong	21	593
	South Korea	10	170
	Taiwan	10	742
	India	21	67
	Malaysia	7	57
	China	28	621
Australia/Oceania	Australia	102	2189
	New Zealand	8	133
Europe	United Kingdom	105	2702
	Turkey	16	133
	Switzerland	7	36
	Finland	11	122
	France	12	147
	Germany	8	164
	Netherlands	9	161
	Sweden	17	431
	Italy	20	347
	Norway	8	105
	Spain	42	577
North America	United States of America	151	3359
	Canada	33	475
South America	Brazil	11	48

The publication having the most citations on gender issues in the construction industry

Examining researchers with a minimum of one publication addressing gender issues in the construction industry and garnering at least 50 citations, we sought to find out the most cited publication. In Table 2, we present the top 10 authors who have significantly contributed to studies on gender issues in the construction industry. Chi & Lin (2018) is the most cited author/paper with 458 citations on gender issues in the built environment. According to the table, Loosemore et al. (2019) emerges as the second most referenced author in this field, with 439 citations. This finding aligns with Galea et al.'s (2023) research, which also designates Loosemore et al.'s (2019) work as the most cited publication on gender issues in the built environment. Notably, Loosemore et al.'s (2019) work appears again as the second most cited, potentially attributed to slight variations in chosen keywords. Other highly cited works include Francis and Prosser (2014) with 261 citations and Lingard and Turner (2022) with 233 citations.

Additionally, table 2 shows that majority of the most cited publications were based on questionnaire and interview surveys. A few of the studies were literature based. Moreover, the main focus of the most cited works on gender in the construction industry was on healthiness, safety, happiness, gender equality and attracting younger women into the built environment. None of the top cited works focused on research trends on gender issues thereby limiting the synthesizing of large body of knowledge on gender issues in the sector.

Table 2: The publication having the most citations on gender concerns in the construction sector

Source	Title	Citation	Method	Focus
Chi & Lin (2018)	Classification scheme & prevention measures for caught-in-between occupational fatalities	458	Questionnaire	Health and safety
Loosemore & Malouf (2019)	Safety training & positive safety attitude formation in the Australian construction industry	439	Questionnaire	Health and safety
Francis & Prosser (2014)	Exploring Vocational Guidance & Gender in Construction	261	Questionnaire	Guiding young people into the construction industry
Lingard & Turner (2022)	Making time for life: A whole-of-industry initiative to reducing work hours & promoting health & gender inclusion in project-based construction work	233	Interview	Working hours, health and safety, well-being
Wright & Conley (2020)	Advancing gender equality in the construction sector through public procurement: making effective use of responsive regulation	199	Review	Gender equality
Powell et al., (2018)	Masculinity & workplace wellbeing in the Australian construction industry	185	Observation and interviews	Workers' well being
Galea et al., (2023)	The Role of Homosociality in Maintaining Men's Powerfulness in Construction Companies	170	Ethnographic Study	Male workers in the construction industry
Kamardeen & Hassan (2023)	Analysis of Work-Related Psychological Injury Severity among Construction Trades Workers	160	Review	Mental health, safety, well being of construction workers
Bowen et al., (2017)	Condom use by South African construction workers	141	Questionnaire	Health and safety of construction workers
Edwards & Bowen (2019)	Language & communication issues in HIV/AIDS intervention management in the South African construction industry: Interview survey findings	140	Interview	Health and safety of workers

The article source having the highest number of articles on gender concerns in the built environment

So as to assess a document source with the highest publication count, source titles which feature a minimum of three publications on gender in construction were examined. Table 3 exhibits the document source having the greatest number of articles pertaining to gender in construction. According to Table 3, the Journal of Work, Employment, and Society emerges as the leading source, featuring 40 papers and boasting a 4.249 impact factor. Other notable sources include Sustainability (n = 22, IF = 3.889), American Journal of Industrial Medicine (n = 22, IF = 3.079), Journal of Safety Science (n = 17, IF = 3.692), Journal of Safety and Health at Work (n = 13, IF = 4.045), Occupational and Environmental Medicine (n = 13, IF = 4.952), The Journal of Professional Issues in Engineering Education & Practice (n = 11, IF = 1.19), and Journal of Management in Engineering CIRP (n = 10, IF = 6.4). Further scrutiny of the publication titles in Table 2 reveals that publications addressing gender issues in the construction industry were disseminated across outlets spanning various knowledge disciplines. This suggests that the topic of gender exhibits broad applicability and embodies a multidisciplinary nature.

Table 3: The document source having the highest number of journal articles on gender issues in the construction industry

Source Title	Documents	Impact Factor (IF)
Journal of Work, Employment & Society	40	4.249
Sustainability	22	3.889
American Journal of Industrial Medicine	22	3.079
Journal of Safety Science	17	3.692
Journal of Safety & Health at Work	13	4.045
Occupational & Environmental Medicine	13	4.952
The Journal of Professional Issues in engineering Education and Practice	11	1.19
The Journal of Management in Engineering (CIRP)	10	6.415
The Journal of Engineering, Design & Technology	10	0.371
The Journal of Construction Engineering & Management	10	5.1

Frequently investigated keywords or themes in research studies on gender concerns in the construction industry

In order to pinpoint most frequently explored keywords or themes regarding gender issues in the built environment research, we initially set a minimum threshold for keyword co-occurrences. Even though the default minimum co-occurrence of keywords in the VOS viewer software is 5, using this value might yield either a restricted or an excessive output. Thus, to refine the outcomes, we adjusted the minimum co-occurrence threshold to 10 for this study. Consequently, keywords must appear ten times in the indexed writer and document keywords to be extracted. 1837 keywords were obtained from 678 papers reviewed. Out of these, 17 keywords fulfilled the requirement of occurring at least 10 times. These 17 keywords were then categorized into 5 clusters, with "gender" acting as the central keyword interlinking others. This categorization is shown in figure 3.

Cluster 1 (Gender Equality)

Cluster 1, denoted as Gender Equality and visualized by the red area in Figure 2, is recognized as the gender equality cluster. It encompasses six interconnected keywords: construction, construction workers, employment, gender equality, occupational health, and women. Gender equality embodies the principle of fair and equal rights, opportunities, and treatment irrespective of gender. This principle advocates for all genders to have equitable access to resources, opportunities, and involvement in decision-making (Powell & Sang, 2013).

In practical terms, achieving gender equality involves identifying and dismantling discriminatory barriers and practices that disadvantage individuals based on their gender. This includes challenging stereotypes and traditional gender roles that prescribe certain behaviors or roles for men and women. Gender equality aims to create a society where human beings are treated equally.

Achieving gender equality benefits society as a whole by promoting social justice, economic growth, and sustainable development. It allows for the full participation of all individuals in society, leading to increased productivity, innovation, and creativity. Additionally, gender equality fosters healthier and more fulfilling relationships and families, as well as greater overall well-being and happiness.

For the construction industry to contribute to a nation's sustainable development, both male and female professionals must feel comfortable co-existing. This necessitates changes in the work environment, culture, and management style to accommodate women. Women face challenges due to perceptions of construction work as hazardous and unsuitable for them (Hassan et al., 2007). Despite the mandatory use of safety gears on construction sites, safety concerns persist, and the occupational health of construction workers is often overlooked (Biswas et al., 2017).

The construction industry remains heavily male-dominated globally, as highlighted by Galea et al. (2015). Despite the introduction and implementation of formal gender equality initiatives, progress has been slow (Galea et al., 2015; Biswas et al., 2017). Increased female participation is crucial to address labor shortages and promote gender equality and efficiency in the industry. However, despite recruitment efforts, the construction industry remains highly gender-segregated. Advancing knowledge about gender dynamics is essential to challenge this status quo (Norgerg & Johansson, 2021).

Cluster 2 (Diversity)

Diversity is represented by the color green in fig 2. This cluster has 3 keywords. They are construction industry, diversity and leadership. This cluster is named diversity cluster. Gender diversity refers to the existence of people from different gender identities and expressions within a set, organization, or society (Seidu et al., 2022). It recognizes that gender is not binary (male or female) but exists along a spectrum, including non-binary, transgender, gender-queer, and other identities. Embracing gender diversity involves acknowledging and respecting the unique experiences, perspectives, and contributions of individuals of different genders. It encompasses creating inclusive environments where people of all genders feel valued, empowered, and able to fully participate and thrive. Promoting gender diversity involves taking proactive steps to address systemic barriers and biases that may limit opportunities for individuals of marginalized genders. This can include the implementation of comprehensive policies and practices, the provision of awareness training programs on gender diversity and inclusion, to boost a culture of respect and acceptance. Gender diversity is important for creating more equitable and just societies. It allows for the celebration of individual differences and promotes innovation, creativity, and collaboration. By embracing gender diversity, organizations and communities can better meet the needs of all individuals and create environments where everyone can reach their full potential.

Traditionally, the construction industry has been male-dominated, with a significant lack of gender diversity at all levels of the workforce, including leadership positions. This historical context has created a culture within the industry that may be resistant to change and may perpetuate gender stereotypes. Research has shown that employing gender-diverse and inclusive professionals will foster innovation, creativity, and effective problem-solving. In the construction industry, where complex projects require diverse skill sets and perspectives, having gender-diverse leadership teams will boost competitive advantage. Promoting gender diversity in leadership can help construction companies attract and retain top talent. By creating inclusive environments where individuals of all genders feel valued and supported organizations can tap into a broader talent pool and enhance their competitiveness in the marketplace. Construction projects often impact local communities, and having gender-diverse leadership can enhance communication and relationships with stakeholders. Reflecting the diversity of the community in leadership positions can improve understanding and responsiveness to community needs and preferences. Many countries have legislation and regulations aimed at promoting equality in the workplace, including requirements for gender diversity on corporate boards. Compliance with these regulations is important for construction companies to avoid legal risks and reputational damage. Despite the potential benefits, boosting gender diversity is fraught with several challenges. These may include entrenched gender biases, lack of representation in talent pipelines, limited access to mentorship and networking opportunities for women, and workplace cultures that are not conducive to diversity and inclusion. Promoting gender diversity in leadership requires strong commitment and leadership from top executives and managers within construction companies. This includes implementing policies and initiatives to support gender diversity, such as diversity training, mentorship programs, flexible work arrangements, and transparent promotion processes.

In conclusion, the connection between gender diversity and leadership in the construction industry is complex and multifaceted. While challenges exist, promoting gender diversity in leadership is crucial for organizational performance, talent management, stakeholder relations, and legal compliance. By fostering inclusive cultures and implementing proactive initiatives, construction companies can create environments where individuals of all genders can thrive and contribute to the industry's success.

Cluster 4 (Occupational Health)

In Figure 2, the cluster representing Occupational Health is highlighted in yellow. Within this cluster, three prominent keywords are Australia, epidemiology, and occupation, collectively labeled as occupational health. Occupational health is a crucial field within public health that aims to safeguard the mental, psychological, and societal interests of workers across all industries. It involves efforts to maintain and enhance workers' health and productivity, enhance working conditions, and foster work environments conducive to safety and health. This interdisciplinary field encompasses various specialties such as occupational medicine, nursing, ergonomics, psychology, hygiene, and safety. Its goals include preventing work-related injuries and illnesses, improving working conditions, and providing occupational health services. Occupational health addresses a wide range of workplace hazards, including safety, physical, chemical, biological, and ergonomic risks.

Regarding research studies on gender issues in the built environment, Australia emerged as a leading focal point. Studies by Loosemore & Galea (2008), Galea et al., (2015), Salignac et al., (2018), and Wang et al., (2021) argue that gender equality in male-dominated industries like construction faces systemic challenges, often neglecting the occupational health concerns of women in this field. These studies advocate for a fresh perspective and emphasize the necessity of policies to tackle the under-representation of women. Employing a women's empowerment framework, the authors extensively reviewed literature on women in construction in Australia. Furthermore, significant research has examined the costs, workplace settings, and epidemiological aspects of traumatic spinal injuries in the workplace (Sharwood et al., 2018; McInnes et al., 2019).

It is very important not to confine studies of occupational health solely to developed world construction industries. Developing countries can also learn from and enhance the working conditions of women in male-dominated sectors. There is also a need to explore occupational diseases, safety hazards, the provision of safety gears for women, and their impact on all workers within the construction industry, particularly women (Ebekozien, 2022; Nwaogu & Chan, 2021).

Cluster 5 (Culture)

In Cluster 5 (Culture) culture denotes the collective way of life of a group, encompassing behaviors, beliefs, values, and symbols ingrained within their society. It includes aspects like language, religion, cuisine, social customs, music, arts, and traditions, acquired through processes of enculturation and socialization, varying across different societies. Cultural disparities manifest in various forms, with symbols representing surface differences and values reflecting deeper cultural manifestations. Individuals within the same culture carry multiple layers of internalized programming. Culture is dynamic and continually evolving, yet there is often a reverence for preserving traditions. Cultural appropriation involves one group adopting creative or artistic elements from another.

In Figure 2, the purple cluster represents culture. It explores two central themes: culture and discrimination, thus labeled as "Culture." The construction workplace is a very stressful place to work in (Tunji-Olayeni et al., 2021), characterized by a predominantly masculine culture favoring men, establishing it as a male-dominated domain. Women frequently face barriers such as the glass ceiling hindering their career advancement in an industry traditionally seen as male-centric (Amaratunga et al., 2006). Moreover, challenges like extended working hours, rigid workplace structures, and discriminatory practices further deter female participation in construction (Kolade & Kehinde, 2013).

Teravainen et al., (2018) argue that the correlation between organizational culture and quality performance is well-established, particularly within the context of the construction industry's reliance on human labor. Organizational culture significantly impacts operational efficiency. Furthermore, a recent study by Norberg and Johanssen (2021) sheds light on persistent challenges confronting women entering the construction sector, including gender biases, discrimination, and unrealistic expectations.

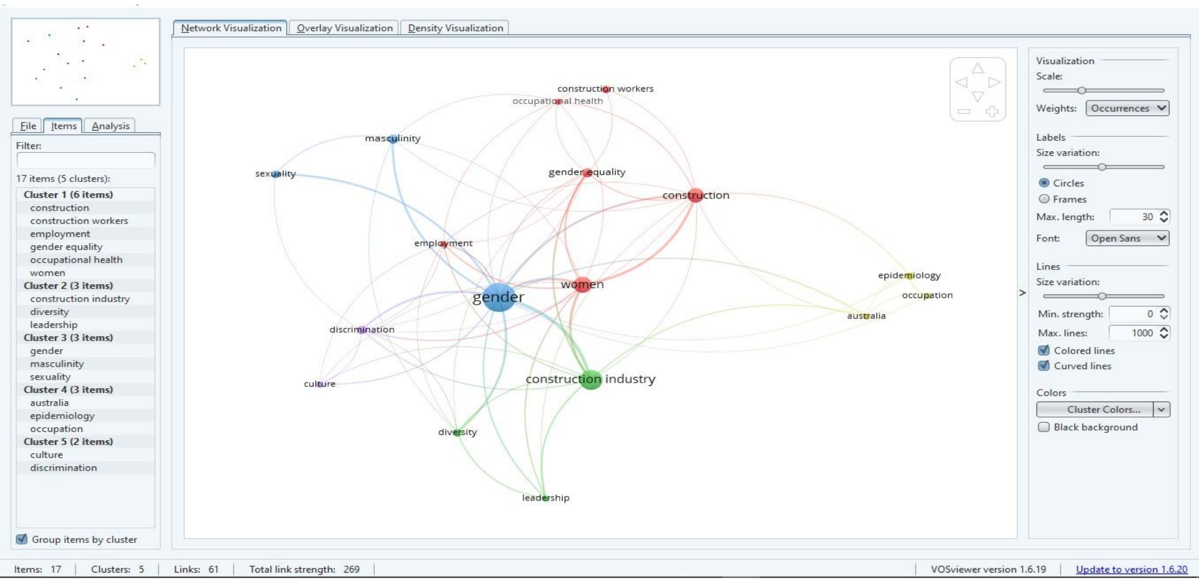

Fig 3 Clusters of research trends

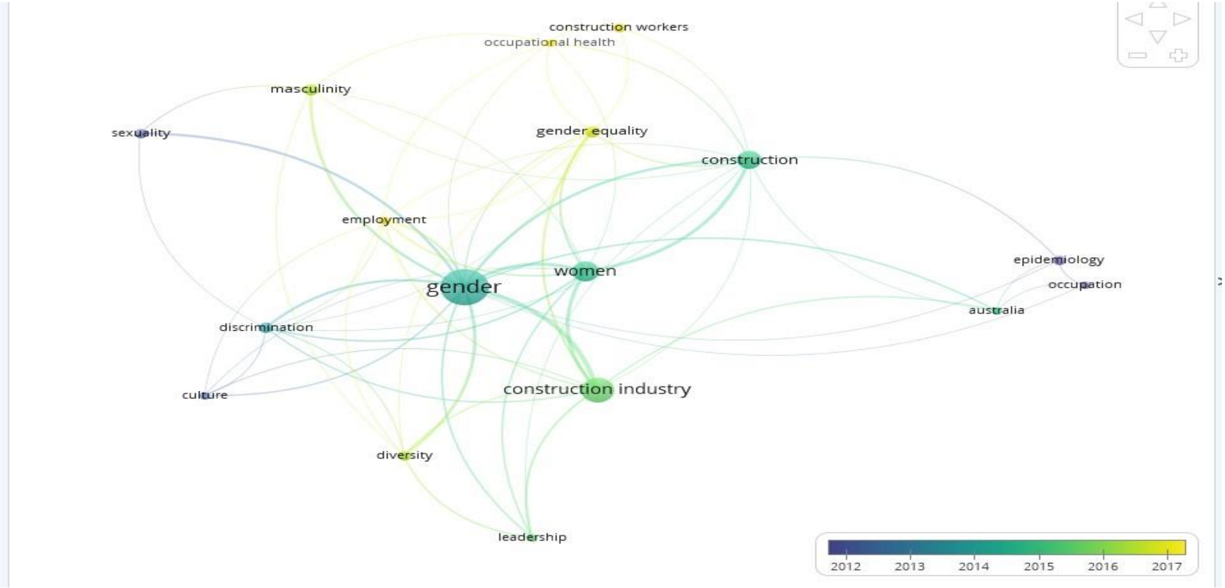

Fig 4: Current research trends highlighted in yellow

Discussion of Current Trends and Future Research Focus

The parts of the network clusters highlighted in yellow are current trends in the construction industry that require further studies. They are listed in no particular order as masculinity, construction workers, occupational health, masculinity, employment, diversity and gender equality. They will be grouped together and discussed briefly below;

- **Employment and masculinity-** Female construction workers in Nigeria confront numerous hurdles, such as discrimination, corruption, familial and domestic responsibilities, cultural gender biases, and entrenched religious convictions. Our study participants underscore the significant obstacles they encounter in progressing their careers. The Nigerian construction industry exhibits a pronounced preference for male employees, leading to heightened career hurdles that underscore the systemic dominance of men within the industry. This is seen in the exhibition of a phenomenon known as the "hypermasculine organization," characterized by an exaggerated bias towards males, a propensity for gender-based exploitation and mistreatment, and a justification rooted in rigid gender norms. These pervasive challenges continue to affect women who work within masculine organizational settings and carry potential ramifications not only for Nigeria but also for other African countries.

- **Construction workers, diversity and occupational health -** The poor conditions of the work environment is a global challenge to women. Therefore, mitigating this issue will go a long away in attracting more women to work in a field traditionally dominated by men. Furthermore, other researchers have expressed concerns about Occupational Health and Safety (OHS) risks for female workers, suggesting that these risks also act as deterrents for women considering employment in this industry. Future research endeavors could explore contemporary health and safety measures aimed at safeguarding female professionals in the construction sector. Subsequent researchers may concentrate on gender empowerment strategies, including the development and implementation of enhanced work-life balance initiatives and the establishment of supportive workplace policies tailored to women's needs. Additionally, prioritizing the well-being of women within construction workplaces could prove instrumental in drawing more women into the industry. Investigating methods to shift the construction industry's culture from one traditionally viewed as male-dominated to a more inclusive and diverse environment would also significantly contribute to enhancing women's sense of belonging in this sector. Furthermore, it's worth noting that many organizations within the industry fail to address or penalize workers who engage in gender-based discrimination, underscoring the need for further studies examining gender discrimination specifically within the construction field.

Implication of the findings of the study

The findings of this study have several implication for both research and practice within the construction industry:

The study identifies a gap in the detailed evaluation of gender issues within the construction industry despite the increasing body of research. This suggests a need for more comprehensive analyses to understand the nuances of gender dynamics within this sector.

The study provides insight into the global research trends on gender issues in the built environment, highlighting the most impactful studies from countries such as the United States of America, the United Kingdom, and Australia. This suggests that gender issues in construction are not limited to specific regions and warrant attention on an international scale.

The shift in research focus from gender challenges to gender empowerment signifies an evolution in the discourse surrounding gender in construction. Emphasis on work-life balance, workplace policies, and mental and occupational health reflects a growing recognition of the multifaceted nature of gender dynamics within the industry.

The emphasis on improving work-life balance, implementing pro-women workplace policies, and prioritizing women's mental health and safety at work suggests actionable steps to be taken by industry stakeholders to recruit and keep more women in the sector. This aligns with broader efforts towards diversity and inclusion within the industry.

By addressing gender disparities and promoting gender empowerment, the construction industry may benefit from a more diverse and inclusive workforce. This can lead to improved innovation, productivity, and overall organizational performance.

The findings may inform policy discussions and advocacy efforts aimed at promoting gender equality within the construction sector. Policymakers and advocacy groups can use this research to support initiatives that address gender-based challenges and promote a more inclusive work environment.

Limitations

Although a systematic literature review using Scopus database was performed using a bibliometric approach, this research has limitations. The current study's findings are based only on the Scopus database with indexing practices and coverage biases, which may influence the holistic accuracy of the analysis through bibliometrics. Another bias is the use of ''keyword search'' wherein only specific keywords such as gender, construction, and industry were used, which may cause bias and a high likelihood of oversight of the relevant studies' wrong use of different terminology. The exclusion from language and document types may lead to bias towards English-language literature and document types, thereby highly excluding valuable contributions from other languages and document types. Based on the temporal dimension, the study's reliance on the chronological database from Scopus limits the inclusion of recent developments in gender-based research in the AEC domain. The dynamic evolvement of the nature of gender issues and research progression does not give a holistic picture. Although the bibliometric analysis method provides the trends and patterns, a potential limitation would be that it may need an in-depth and contextual-based approach, which qualitative methods could generate in thoroughly comprehending the gender-based issues in the AEC domain. However, the findings from this bibliometric analysis provide a concise capture of the gender research trend in the construction sector.

Conclusions

Overall, the implications of these findings suggest a need for continued research and action to address gender issues in the construction sector, should concentrate on creating an inclusive workplace culture.

In conclusion, this study offers valuable insights into the evolving landscape of gender issues within the construction industry. Despite the sector's historically male-dominated nature, there has been a growing body of research addressing gender dynamics. However, a comprehensive synthesis of this literature has been lacking until now.

Through a meticulous bibliometric analysis, this study has identified key trends in global research on gender issues in the built environment. By analyzing over six hundred papers, the study highlights the predominant focus areas and geographic origins of impactful research in this field. Notably, studies from the United States of America, the United Kingdom, and Australia have led the discourse, primarily addressing women's employment, gender disparity, and discrimination.

The findings of this study also point towards a notable shift in research focus, with increasing attention on topics such as work-life balance, workplace policies, and mental and occupational health. This shift signifies a broader commitment to gender empowerment within the construction industry, emphasizing initiatives that support women's well-being and safety at work.

In conclusion, prioritizing gender empowerment through enhanced work-life balance and supportive workplace policies offers substantial potential for increasing female representation in the construction sector. Embracing such changes can cultivate a more inclusive and supportive atmosphere within the industry, fostering diversity, innovation, and overall organizational prosperity. Moving forward, it remains essential for researchers, policymakers, and industry stakeholders to persist in examining and tackling gender-related challenges within the construction field. By capitalizing on these insights and prioritizing initiatives aimed at empowering all genders, we can strive to build a fairer and more prosperous industry for everyone involved.

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TRACK 4: SUSTAINABLE INNOVATIONS IN THE BUILT ENVIRONMENT ECOSYSTEM IN AFRICA

An Assessment on the Current Practices for the Sustainable Construction of Road Infrastructure Projects

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Abstract

In the present day, the implementation of sustainable construction practices in infrastructure projects should not be viewed as a 'ticking of the box' or perceived as achieving compliance through implementing the bare minimum of the environmental requirements. Within road infrastructure projects, there has been a lack of inadequate implementation of sustainable construction practices due to various reasons. This study aims to assess the adoption of existing sustainable construction practices in road infrastructure projects using an in-depth literature review technique named as the Systematic Literature Review (SLR) approach. The qualitative data analysis is conducted with the QSR NVivo software. The findings are analysed using this software, highlighting some of the major existing practices for sustainable construction of road infrastructure projects such as various sustainable design practices, sustainable materials practices, government's participations, and sustainable lighting practices which are detailed in the results section. The results show that there is insufficient research that has focused on sustainable construction approaches in road infrastructure projects especially in developing countries, yet these projects consume a huge number of resources during their construction and post-construction stages. This study enhances the use of more sustainable materials in road infrastructure projects by shedding light on the existing practices applied.

Keywords: Sustainable Construction, Systematic Literature Review (SLT), Road Infrastructure Projects, In-Depth Literature Review

Introduction

There has been a significant increase in the use of sustainable building practices in road projects, leading to a growing interest among specialists in tackling the challenges linked to sustainable construction (Ifije and Aigbavboa, 2020). Furthermore, there has been a significant increase in empirical research that specifically examines sustainable building in the context of road infrastructure projects. Additionally, scholars have explored various techniques to address and overcome barriers to the implementation of sustainable construction practices in these projects. The observed phenomenon is motivated by the acknowledgment that the construction sector, as a substantial consumer of natural resources, has a crucial position in the broader context of

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resource utilisation sustainability (Almakayeel *et al*., 2023). The function of infrastructure development is crucial in the progress of a country and has the capacity to stimulate economic growth at several scales, including local, regional, and global. The achievement of such progress plays a crucial role in the development of a stronger economy, which could enhance social well-being and promote the creation of sustainable infrastructure (Willar *et al*., 2019). The observed tendency has been ascribed to changes in climatic patterns and the efficient utilisation of natural resources, leading to noteworthy environmental ramifications (Zahid, 2021). The building industry has under scrutiny due to its role in exacerbating environmental degradation, a contradiction to the principles of sustainable construction and sustainable development (Ogunmakinde and Maund, 2016). Based on the findings of Tokbolat *et al*. (2019), it has been reported that building practices have a significant impact on the worldwide environment. Specifically, these practices contribute to 40% of global greenhouse gas emissions, 42% of energy consumption, 30% of raw material utilisation, 25% of water consumption, and 25% of trash generation.

The severity of these difficulties has escalated due to the rise in urbanisation and population growth, especially in developing countries (Tokbolat *et al*., 2019 and AlSanad, 2015). The significant consequences of the construction industry have attracted the attention of national governments and prominent construction firms (Tokbolat *et al*., 2019). Hence, in order to effectively tackle this problem and mitigate its repercussions, a novel concept of sustainable building has been introduced (AlSanad, 2015). The introduction of various enhancements in the construction industry has led to an elevation in the principles of sustainable development. These enhancements include the utilisation of environmentally friendly materials and resources, as well as the adoption of non-traditional methods in order to conserve resources and minimise waste output (AlSanad, 2015). This study aim is to examine the current practices of sustainable construction in road infrastructure projects. This is done through a Systematic Literature Review method through review literature journals which meet a set criterion in the SLR method. The collection of the data analysis of the date is conducted through using the SLR stages which are explained in-depth in research methodology section and results section of the research report. The research limitation for the research study is there is inadequate research on sustainable construction practices in road infrastructure projects.

Literature Review

This section presents the literature review, which focuses on sustainable construction practices in road infrastructure projects through focusing on the road projects, sustainable construction, and practices of sustainable construction in road projects.

Road projects

A road project refers to the development of a roadway with the objective of facilitating connectivity and accessibility across various regions (Ahmed, 2013). This kind of infrastructure serves as a fundamental pillar for the economic development of a nation. The economic and social advancement of a country is contingent upon the development of its transportation infrastructure. Road improvements have a significant role in several sectors of a country's economy, including health, education, competitiveness, and quality of life (Herrera *et al*., 2020). Roads have a crucial role in facilitating socioeconomic development, fostering effective communication, and promoting commerce within the circulatory system. The development of roads has facilitated the accessibility of health, education, employment, and other vital social services for both the rural and urban poor (Teye and Okanta, 2017). The significance of road projects in a nation's economic development is underscored by the need of undertaking activities such as designing, planning, building, and maintaining these projects (Herrera *et al*., 2020). The lack of efficient road infrastructure will have a detrimental impact on both economic and social development (Teye and Okanta, 2017).

Sustainable Construction

According to the findings of Tokbolat *et al.,* (2019), the concept of sustainable construction may be characterised as the ability to create and sustain a built environment that simultaneously enhances the welfare of people and optimises the use of resources. Sustainable building is a holistic strategy aimed at ensuring that every phase of the construction process, from initial planning to completion, is carried out in a way consistent with the principles of sustainability. This necessitates the consideration of economic, social, and environmental concerns, in light of the substantial influence of the building industry on society, the environment, and the economy. Indeed, when compared to other industrial sectors, it can be argued that the construction industry has the most significant impact on sustainability (Willar et al., 2021). The construction sector has the capacity to make a substantial contribution towards the conservation of the indigenous environment via the efficient management of resource consumption, the optimisation of asset utilisation, and the implementation of sustainable water practices. Moreover, it assumes a pivotal function in augmenting the general standard of human existence (Oke *et al.,* 2017). The notion of sustainable building entails a comprehensive approach that seeks to develop and maintain a state of balance between natural and manmade ecosystems, hence enabling human habitation within a harmonious economic context (Willar *et al*., 2021). To improve the overall quality of life, maximise work efficiency, and cultivate a healthy work environment, it is imperative for sustainable building practices to adequately tackle environmental objectives and establish significant connections with social and economic factors (Willar *et al*., 2021). Furthermore, sustainable construction places significant attention on the mitigation of energy consumption throughout both the construction and operational stages of buildings, taking into account resource utilisation and waste generation (Willar *et al.,* 2021).

Practices in Sustainable Construction in road projects

The execution of road construction and maintenance is inherently defined by the adoption of lean and efficient practices, principally motivated by the economic benefits obtained through the reduction of resource waste. In the contemporary period of conservation and environmental management, there is a focus on improving and broadening the inherent sustainability of traditional road construction practices. This has led to the development of several environmentally sustainable alternatives (Newman *et al.,* 2012). The rise of a concept known as "sustainable road" has been seen throughout the construction industry and academic communities. According to Newman *et al*. (2012: 3-4), a sustainable road may be defined as a road that is built with careful consideration of environmental factors, optimising its alignment in both vertical and horizontal dimensions, and taking into account ecological limitations and the operating needs of vehicles. Furthermore, it is imperative that the design of the system takes into consideration its ability to endure future economic and environmental challenges, including but not limited to resource shortages and climate change. Furthermore, it is essential that the system have adaptability to accommodate evolving needs, such as the escalation in travel volumes and the growing preference for public and active transport modes, including cycling and walking. In addition, it is essential for a road to possess the capacity to use energy in order to sustainably power its lighting systems (Newman *et al*., 2012). The first endeavours to establish environmentally friendly roadways mostly concentrated on addressing the ecological ramifications linked to the development of new road infrastructure. The aforementioned endeavours included several tactics, including the optimisation of the route, the implementation of storm water runoff management measures, and the implementation of erosion control methods (Newman *et al*., 2012). The development and operation of road networks have entered a new phase as a result of the adoption of sustainable road construction practices, which have evolved into a subsequent generation of initiatives (Newman *et al*., 2012). The focus of the current wave of innovation in road building, taking into account environmental factors, is on the utilisation of methods and materials that exhibit resource and energy efficiency (Newman *et al.,* 2012). It is crucial to promptly address the shift in focus in order to allow road authorities sufficient time to develop road networks that can effectively withstand significant environmental and resource-related challenges in the future, as well as anticipated resource-related obstacles in the coming years (Newman *et al.,* 2012).

The extent of the Australian government and corporate sectors' efforts to foster the progress of sustainable road building practices has been constrained. The allocation of research money has mostly focused on engineering solutions that attempt to accelerate road building processes and improve their efficiency and safety, as emphasised by the Sustainable Built Environment National Research Centre (2012).In the current global landscape, which is marked by an increasing scarcity of resources and energy, governments have acknowledged the necessity of directing financial resources towards research and development endeavours that prioritise the creation of sustainable road infrastructure (Newman *et al*., 2012 and Sustainable Built Environment National Research Centre, 2012). This is demonstrated by several recent initiatives, including the implementation of revised standards for recycled materials and the launch of the Australian Green Infrastructure Council (AGIC) rating system, which attributes added economic value to environmentally sustainable roads (Newman et al., 2012 and Sustainable Built Environment National Research Centre, 2012). The significance of resource efficiency and carbon neutrality has garnered widespread recognition as crucial factors for the success of road building firms that want to foster innovation. Newman *et al*. (2012) performed a literature study that focused on projects in sustainable road construction and maintenance, specifically highlighting those that demonstrate innovation and are considered to be at the forefront of the field. The aforementioned initiatives encompass a range of projects that involve the utilisation of plant-based alternatives to bitumen, substantial reductions in energy consumption and costs through the adoption of innovative lighting and signal technology, the reuse of previous pavement layers as a resource material instead of relying on virgin quarries for road bases, and the construction of road surfaces using scrap tyres and plastic bags as durable wearing surfaces (Newman *et al*., 2012). The effective implementation of these sustainable methodologies relies on the proficiency and decision-making capabilities of road designers. Therefore, it is essential to emphasise the improvement of design methods and pavement design as strategies to reduce environmental impacts and facilitate the construction of eco-friendly road networks. This concept is further explained in Figure 1.

Figure 1: Options for reducing environmental pressures in road infrastructure projects
Source: Sustainable Built Environment National Research Centre, (2012)

The objective of the literature evaluation was to demonstrate the existing research deficiency regarding sustainable building practices in road infrastructure projects, given their substantial consumption of environmental resources. Hence, it is essential to provide significant attention to the incorporation of sustainable building practices in these projects. Several countries, particularly those in Africa, are facing challenges in the implementation of sustainable practices, particularly in the construction of roads. There is a lack of significant progress in terms of technological advancements and government support for promoting sustainable construction practices, particularly in African countries. The extant body of literature reveals a multitude of elements that have influenced the successful adoption of sustainable building practices in various projects. This has been accomplished via a comprehensive examination of the obstacles and challenges encountered in the realm of sustainable construction.

The literature assessment reveals a dearth of research on sustainable road building practices. The conducted study pertains to the broader construction sector, with a lack of specific focus on sustainable building within road infrastructure projects. According to Agbajor and Mewomo (2022), there is a need for more study on sustainable construction and green building in South Africa, despite the growing body of knowledge in this field. According to Windapo and Goulding (2015), there is an identified discrepancy between sustainable construction (SC) and green building regulations, as well as the actual implementation of sustainable practices inside construction companies in South Africa. The argument put forth by Darko *et al*., (2017a) is further substantiated by the existence of substantial gaps in knowledge and data. These gaps include a dearth of empirical information that would enable meaningful comparisons between the costs of conventional construction, sustainable construction, and green building. Additionally, there is a lack of comprehensive data on the energy, water, and other resource savings that can be achieved through green building and sustainable construction practices.

Research Methodology

The researchers conducted a Systematic Literature Review (SLR) using the QSR NVivo software to assess articles relevant to the research topic. Guillaume (2019:1635) defines the SLR method as "a rigorous methodological strategy used to synthesise scientific information in order to effectively investigate a particular research enquiry. This methodology is characterised by its transparency and replicability". The primary objective of a SLR is to comprehensively include all pertinent published material related to a certain issue, while concurrently assessing the credibility and reliability of the evidence. Guillaume (2019) posits that the primary objective of using the SLR methodology is to minimise bias and promote transparency while conducting a review. The objective is achieved through the implementation of transparent and methodical approaches designed to mitigate bias during the selection and integration of research, assessment of study quality, and impartial synthesis of research findings.

The use of a SLR is a very successful method for reducing a substantial level of uncertainty, as it facilitates the identification of topics that are substantiated by an ample amount of data. The process of conducting a SLR enables the integration of various research results, hence promoting the emergence of innovative viewpoints. Moreover, SLR offers a means of ascertaining the presence of an adequate corpus of evidence. In addition, the use of this approach serves to mitigate the possible ramifications of mistakes that may arise within the context of a research (Samimpey and Saghatforoush, 2020). In consideration of the aforementioned assertion, a comprehensive examination of the existing body of literature was undertaken via the use of QSR NVivo software, using a methodical approach. The QSR NVivo software is a well-known qualitative data analysis tool that is particularly developed to enhance the organisation and execution of coding procedures. The work of Hilal and Alabri (2013), has received much acclaim for its outstanding performance in this particular field. The Figure 2 depicts the sequential procedure included in the execution of the SLR methodology.

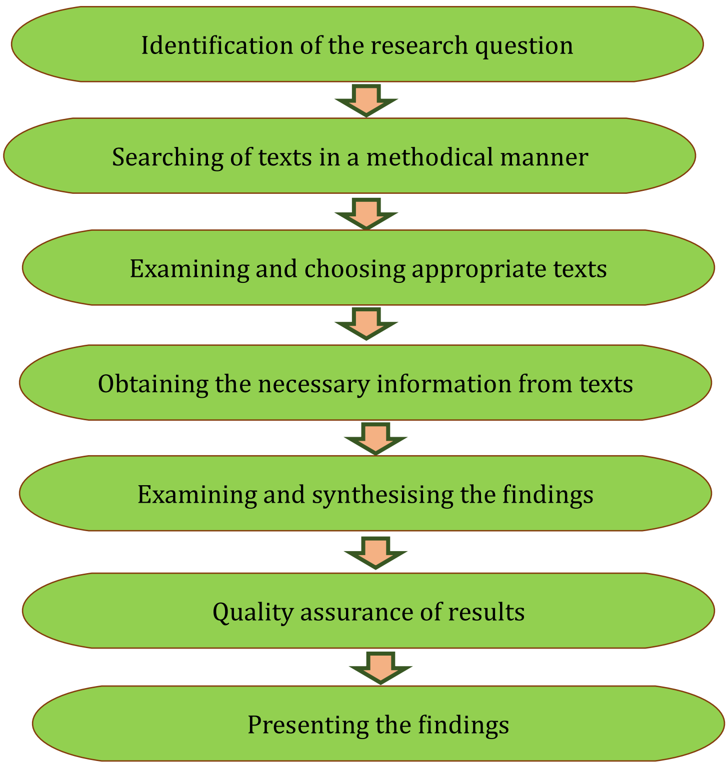

Figure 2: Steps in undertaking an SLR.
Source: Wright *et al.*, 2007

Samimpey and Saghatforoush (2020) argued that a comprehensive examination of textual material that centres on a particular research inquiry is referred to as a complete study of texts. This kind of review involves the identification, selection, and critical assessment of all relevant papers (Samimpey and Saghatforoush, 2020). The research conducted by Samimpey and Saghatforoush (2020) include the collection and analysis of data. The procedural stages involved in conducting a SLR are shown in the Figure 2 and then elaborated upon.

Results

Step 1: Identification of the research question for the research topic

The researcher had to provide answers to the four simple questions as follows:

- The first inquiry related to the question of "What?" The main aim of this study subject is to evaluate the existing methodologies used in the development of road infrastructure projects, focusing particularly on their sustainability. The prevailing state of affairs might be ascribed to a lack of complete comprehension and knowledge of contemporary sustainable building techniques for road infrastructure.
- In order to address the second question, "Who?", a range of reputable sources including recognised databases, scientific and engineering journals, university dissertations, articles, and books are consulted. The aforementioned solutions have been selected based on their established reputation for reliability and extensive recognition within the discipline.
- The third question pertains to the temporal aspect, specifically addressing the issue of "When?" The time period including the years 2000 to 2023 has been selected as the temporal scope for this research endeavour. The selected time period was determined based on the significant increase in the availability of professional and academic literature, techniques, and technology pertaining to sustainable construction practices seen in the last twenty years. This is a primary rationale for our selection of this particular temporal epoch.
- Lastly, for the final question “How?”, there includes discussion of prior research as well as studies that have been published on the most recent environmentally friendly building strategies. Therefore, the following will serve as this study's research question: What are the standard procedures for the environmentally responsible building of road infrastructure projects today?

Step 2: Searching of texts in a methodical manner for the research topic

In the second phase of the study procedure, the investigator performed a comprehensive examination of literature accessible in esteemed and reliable scientific and engineering databases. The search was conducted by selecting a phrase that was pertinent to the study subject, as shown in Table 1 and Table 2. The terminology pertaining to the assessment of current approaches for the ecologically sustainable construction of road infrastructure projects is:
Current practices of sustainable road projects (with synonyms current activities for sustainable road infrastructures).

Recognised and reliable scientific databases reviewed for the research study, are listed below:

- Elsevier
- Emerald group publishing
- Google scholar
- Multidisciplinary Digital Publishing Institute
- Science direct
- Taylor and Francis

The results of the literature reviews are shown in Table 1. The results provide the aggregate count of articles that were identified and selected based on the use of keywords. The databases that were queried using the relevant keywords include Google Scholar, Emerald Group Publishing, Elsevier, Multidisciplinary Digital Publishing Institute, Taylor and Francis, and Science Direct. Subsequently, a total of 209 articles remained after excluding publications that were beyond the scope of the review.

Table 1: Secondary search results sustainable construction practices in road projects articles

Keywords used to search for articles	**Google Scholar**		**Emerald Group Publishing**		**Elsevier**		**Multidisciplinary Digital Publishing Institute**		**Taylor and Francis**		**Science Direct**	
	Found Papers	Chosen Papers	Found Papers	Chosen Papers	Found Papers	Chosen Papers	Found Papers	Chosen Papers	Found Papers	Chosen Papers	Found Papers	Chosen Papers
Current practices of sustainable road projects	250	73	50	5	200	57	30	15	19	9	55	6
Current activities for sustainable road infrastructures	50	9	25	1	50	26	20	3	25	0	45	5
Total	300	82	75	6	250	83	50	18	44	9	100	11

The original search yielded a diverse array of publications, including various types such as case studies, experimental academic works, and others. During this phase, information retrieval was conducted by using certain keywords and thereafter analysing the abstracts of the articles identified in the preceding step. Ultimately, as seen in Table 2, the researcher obtained a total of 52 articles.

Table 2: Secondary search results sustainable construction practices in road projects articles

Keywords used to search for articles	**Google Scholar**	**Emerald Group Publishing**	**Elsevier**	**Multidisciplinary Digital Publishing Institute**	**Taylor and Francis**	**Science Direct**
Current practices of sustainable road projects	31	1	0	9	0	2
Current activities for sustainable road infrastructures	0	0	9	0	0	0

Step 3: Examining and choosing appropriate texts for the research topic

In the third step, the texts are put through a meta-synthesis process. During this stage, we will seek for any studies that may be relevant and examine them to see whether they meet the criteria we have established for inclusion. In order to identify and establish a criterion, some of the texts may need to be removed from consideration. The timing of publishing (the publication period from the year 2000 to the year 2023) and the credibility of the texts that were investigated are the criteria for this research. The Critical Appraisal Skills Program (CASP) method is used to the articles that have been gathered to determine the level of quality of the articles that have been left. Figure 3 provides a visual representation of the steps involved in the process of looking for and choosing articles.

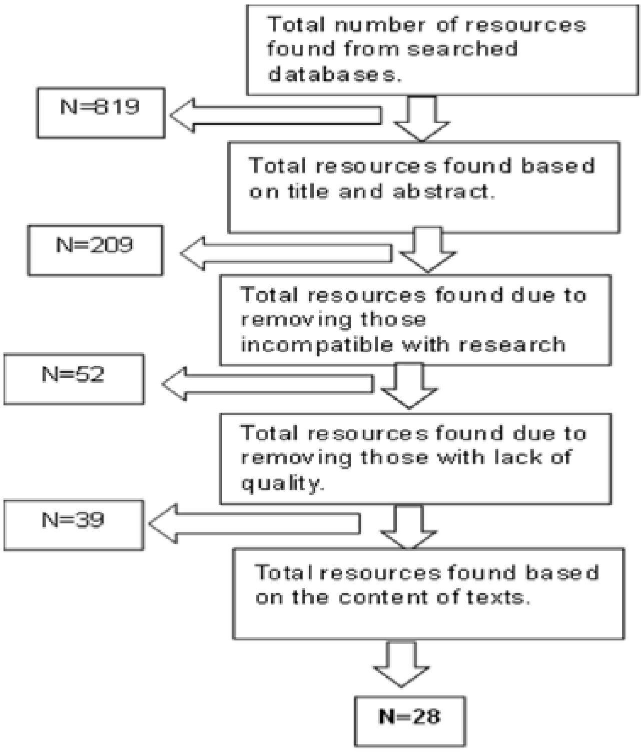

Figure 3: Stages of searching and selecting articles for research topic

The last step of the study used the CASP instrument filter, which is often utilised for the purpose of critical evaluation. The instrument shown in Table 3 used a checklist including indications pertaining to research goals, research procedures, research design, sampling methods, data collecting, reflectivity, ethical issues, correctness of analysis, clear presentation of findings, and research value. Each indicator was given a numerical value on a scale of 1 to 10, reflecting different degrees of quality. Scores ranging from 81 to 110 were categorised as very excellent, scores from 61 to 80 were considered acceptable, scores from 41 to 60 were categorised as medium, scores from 21 to 40 were considered awful, and scores from 1 to 20 were categorised as very poor. Subsequently, the products that were requested were categorised according to the aforementioned grading methodology. The evaluation done by the researcher is considered to possess validity. As a result, a cumulative count of 11 articles were excluded from further analysis as their scores did not meet the predetermined criterion of 41. As a result, a selection of 28 publications was made from a larger pool of 39 papers in order to conduct a more detailed analysis and answer the research question at hand.

Table 3: CASP scoring for the research topic articles

Row	Name of article	Authors	Publication year	Number of pages	Research objective	Methodology of the research	Research project	Sampling	Collecting data	Reflectivity	Considerations of ethics	Accuracy of the analysis	Presenting the findings in a clear manner	The Significance of the study	Score accomplished
1	Framework for developing construction sustainability items: the example of highway design	Tsai, C.Y and Chang, A. S.	2012	5	9	5	5	5	5	5	2	9	5	5	60
2	Sustainable design of pavement systems in highly urbanized context: A lifecycle assessment	Hossain, M.U., Wong, J.J.Y., Ng, S.T., and Wang, Y.	2022	5	5	5	7	5	5	8	6	9	8	8	71
3	Evaluating the performance of sustainable perpetual pavements using recycled asphalt pavement in China	Sultan, S. A and Zhongyin, G. (2016)	2016	6	8	2	6	2	5	5	2	8	5	5	54
4	Waste utilization to enhance performance of road subbase fill	Onturk, K., Firat, S., Yilmaz, G. and Khatib, J.	2022	8	8	5	5	2	8	9	5	9	5	8	72
5	Sustainable Use of Construction and Demolition (C&D) Waste as a Road Base Material	Batmunkh, N; Siripun, K; Jitsangiam, P; Nikraz, H.	2010	5	8	2	6	6	8	8	2	9	9	9	72
6	Practical Application of Sustainable Road Structure: Mechanical and Environmental Approach	Kowalski, K.J., Bankowski, W., Król, J.B., Andersen, B.H., Komkova, A., and Barrasa, R.C	2022	9	9	6	8	9	9	9	5	8	8	9	89
7	A Critical Perspective and Inclusive Analysis of Sustainable Road infrastructure Literature	Alhjouj, A., Bonoli., A., Bonoli, A., and Zamorano, M.	2022	10	8	8	2	2	8	8	5	6	8	7	72
8	Beneficial Utilization of Municipal Solid Waste Incineration Ashes as Sustainable Road Construction Materials	Tasneem, K	2014	8	8	8	9	9	9	9	8	9	9	9	95
9	Sustainable Concrete Pavements: A Manual of Practice	Van Dam, T., Taylor, P., and Fick, G.	2012	10	8	8	10	10	10	10	6	8	8	10	98
10	Cement-Stabilized Waste Sand as Sustainable Construction Materials for Foundations and Highway Roads	Shalabi, F.I, Mazher, J., Khan, K., Alsuliman, M., Almustafa I., Mahmoud, W., and Alomran, N.	2019	9	9	5	5	5	5	6	5	6	6	5	66
11	Leveraging Infrastructure BIM for Life-Cycle-Based sustainable road Pavement management	Oreto, C., Biancardo, S.A., Abbondati, F., Veropalumbo, R.	2023	9	6	6	5	6	5	5	5	6	6	6	65
12	Sustainable Asphalt-The Way Forward for the Malaysian Asphalt Industry	Amzah, M.O., Shahadan, Z., Hasan, M.R.M., and Jamshidi, A.	2010	8	8	8	6	8	8	8	5	6	8	8	81

13	Recycled Asphalt Pavement with Warm Mix Additive for Sustainable Road Construction	Hamzah, M.O., L Gungat, L., Yusoff, N.I and Valentin, J.	2016	9	6	6	6	5	5	5	6	6	6	6	66
14	Recycling Concrete for Sustainable Construction	Dardis, J.M.	2012	8	8	8	8	7	5	2	2	8	6	9	71
15	Encouraging Sustainable Use of RAP Materials for Pavement Construction in Oman: A Review	Dughaishi, H.A, Lawati, J.A., Bilema, M., Babalghaith, A.M., Mashaan, N.S., Yusoff, N.I., and Milad, A	2022	5	5	8	8	8	8	7	6	8	8	10	81
16	The Future of Roads: How Road agencies are facing a conflicted future	Newman, P., Hargroves, K.J., Desha, C.J.K., Whistler, L.	2012	10	9	8	8	8	8	8	6	8	8	9	90
17	Reducing the environmental impact of road construction	Newman, P., Hargroves, K.J., Desha, C.J.K., Whistler, L.	2012	10	9	8	8	8	9	9	6	9	9	9	94
18	The Sustainability of Reclaimed Asphalt as a resource for road pavement management through a circular economic model	Mantalovas, K., and Di Mino, G.	2019	8	9	6	6	8	5	5	6	8	8	6	75
19	Use of Recycled aggregates made from construction and demolition waste in sustainable road base layers	Teijon-López-Zuazo, E.T., Vega-Zamanillo, A., Calzada-Perez, M.A., and Robles-Miguel, A.	2020	6	6	6	5	5	5	8	6	6	5	2	60
20	Toward Sustainability: Green Road Construction in Indonesia	Djalante, S., Oneyama, H., and Arsyad, L.O.M.N.	2020	9	5	6	6	6	6	5	5	6	6	2	62
21	Waste Plastics for Eco-friendly & Sustainable Road Construction in Bangladesh	Alam, S.	208	5	8	8	9	8	9	5	2	6	6	6	72
22	Use of system dynamics for proper conservation and recycling of aggregates for sustainable road construction	Rajib B. Mallick, R.B., Radzicki, M.J., Zaumanis, M., and Frank, R.	2014	5	8	6	6	6	5	5	2	5	5	5	58
23	Environmental and economic assessment of pavement construction and management practices for enhancing pavement sustainability	Flintsch, G., and Ferreira, A.	2017	5	5	6	5	8	5	5	2	5	6	6	58
24	SUP&R DSS: A sustainability-based decision support system for road pavements	Santos, J., Bressi., S., Cerezo, V., Presti, D.L.	2019	8	8	6	5	5	6	5	2	5	5	2	57
25	Analysis of the scientific evolution of self-healing asphalt pavements: Toward sustainable road materials	Nalbandian, K.M., Carpio, M., and González, A.	2021	8	7	8	5	6	5	6	2	8	7	6	68
26	A review on green economy and development of green roads and highways using carbon neutral materials	Attahiru, Y.B., Aziz, M.A., Kassim, K.A., Shahid, S., Bakar, W.A.W.A., NSashruddin, T.F., Rahman. F.A., Ahamed, M.I.	2019	8	8	5	5	2	6	6	5	6	7	6	64
27	Geotechnical Properties of soil stabilized with blended binders for sustainable road base applications	Per Lindh, P. L.	2023	7	7	5	5	5	5	5	5	5	5	5	59
28	Green Highways: Strategy for Recycling Materials for Sustainable Construction Practices	Tuncer B. E.	2006	8	5	8	7	5	8	9	5	8	8	9	80

The Table 3 displays the retrieved data based on the criteria indicated below. When evaluating these criteria, data were collected using designated forms and efforts were made to exclude duplicate publications.

- Does the paper discuss the contemporary approaches to sustainable building in road projects?
- Are the aims of the paper well communicated and articulated?
- Does the article make reference to the responses to the research question?

During the main and secondary analyses, the researchers examined the title, abstract, and results sections of the papers in connection to research question.

Step 4: Obtaining the necessary information from texts for the research topic

In the fourth step, a more detailed analysis was conducted on the 28 resources that remained after using the CASP approach. The existing methodologies used in the development of environmentally friendly road infrastructure projects were developed. The identification and categorization of sustainable building practices in road infrastructure projects has significance due to its use in discerning sustainable construction practices within road projects.

Step 5: Examining and synthesising the findings for the research topic

According to the meta-synthesis technique, Step 5 involves the use of descriptive analysis and pattern coding. The pattern analysis was conducted with the QSR NVivo software.

Step 6: Quality assurance of results for the research topic

The CASP approach was used as a quality assurance tool in Step Three for the purpose of selecting the 28 articles. Furthermore, the coding and categorization of data used in Step Five, which involves assigning the existing methods for sustainable building of road infrastructure projects, serves as an additional measure to assess the quality of the selected data.

Step 7: Presenting the results for the research topic.

The study topic, which was first formulated in Step One, is addressed, and afterwards shown in the table provided in the concluding Step Seven. This categorization examines the existing techniques pertaining to the sustainable building of road infrastructure projects. The identification and categorization of sustainable building practices in road infrastructure projects has significance due to its use in discerning sustainable construction practices within such projects.

The existing techniques for achieving sustainable construction in road infrastructure projects were identified and the results are provided in Table 4.

Table 4: Findings of research topic

Categories	List of current practices of sustainable road projects	Source
Sustainable design practices	Life Cycle Assessment (LCA) is used to carry out a comparative evaluation of the environmental sustainability of two different types of asphalt: the traditional baseline and the non-conventional baseline known as Warm Mix Asphalt (WMA).	Kowalski, K.J., Bankowski, W., Król, J.B., Andersen, B.H., Komkova, A., and Barrasa, R.C (2022)
	The use of Autodesk Civil3D software primarily centres on the computation and assessment of the effect of global warming potential.	Oreto, C., Biancardo, S.A., Abbondati, F., Veropalumbo, R. (2023)
	The use of JOULESAVE enables the road designer to efficiently assess the energy demands associated with various stages of road building and to make comparisons between different alternatives.	Newman, P., Hargroves, K.J., Desha, C.J.K., Whistler, L. (2012)
Sustainable materials practices	Utilization of either self-compacting concrete or light weight concrete in the building of freeways or roads.	Tsai, C.Y and Chang, A. S. (2012)
	Reuse and repurpose the materials from the pavement in the road construction.	
	Road construction using recycled asphalt pavement (RAP) used in the flexible lanes.	Hossain, M.U., Wong, J.J.Y., Ng, S.T., and Wang, Y. (2022)
	To mitigate the adverse environmental impacts, it is recommended to use warm mix asphalt instead of hot mix asphalt.	
	Utilization of recycled asphalt pavement (RAP) components that have been cement stabilized in new or restored permanent pavements as the base layer.	Sultan, S. A and Zhongyin, G. (2016)
	The consolidation of expansive soil by the use of bentonite and quicklime as hydraulic binders, respectively.	Onturk, K., Firat, S., Yilmaz, G. and Khatib, J. (2022)
	The practice of incorporating waste materials (such as coal fly ash, marble dust, and waste sand in proportions ranging from five to twenty percent by mass) into previously dug soil.	
	The use of the optimal moisture content for recycling crushed demolition road base (CDRB) and crushed concrete road base (CCRB) materials for road building. Both of these types of road bases comprise solely non-structural grade concrete.	Batmunkh, N; Siripun, K; Jitsangiam, P; Nikraz, H. (2010)
	Mixtures that are kept at a low temperature are used.	Kowalski, K.J., Bankowski, W., Król, J.B., Andersen, B.H., Komkova, A., and Barrasa, R.C (2022)
	The use of significant quantities of recovered asphalt (RAP) as well as the extensive application of recycled materials.	
	The incorporation of construction and demolition waste (CDW) as a bio-additive into RAP results in an increased proportion of rejuvenated RAP in the sub-base.	
	The use of recycled asphalt pavement as an alternate pavement design for usage in newly constructed roads, as well as in maintenance and reconstruction efforts.	Alhjouj, A., Bonoli., A., Bonoli, A., and Zamorano, M. (2022)
	The use of waste from building and demolition, fly ash, and jet grouting as alternative fillers in the form of materials.	

	When building gravel roads, bottom ash may be used as a sub-base below asphalt or concrete before the gravel is added.	Tasneem, K (2014)
	In road construction, the use of a two-lift concrete pavement with recycled pavement elements included into the bottom lift.	Van Dam, T., Taylor, P., Fick, G. (2012)
	Construction of unbound foundation courses or flexible pavements using recycled concrete aggregate.	
	Utilization of cement-stabilized waste sand in the building of roadway foundation courses.	Shalabi, F.I, Mazher, J., Khan, K., Alsuliman, M., Almustafa I., Mahmoud, W., and Alomran, N. (2019)
	Utilization of RAP mix design inside a building project including roads.	Amzah, M.O., Shahadan, Z., Hasan, M.R.M., and Jamshidi, A. (2010)
	The building of roads often makes use of recycled asphalt and a WMA additive.	Hamzah, M.O., L Gungat, L., Yusoff, N.I and Valentin, J. (2016)
	Utilization of recycled concrete aggregate in road building as base course material.	Dardis, J.M. (2012)
	The resurfacing or reconstruction of roads in the WMA using recycled asphalt pavement (RAP).	Dughaishi, H.A, Lawati, J.A., Bilema, M., Babalghaith, A.M., Mashaan, N.S., Yusoff, N.I., and Milad, A (2022)
	The construction of roads should make use of recycled building materials (for example, recycled concrete as an alternative aggregate source).	Newman, P., Hargroves, K.J., Desha, C.J.K., Whistler, L. (2012)
	Tires from recycled vehicles are used, as well as reclaimed asphalt.	
	The recycling of the waste from bauxite production.	
	Tires from recycled vehicles are used, as well as reclaimed asphalt.	
	The recycling of the waste from bauxite production.	
	the use of in-situ stabilization, which includes the application of methods such as foamed bitumen, cement stabilization, and the utilization of geopolymers.	
	Make use of RAP and WMA formats.	
	The use of recycled asphalt pavement (RAP) in the building of roadways.	Mantalovas, K., and Di Mino, G (2019)
	The use of construction and demolition debris as a substitute for traditional aggregates in the sub-base layer of road building.	Teijon-López-Zuazo, E.T., Vega-Zamanillo, A., Calzada-Perez, M.A., and Robles-Miguel, A. (2020)
	The use of discarded plastic in conjunction with bituminous materials for road building in Bangladesh.	Alam, S. (2008)
	The use of recycled asphalt pavement (RAP) material in the construction of new roadways.	Rajib B. Mallick, R.B., Radzicki, M.J., Zaumanis, M., and Frank, R. (2014)
	The life cycle cost (LCC) is used to evaluate and compare various pavement choices, such as asphalt and concrete.	Flintsch, G., and Ferreira, A. (2017)
	The use of Multi-Criteria Decision Analysis (MCDA) is employed to evaluate the relative sustainability of several mixes utilized in road building, specifically the combinations including Warm Mix Asphalt	Santos, J., Bressi., S., Cerezo, V., Presti, D.L (2019)

	(WMA) with 50% Reclaimed Asphalt Pavement (RAP), Hot Mix Asphalt (HMA) with 50% RAP, and the regular HMA mixture.	
	Utilization of self-healing asphalt pavements in nations like China, the United States of America, and the Netherlands	Nalbandian, K.M., Carpio, M., and González, A. (2021)
	Utilization of carbon-neutral building materials for the construction of roads (i.e., the transformation of certain waste products into carbon-neutral building materials for use in construction, such as recycled asphalt pavement, scrap tires, steel slag, and plastic; fly ash, coal ash, and bottom ash; and recycled asphalt).	Attahiru, Y.B., Aziz, M.A., Kassim, K.A., Shahid, S., Bakar, W.A.W.A., NSashruddin, T.F., Rahman. F.A., Ahamed, M.I. (2019)
	For the purpose of soil stabilization in road building, the use of blended binders such as cement, lime, slag, bio fly ash, and energy fly ash is encouraged.	Per Lindh, P. L. (2023)
	The stabilization of highway subgrade in road building in countries such as the United States of America and Turkey may benefit from the use of bottom ash and fly ash as alternative earthen materials and aggregates.	Tuncer B. E. (2006)
	Utilization of RAP in the building of roadways	
Government's participation	Utilization of Pavement management system models (PMS), which monitor the ideal structural restoration design as well as the future budgetary requirements of roadways.	Sultan, S. A and Zhongyin, G. (2016)
	Utilizing Life Cycle Assessment (LCA) as a method for measuring the effects of highway design throughout the course of its useful life.	Alhjouj, A., Bonoli., A., Bonoli, A., and Zamorano, M. (2022)
	Life Cycle Assessment (LCA) and infrastructure building information modelling (IBIM) should be used to evaluate the financial and ecological viability of a proposed road project.	Oreto, C., Biancardo, S.A., Abbondati, F., Veropalumbo, R (2023)
	Utilization of a green highway rating system, which measures the effectiveness of a decision or strategy pertaining to transportation by awarding credits for environmentally responsible behaviours.	Djalante, S., Oneyama, H., and Arsyad, L.O.M.N. (2020)
	Compare the many possible options for the pavement, such as asphalt and concrete, using the life cycle cost (LCC) method.	Flintsch, G., and Ferreira, A. (2017)
Sustainable lighting practices	LEDs should be used for the traffic lights.	Newman, P., Hargroves, K.J., Desha, C.J.K., Whistler, L. (2012)

Discussion

Several sustainable construction practices for road infrastructure projects were found. The content analysis yielded the identification of four distinct types. The aforementioned techniques have been classified as sustainable design practices. This paper examines the topic of sustainable materials practices, focusing on the financial and economic constraints that hinder their widespread adoption. Additionally, it explores the role of government engagement in promoting sustainable materials practices. Lastly, the paper delves into sustainable lighting practices and their significance in achieving environmental sustainability. The categories are visually depicted in a model shown in the mind map diagram seen in the Figure 3.

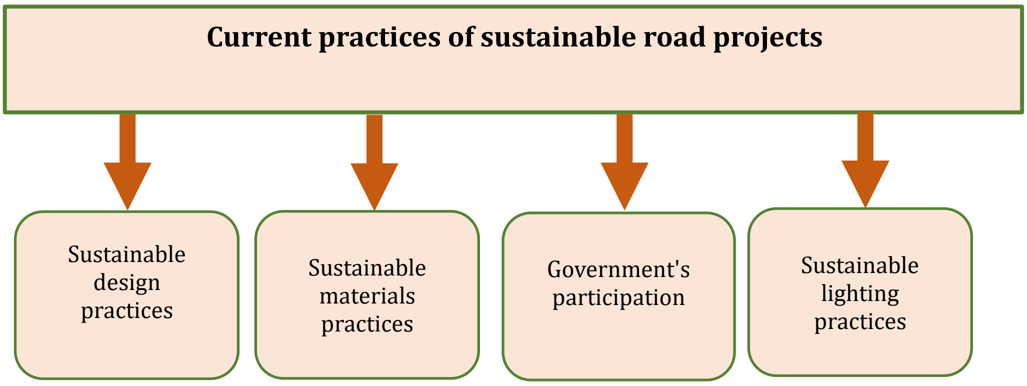

Figure 3: Model for categories of sustainable construction practices for the research topic

Sustainable design practices

The implementation of sustainable design plays a crucial role in promoting sustainable building by means of using sustainable methods. The use of sustainable design principles in road projects is of paramount importance in the mitigation of carbon emissions and the advancement of environmental efficiency (Newman *et al*., 2012; Corriere and Rizzo, 2012). Sustainable design has been identified as a potential factor that might mitigate the environmental impacts of roadways (Rooshdi *et al.,* 2014). The design, building, and management of transportation infrastructure, such as roads, parking lots, and other related facilities, might potentially have an impact. Rooshdi *et al*. (2014), assert that in recent times, the field of highway design has seen the incorporation of novel technologies, including advanced planning, transportation systems, and intelligent construction and maintenance procedures. These advancements have been implemented with the aim of mitigating the environmental impacts associated with roads.

***Sustainable* materials practices**

The use of sustainable resources, as a substitute for conventional materials, as well as the incorporation of recycled materials instead of virgin materials, plays a crucial role in the successful execution of sustainable building practices within road projects. The most efficacious methodologies and practice of sustainable construction typically entails reducing the reliance on newly extracted materials in favour of utilizing a range of recycled, co-product, and waste materials (RCWMs). This is achieved by increasing the utilization of aggregates obtained from RCWM sources (Muench and Van Dam, 2014). Additionally, the use of virgin material can be minimized through improved mix design and increased durability, such as incorporating reclaimed asphalt pavement (RAP) (Muench and Van Dam, 2014). Furthermore, the environmental impacts associated with materials production can be mitigated by enhancing efficiency and reducing emissions (Muench and Van Dam, 2014).

Government's *participation*

The involvement of the government plays a crucial role in the enforcement of sustainable building practices by requiring the use of software tools like Building Information Mode, JOULESAVE, and using models such as the Life Cost Cycle (Slobodchikov *et al*., 2019). The implementation of software and models in road infrastructure projects enables the government to establish targets for the reduction of greenhouse gas (GHG) emissions. These software models possess the capability to evaluate road projects, calculate emissions, and assess the environmental impact of the projects starting from the design phase (Slobodchikov *et al*., 2019; Hou *et al*., 2022; and Moins *et al*., 2020). Consequently, the government has the capacity to determine the feasibility of project implementation by leveraging the acquired data pertaining to emissions (Slobodchikov *et al*., 2019).

Sustainable lighting practices

According to Newman *et al*. (2012) and Osigbemeh *et al*. (2017), one of the most important aspects of sustainable building practices is the use of sustainable lighting. This is because traffic signal lights and street lighting are responsible for the generation of a considerable quantity of indirect greenhouse gases. According to Newman *et al*. (2012) and Osigbemeh *et al*. (2017), one of the sustainable lighting solutions that can be adopted on highways as a method for decreasing indirect greenhouse gas emissions is the use of LED lights on streetlights and as well as traffic signal lights that are powered by solar panels. These lights may be used in conjunction with one another.

Conclusion and Further Research

The method of conducting a Systematic Literature Review was used in order to look at the difficulties associated with putting sustainable construction practices into practice in road infrastructure projects. The usage of the SLR offers a comprehensive picture of the variety of obstacles that must be overcome before a road infrastructure project can be considered viable and also sustainable construction practices in road infrastructure projects. On the basis of this technique, 28 articles were analysed. The articles' content was analysed, and the results revealed four important categories of sustainable construction practices that can be implemented in road infrastructure projects. The practices were grouped into four key categories, namely, Sustainable design practices; Sustainable materials practices; Government's participation and Sustainable lighting practices. The results of this analysis revealed a total of 48 practices to sustainable construction in road projects. From the findings, it shows that there are very few or new technologies have been identified which then implies that there is inadequate implementation of sustainable construction in road projects.

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A Systematic review of Leadership Development in the Ghanaian Construction Industry

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Abstract

In recent times, the nexus between construction and leadership has become even stronger. Construction is seen as a major vehicle for pursuing sustainable development goals. Leadership training is essential in the construction sector for a variety of reasons. While the construction industry in Ghana is a widely researched topic in the literature, relatively little effort has been given to exploring the leadership development dimensions of the phenomenon. A comprehensive analysis of the relevant literature was carried out on existing literature on leadership development in the Ghanaian construction industry. With the help of a multi-layered hierarchical iterative method, it conducted a search of important databases and conducted a thematic analysis of each of the papers that fit the inclusion criteria. It emerged from the analysis of the twelve documents that fit the inclusion criteria that the existing Ghanaian literature on the subject revolves around three key themes within the construction literature, namely, the role of leadership development, the types of leadership, and the importance of leadership in construction operations. The majority of the studies focused on the theme of leadership development, with the least being the types of leadership. The implications of these themes for the broader literature are discussed.

Keywords: Construction, leadership development, Ghana, leadership styles

Introduction

Despite being one of the oldest activities, the construction industry has recently become perhaps more central to human affairs than ever before (Wu, 2019). In recent times, particularly in the last decade, construction has found expression in the discourse on development and, in several ways, has almost become synonymous with development. An assessment of the Sustainable Development Goals shows a clear representation of construction in Sustainable Development Goal 9 (Industry, Innovation, and Infrastructure), but it is also patently present in several other Sustainable Development Goals. Goal 4, for example, (Quality Education for All) cannot be

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achieved without the creation and expansion of physical learning spaces to create access for students and pupils. Goals 3 (good health and well-being), 6 (clean water and sanitation), 7 (affordable and clean energy), and 11 (sustainable cities and communities) are all motivated in the same way. Hence, in some sense, and very much so in the context of developing countries, development means construction and vice versa. (Ofori & Toor, 2021).

Aside from its almost symbiotic relationship with development, the construction industry is critical to every nation for a myriad of readily-fathomable reasons, such as jobs and economic growth. The construction sector makes a substantial contribution to the economic and social growth of a nation. Construction is Ghana's second-largest contributor to GDP, accounting for 13.7 percent, trailing only agriculture (Boadu et al., 2020). As a result, it is not surprising that academics are interested in the construction business. A cursory Google-indexed search shows that there are more than 100 academic journals on the construction industry alone, and it is no exaggeration to indicate that producing an estimate of the number of scholarly pieces on the subject is simply impossible owing to the sheer number of publications turned out each year.

Leadership is important in every sphere of life, and in construction, it becomes even more imperative for three reasons. The first relates to the fact that construction is almost synonymous with development, a point that has already been exhaustively explained. Secondly, the peculiar nature of the construction industry makes leadership a critical ingredient of success in the field. According to Ofori and Toor (2012), the unique features of construction, such as the huge expense, diverse clientele, wide scope and range of operations, and long length of time such as projects span, make the call for leadership urgent. The third reason for which leadership is critical in the construction industry pertains to its implications for safety. Construction work, and by extension, the construction industry, is dangerous by default and fraught with many injuries and even fatalities (Grill et al., 2019). Thus, leadership in such an undertaking is critical to the preservation of human life. This recognition of construction as a key vehicle for sustainable development, as well as its well-documented central role in any country's life, community, or business, places an even greater imperative on leadership.

For these and many other reasons, one would have expected an abundance of scholarly interest; however, the opposite is true, especially in the context of Africa, and by extension, Ghana, Ofori, and Toor (2021) acknowledge a gradual increase in scholarly interest in the subject but still bemoan the general paucity of literature on leadership development in the construction sector, indicating that there is still a gap in leadership studies in the construction industry, especially in developing countries.

Starting with pioneering work by Ofori (1989) and Ahadzi (2007), Ghana’s construction industry has been comprehensively researched through the years from different perspectives. Nonetheless, a scan of the extant literature suggests two deficits. The first is that in Ghana's construction industry, few insights into the understanding and practices of leadership development are available. There is a general, relative underrepresentation of studies focusing on leadership within the broad construction literature on Ghana. Secondly, there is an absence of a contemporary study that provides a synthesis of the available literature on the matter. But, as Tranfield et al. (2003) aver, it becomes imperative to undertake some form of summary so that the knowledge becomes properly organised and documented.

A key critique of the ‘traditional literature is that it lacks structure, exhaustiveness, and transparency. As Mallet et al. (2012) opine, systematic reviews afford the authors the ability to conduct deeper, well-structured searches of the literature rather than the ‘cursory’ searches that are undertaken in traditional reviews. Systematic reviews have always been used in the field of medical research but are only recently becoming widespread in humanities research (Hiebl, 2021).

This article is cast in the form of a systematic review and sets out to undertake a systematic review of the previously published material on leadership in Ghana’s construction sector over the last few decades with the aim of providing an organised thematic summary of the knowledge produced so far in the area. The study is driven by two key research questions: What does the existing literature say about leadership development in Ghana’s construction industry? And what themes emerge from the analysis of the existing literature? The paper ends by identifying knowledge gaps and proposing new frontiers to be chartered in the enterprise of researching the country's construction industry.

Literature Review

An overview of the general leadership in construction literature

During the 1990s, the majority of leadership studies in the construction industry focused on leadership style, traits, and behaviours (Rowlinson et al., 1993; Muir & Langford, 1994; Zimmerer & Yasin, 1998; Dulaimi et al., 2005). Transformational leadership (Chan & Chan, 2005), power dynamics (Liu & Fang, 2006), intercultural communication (Toor & Ogunlana, 2008), emotional intelligence in leaders, and leadership development (Skipper & Bell, 2006) are some of the topics that have become the focus of construction leadership studies in the past decade. Several studies are continuously being conducted on the issue of leadership styles, personality traits, and behaviours in the construction industry (Songer et al., 2006; Wong, 2007). Questions have been raised (e.g., Abdelhaleem & Seymour, 1995) about the degree to which models of leadership developed in other disciplines are useful when applied in the construction industry. Nonetheless, the literature is unequivocal in its assessment of the significance of leadership in the construction industry. According to Ofori and Toor (2012), effective leadership is a critical but lacking component in the construction industry in developing countries. They further argue that effective leadership in construction is more needed in developing countries because of the long-term implications it has for such nations and their citizens.

Leadership is a skill that is essential in every aspect of human endeavour. The building process as a whole, as well as individual construction projects, make effective leadership even more important. Construction projects are costly and difficult technically, and the project teams are broad and diversified to accommodate these challenges (Ofori and Toor, 2012). Leadership is one of the primary factors that contribute to the success of a company, and one might argue that leadership is of even greater significance in the construction sector than in the vast majority of other types of industries. Due to the unpredictability of the external environment in which construction organisations operate, effective leadership and management have evolved from the status of mere buzzwords to that of an absolute requirement (Kouzes & Posner, 2007). According to Odusami et al. (2003), the absence of a focus on leadership is not only a problem in practice but also in academic research.

Leadership and the construction industry; The 4Ss

The literature uncovers four major reasons why leadership is important in the construction industry, which are summarized in the 4Ss: safety, success, sustainability, and size. The first has to do with safety. Construction has always been known as a rough and steady industry (Abdelhaleem & Seymour, 1995) because it has a high risk factor in terms of injuries and other occupational hazards. A Eurostat (2017) report indicates that more than one-fifth of all occupational injuries happen in the construction industry. Consequently, leadership is critical to avoiding risk (Grill et al., 2019). According to Grill et al. (2019), leadership is responsible for reducing injuries as a moderating factor. Similar findings have been made by Pilbeam et al. (2012). In the words of Grill et al. (2019), leadership is an important component of effective safety. Finally, the projects and the finished product have serious implications for the workers' and the general public's health and safety. Another reason that leadership is important is that it helps construction projects succeed. Amirali (2016) asserts that a project's ability to succeed hinges on the presence of strong leadership within the team. According to Ofori (2000), the key to success in businesses is no longer repeating yesterday's procedures or doing them marginally more effectively. Instead, he recommends that significant adjustments be made to company procedures, methods, and leadership capabilities.

According to Alkahtani (2015), the leader's choice of desirable behaviour is an essential component for the achievement of organisational success in terms of the timely delivery of the project. Oyetunji et al. (2019) discovered a positive linear correlation between leadership and construction worker performance in a study conducted in Nigeria. Their research went on to identify relationships between the type of leadership and the outcomes of construction projects, and they came to the conclusion that the success and quality of construction projects, as well as their timely delivery, are dependent, among other things, on the leadership qualities of the project manager. Leadership skills are very important to project success and, in some cases, can even be a substitute for technical deficiencies. (Mascarenhas-Mateus; 2020; Jones 2022)

In the construction sector, business and project failures are widespread. According to numerous studies from both developed and developing countries (Jannadi, 1997; Enshassi et al., 2006). These mishaps have been blamed on a variety of factors. According to Bjeirmi et al. (2007) findings, the construction industry in the United Kingdom has been subjected to criticism for a very long time due to its fragmentation as well as its track record on quality, waste, financial claims, and efficiency. As a result of improper procurement practices, the construction process has been criticized for its lack of communication and transparency. Inadequate procurement systems, lack of resources, design and construction discrepancies, insufficient project management practices, variation orders, communication gaps, cultural issues, and differences in the interests of the participants are among the major issues confronting Thailand construction projects (Toor & Ogunlana 2008).

Abdul-Rahman et al. (2007) discovered that in Malaysia, the quality of management for contractors working on public design-and-build projects was inadequate. This situation was exacerbated by budget constraints, time constraints, client complexity, poor communication, and design variations. According to Davidson and Maguire (2003), the leading ten reasons for the failure of construction companies in the United States are as follows: rapid growth; work in new geographic regions; an increase in the size of single jobs; new types of work; high employee turnover; insufficient capitalization; poor estimations; poor accounting systems; and poor cash flow. Similar issues, such as frequent delays, cost overruns, insufficient quality, and inadequate safety, were identified by Pires et al. (2007) in Portugal. These issues have made the industry less competitive. The following factors, according to their survey, contribute to such issues: design and client responsibilities, insufficient construction management, and insufficient specific training. According to numerous studies, leadership is even more important in construction (Odusami, 2002; Long et al., 2004). For example, Thamhain (2003) emphasized the importance of the leader in creating a supportive work environment for project participants. Whether a project succeeds or fails is strongly dependent on the project leader, according to Munns and Bjeirmi (1996). Chinyio and Vogwell (2007) discovered that effective leadership among a construction project's many stakeholders can help align their goals and avoid conflict.

Closely linked to success is the third‘s’ importance, which relates to sustainability. The literature posits a clear association between leadership style and the sustainability of projects. Numerous studies, including Archer et al. (2010), Wang et al. (2019), and Zhao et al. (2021), have discovered a positive relationship between construction site managers' leadership abilities and project sustainability. All of these studies argued that the project manager's leadership abilities are critical determinants of project success. It has mostly been found empirically (e.g., Scott-Young et al., 2019; Iqbal et al., 2020) that a higher level of psychological empowerment will result in a higher indirect influence of sustainable leadership on sustainable performance through organisational learning.

Finally, size (the fourth S) is a key reason the literature adduces for leadership being important in the construction industry. The central hypothesis in the literature is centred on the fact that the sheer size and diversity within and among construction require good leadership to ensure success. Construction projects tend to be vast and complex, requiring a wide range of specialized skills and knowledge. There are many different construction disciplines represented on these huge teams, which need strong leadership in the sector (Hillebrandt, 2000; Mascarenhas-Mateus, 2020).

Furthermore, today's projects are typically expensive, and a country's savings are heavily reliant on its building stock (Jones, 2022). As a result, the quality of the finished product is critical. In general, the completion of projects can take a significant amount of time and include a large number of distinct activities, both of which contribute to a rise in the number of time-related hazards as well as complications in communication, coordination, and risk management (Oyetunji et al., 2019). The construction industry, therefore, has a need for effective leadership to manage the sheer size and diversity as well as the multiplicity of problems outlined.

Leadership styles in the construction industry

Leadership styles have also been considered in the literature in this regard. Leadership styles are defined by how people engage with the people they want to lead. Some of the leadership styles categorized are autocratic leadership, democratic leadership, transformational leadership, and transactional leadership (Price, 2009). Autocratic leaders tell others what to do and then expect them to do it. Although it may be effective in certain circumstances and in the short run, it is not effective in the long run. Democratic leaders are those who make final decisions after consulting with the people they lead and seeking consensus (Bartol et al., 2003). Critics of this approach argue that popular decisions are not necessarily the best ones to make and, hence, may fail to achieve the intended outcome. Transformational leaders, on the other hand, offer their team members the freedom to make their own judgements based on the knowledge they have and have limited influence over the decision-making process. Although this is a time-consuming procedure, it is successful when the members of the team have a strong dedication to the accomplishments of the firm. Transactional leaders are goal-oriented leaders who want their team members to be entirely focused on the work at hand. These leaders have very high expectations for their team members. These leaders also believe in rewarding their employees. Opponents argue that this leadership style is too narrowly focused and frequently focuses on the wrong issues (Bartol et al., 2003).

To this end, it is commonly considered that a leader's personal qualities influence their leadership qualities or style, and thus their success. Leaders are born with the qualities they possess, according to this approach. Traditional and behavioural techniques compare and contrast ineffective and effective leadership behaviour. Proponents of this idea hold the belief that effective leadership is defined more by acceptable behaviour, abilities, and actions than by personal attributes. The distinction between this strategy and the one that came before it is crucial due to the fact that qualities are often stable over time, but skills are something that can be acquired and modified (Bass & Avolio, 1994). In order for managers to be effective, they must not rely on predetermined sets of successful attributes but rather be able to recognise and utilise the leadership style that is most suited to the circumstances. In addition, they should be able to adjust to new conditions and situations that are often contradictory, which requires them to demonstrate adaptability and flexibility.

According to Price (2009), the success of any type of leadership depends on a combination of transformational and transactional factors. Transformational factors include characteristics such as charisma, inspirational motivation, intellectual stimulation, and individualised consideration. Transactional factors include characteristics such as contingent reward, management-by-exception, active and passiveness. In addition, the research suggests that characteristics of a leadership style that are positively viewed by construction professionals include inspiring motivation, idealised traits, intellectual stimulation, idealised behaviours, contingent reward, and individualised concern. According to Price (2009), building construction professionals should embrace and encourage transformational leadership in their interactions with employees in order to generate improved employee satisfaction. One of the few studies that have been conducted on the topic of construction leadership in developing nations revealed that transformational leadership was the most prevalent method taken by construction project managers in Thailand (Limsila & Ogunlana, 2008). They came to the conclusion that the transformational leadership strategy was more successful in delivering the targeted leadership results than the transactional leadership approach or the laissez-faire leadership approach. Through transformational leadership, it is possible to attain higher levels of productivity and quality, as well as imaginative problem-solving by subordinates.

A review of Ghana's Construction industry

Large-scale construction in Ghana began during the colonial era after the country became a British protectorate and was characterised by the construction of some schools, hospitals, and, most importantly, railways and two harbours for the colonial government's exploitative agenda. Mass housing construction works, however, took off much later, some three decades after independence, when the government in the late 1980s, through the Social Security and National Insurance Trust (SSNIT), initiated a number of mass housing building projects (Ahadzie & Amoah-Mensah, 2010). According to Laryea (2010), the growth of the building industry began in 1945, when contractor development began.

The construction industry in Ghana is multifaceted, with a diverse set of stakeholders. (Dadzie et al., 2012). Since October 2012, the Chartered Institute of Building in Ghana estimates that over 1,600 building contractors have been working in Ghana (Oxford Business Group, 2014), and they have been classified into different groups based on their worth and the value of the projects they execute. Building contractors are divided into four categories by the Ministry of Water Resources, Works, and Housing, which is in charge of the country's housing infrastructure and construction. Projects worth up to $75,000 (D4K4), projects worth $75,000–250,000 (D3K4), projects worth $250,000–500,000 (D2K2), and projects worth more than $500,000 (D1K1) (Frimpong & Kwasi, 2013). The vast majority of Ghana's companies fall into either the D4K4 or D3K4 categories (Oxford Business Group 2014).

The construction business is marred by unethical activities, despite the fact that it makes a major contribution to the nation's economy and, by extension, to the advancement of social progress (Asamoah & Decardi-Nelson, 2014; Boadu et al., 2020). Lack of planning plagues the industry, resulting in wasteful consumption of both water and electricity, excessive building material consumption, failure to address the requirements of consumers and tenants, and fragmented stakeholder collaboration (Twumasi-Ampofo et al., 2014). These problems are the product of an industry that is rife with corruption and does not have transparent recruiting procedures for consultants and contractors (Asamoah & Decardi-Nelson, 2014). Building construction techniques that are unsustainable combined with constant environmental degradation continue to impede Ghana's development (Djokoto et al., 2014). Ghana's building construction industry now lacks cohesion in its approach to addressing current challenges, necessitating the formation of a regulatory council to oversee the industry's efforts (Ofori-Kuragu et al., 2016).

All these problems underscore the importance of having strong leadership at every tier in the building construction industry. In summary, this paper has explored some definitions and types of leaders and has sought to forge a nexus between leadership and the building construction sector. It has emerged from the literature that leadership and leadership development are very critical success factors in determining the success and sustainability of building construction projects. In addition, many of the issues in the building construction business can be overcome if leadership development is treated seriously. Construction projects are costly and technically demanding, with large and diverse project teams. The process takes a long time and is comprised of a large number of separate yet interrelated steps. Because the goods that are created have an impact on the socioeconomic growth of developing countries over the long term, unsatisfactory project performance can have severe repercussions for the nation and its citizens. As a result, the need for effective construction leadership is even greater. To that purpose, leadership development should be given more attention.

Methods

A multi-layered iterative approach was adopted. At the first stage, a bibliometric search was undertaken in the SCOPUS database in the top 10 ranked construction journals using the keywords ‘leadership development in Ghana’s construction industry’. This search yielded only one result, and it thus became necessary to refine the search query by broadening the scope of both key words and databases. New keywords such as 'performance', 'human capital development', 'management practices', ‘leadership styles’, 'project management', 'management styles', and ‘importance of leadership’ were included in the search because it was observed that leadership was often used interchangeably with such words and phrases. The search query was also expanded to include all sources that the Google Scholar-indexed search could find. Google Scholar is recognised as a credible, useful, and powerful bibliometrics search engine and has become a major search tool used by scholars. A similar approach has been adopted by Allam et al. (2014), Haddaway et al., (2015), Fagan, (2017), Halevi et al., (2017), and Strzelecki (2020).

The search yielded a total of 33 documents, and at the third level, the documents were screened using the criteria (inclusion and exclusion) outlined in Table 1. Thus, in all, a total of 12 documents were used for the analysis.

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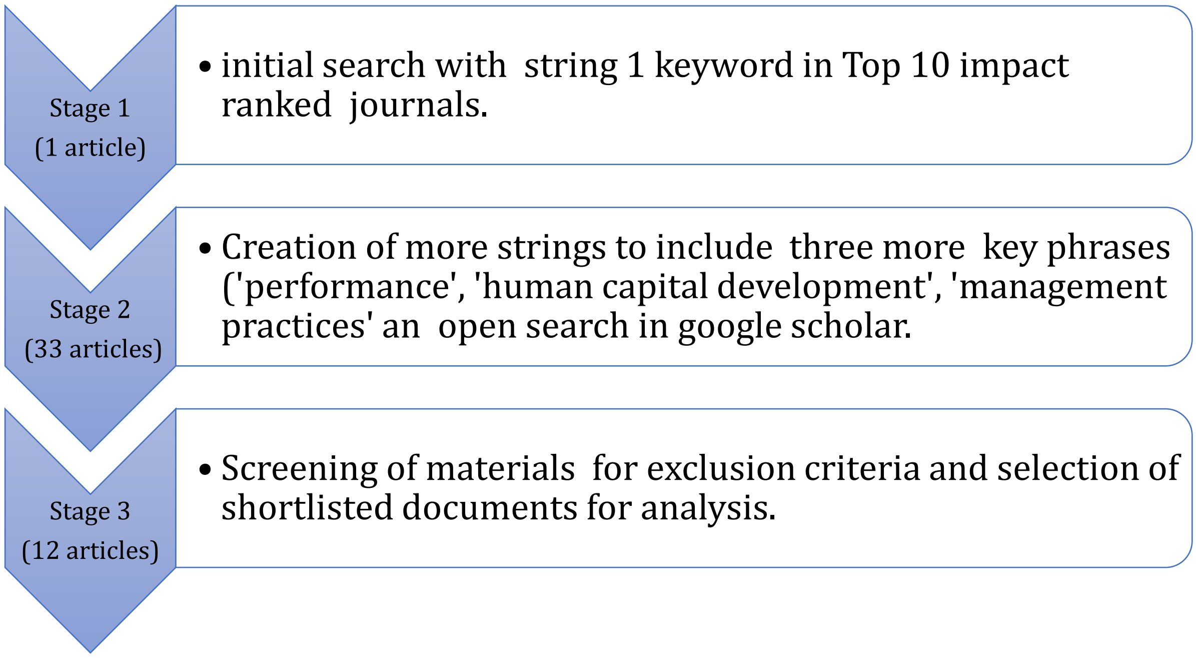

Figure 1: information search process

Table 1: Inclusion and Exclusion Criteria

Inclusion criteria	**Justification**
Published papers in 2010 to 2021 in journal or conference proceedings.	Focus on relatively recent information
Papers which have information on leadership or leadership development in Ghana's construction industry	Helps to narrow down the search to the specific topic of leadership development
Papers relating to project management in the construction industry.	In the literature, project management and construction are closely related, particularly in construction journals.
Exclusion criteria	**Justification**
Papers published in leadership development in construction but not focused on Ghana.	The article country-specific information
Papers not written in English	The target audience of the article.
Grey Literature	Not all grey literature is subject to scientific standards

The data, once accessed, was mapped and categorized based on emerging themes (Booth et al., 2016; Tranfield et al., 2003).

Findings

The study found that the existing literature is organised around three key themes, namely, the role, type, and importance of leadership (Table 2). The role of leadership was the most commonly occurring theme, with a total of five articles. This was followed by the 'importance of leadership in construction' and 'types of leadership' themes with three and four articles, respectively. Table 2.

Table 2: Breakdown of literature by themes

Theme	**Authors**	**Key findings/ argument**
1. The role of leadership in construction	Ofori &Toor, 2012	The sheer size, cost, nature, diversity and numerous stakeholders in the construction industry, makes leadership an imperative. Without good leadership, the industry is in disarray.
	Kissi, et, al., (2014).	The authors found that three out of the five major constraint of project management were leadership oriented. These include lack of clearly defined roles, poor communication and weak operational environment.
	Nubuor, et, al., (2017).	Findings from the study demonstrate that the project manager's influence and leadership style play a significant role in the success of a construction project.
	Baffoe & Ofori-Kuragu (2019)	The leadership abilities of management staff of construction firms is an important factor in their success.
	Acheampong, et al, (2021)	Emotional intelligence can boost project performance by up to 50.7 percent.
2. Type of leadership style	Addy & Cofie (2014)	Situational leadership, contingency leadership, transactional leadership, and transformational leadership are the most common forms of leadership in Ghana.

	Boateng &, Ackon (2018).	According to the findings of this study, transactional leadership is more prevalent in Ghana's construction sector than transformational leadership
	Owusu-Manu et al., (2021),	The outcomes of the study indicated that the Ghanaian construction sector was characterised by a prevalence of democratic, transformational, and situational leadership styles. The "development attitude" was found to be favoured by project managers, according to the findings of the study.
3. Benefits of developing leadership for the construction industry.	Ahadzie & Amoa-Mensah, 2010	Developing the leadership potential of project managers is critical in helping to improve the effective delivery of future housing projects.
	Ofori & Toor, 2012,	Developing leadership skills in the construction industry goes a long way toward resolving many of the industry's problems.
	Fugar, et, al., (2013).	Investing in leadership development is the human capital base of a construction firm and places it in a good position for growth
	Boadu, et, al., (2020)	Lack of leadership at the institutional level poses a major challenge within the construction industry in Ghana.

Discussion

The findings validate the earlier assertions by Ofori and Toor (2021) on the paucity of data on leadership development in the construction industry. While the 12 papers finally settled upon are generally low, they represent the best reflection of the available information on the topic. Though a further broadening of the search filters, as happened in stage two (Figure 1), yielded almost triple the number of papers, the expansion introduced other information that provided diversionary information. Here, we address two of the reasons why there is a lack of research on construction leadership. In the first place, social scientists performing leadership research are not aware of the construction industry's vast study prospects (Langford et al., 1995). To add to this lack of interest, the construction industry has tended to stress project and organisational management above leadership; therefore, the topic has not arisen as one worth exploring. Finally, only a small number of researchers have the requisite knowledge and resources to conduct this type of study (in most countries) (Chinowsky & Diekmann, 2004).

One intriguing fact is that all the articles were co-authored. It could well be a metaphorical representation of the fact that in the real world, construction work involves a wide range of actors and services (Ofori & Toor, 2012; Boadu et al., 2020). A typical construction project will involve architects, Quantity surveyors, electricians, plumbers, masons, and procurement specialists, to name a few. On the whole, the findings point to the fact that, while the Ghanaian literature is relatively recent, it covers essentially the same areas as the mainstream literature. The three themes that emerged from the findings are similar to the main themes of leadership development in the broader literature. The themes of the role, types, and relevance are also reflected in broader themes that have been reviewed in the literature.

In conclusion, the study found that the literature on leadership development in Ghana's construction industry is at present narrow and focused on three key themes, namely the role, type, and importance of leadership. Other areas of interest could be the strategies for leadership development, determinants and antecedents of leadership development, challenges facing leadership development, and more recently, leadership development in a crisis period such as the COVID-19 pandemic. Also of interest will be information on the experiences of leadership trainees as well as the role of technology in leadership development in the industry.

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Circular Immersive Parametric Design Workflow for Sustainable Construction Materials Development

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Abstract

Universities can play an essential role in educating students on Building and Information Modelling before they enter the construction industry. Educating students is related to technological constraints against which researchers and BIM providers face as they accelerate the process of compatibility and data exchange in BIM workflows. Revit is a leading BIM platform and works with Enscape, Unity, and other software for translation. Subsequently, virtual environments have been implemented successfully in residential and commercial projects However, in Sub-Saharan Africa, the potential for BIM and virtual reality (VR) are still unexploited for the realization of construction projects. The use of new technologies could increase the willingness of construction professionals to use BIM. This paper presents an innovative workflow towards sustainable construction material application through VR-enabled BIM for architecture, engineering, and construction (AEC) industries towards improving circularity. Students applied BIM and VR in a Building Design course.

Therefore, this study introduces a workflow for circular immersive parametric design (CIPaDe). The CIPaDe Workflow includes stages of 1) material selection for load-bearing and non-loadbearing elements 2) geometry exploration and 3) unit and systems design applying modular design, design for disassembly, and design for deconstruction principles. There is sufficient evidence that the use of BIM and VR in AEC education environments is desirable and beneficial. The proposed CIPaDe, BIM-into-VR-based workflow is expected to improve students' learning performance, provide an environment similar to the real world, increase the visualization of models before they were built, and enhance their creativity.

Keywords: Virtual Reality, Sustainability, BIM, Design Review, Immersive Virtual Reality

Introduction

Universities around the world are adopting Building Information Modelling (BIM) for their built environment courses and consider it a necessary component of professional practical training (Pillay et. al., 2018). Design education usually involves the use of freehand and software, creators go through the processes of sketching, shaping the forms, detailing, and final renderings (Drampalou et. al., 2022).

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The design process is full of iteration and commences with the exploration of concepts which leads to two-dimensional sketches. Subsequently, the geometry became defined and the repetitive actions of sketching and considering the ways to communicate design intentions resulted in a final render that represented the design in the best possible way. In current times, the use of software in the design process has introduced tools for more efficient and sustainable design, early material selection, and mass simulation that contribute to decision-making at the early stages of design. In addition, adopting BIM technologies at the early design stage allows for additional information into building models such as time, cost, manufacturers, details, sustainability, and maintenance information (Ogwueleka & Ikediashi, 2017).
This paper seeks to provide an educational framework for adopting immersive exercises and BIM during sustainable building design education in universities. The following sections presented are the literature review, methodology, findings, discussion, and conclusion.

Literature Review

A lack of skills, education, and knowledge of BIM are the biggest barriers to the full implementation of BIM in South Africa. Furthermore, the results also show that educational and skill development initiatives are widely considered to be the answer to the existing barriers to BIM adoption (Kekana et al., 2015).

There are many BIM tools in the Architecture, Engineering, and Construction (AEC) industry. The top ten BIM software sourced from three websites; Plannerly, Parametric Architecture, and LinkedIn showed that Autodesk Revit was the most popular software. Other useful software included Plannerly, Trimble Connect, Revizto, BIMcollab, Dalux, Autodesk Construction Cloud formerly known as BIM 360, Graphisoft Archicad, Solibri Model Checker, BricsCAD BIM and others, Table I.

Table I: Popular BIM Software from three websites. Access date February 2024

SN	Plannerly	Parametric Architecture	LinkedIn
1	Autodesk Revit	Autodesk Revit	Autodesk Revit
2	Plannerly	Graphisoft Archicad	Plannerly
3	Trimble Connect	SketchUp	Trimble Connect
4	Revizto	Rhino	Revizto
5	BIMcollab	Vectorworks	BIMcollab
6	Dalux	AutoCAD	Dalux
7	Autodesk Construction Cloud / BIM 360	Plannerly	Autodesk Construction Cloud / BIM 360
8	Graphisoft Archicad	Trimble Connect	Graphisoft Archicad
9	Solibri Model Checker	Revizto	Solibri Model Checker
10	BricsCAD BIM	BIMcollab	BricsCAD BIM

In higher education students have explored immersive experiences in design-related subjects. In a previous study, participants were asked to imagine teaching and learning situations twenty years ahead, in a future where Virtual Reality (VR) technology and the design studio are harmoniously integrated, findings showed that VR use combined with a lesser amount of real-world interactions was perceived as undermining student maturity or growth. This hints at implications in the design process, pedagogy, curriculum, teacher and student dynamics, and role repositioning, showing that integrating VR may have ramifications stretching far beyond the design studio context (Bernando & Duarte, 2022). However, the design of technology education does not only satisfy the students' needs but also the requirements of teachers, industries, and market trends and soft systems methodology is an effective approach in designing courses regarding hands-on technologies, and the use of immersive technologies improves the learning performance for acquiring fundamental knowledge and application know-how (Wu et al., 2021). (Cho & Park, 2022) proposed an immersive virtual reality simulation for environmental education based on the virtual ecosystem model and presented two applications developed based on simulation. Their research encouraged students' active participation and motivation to solve environmental problems while experiencing the results of interaction related to environmental factors in a virtual environment.

VR has been used in conjunction with project-based learning for a self-directed approach to designing and implementing a product using 3D software whilst also using virtual reality to evaluate their design. The hypothesis was that the use of VR with a project-based learning approach to facilitate the attainment of desirable goals in the engineering design project, improved achievement of course learning outcomes and promoted effective communication. In the findings, the VR approach significantly affected the distribution of cumulative project grades, particularly the implementation component. In addition, the course outcomes related to project design were better achieved in the VR approach. The communication and problem-solving skills were improved in the VR approach as compared to the traditional approach (Frasson et al., 2021, Halabi, 2020).

Frasson et al. (2021) proposed a framework for based on VR technology and contemporary head-mounted displays incorporating game-based techniques and adaptive design in education for educational applications to transform learning procedures into entertaining, engaging, enjoyable, and effective experiences. The use of VR enabled users to engage in the Energy SIM simulation tool (Anifowose et al., 2023). VR could encourage students in sustainable material selections. This study explored sustainable material selection in a design exercise that incorporated the use of VR for project reviews.

Research Methodology

The students began by sketching their modular panels for a shading wall. This was an iterative session and the focus was on the shading wall on the south-facing side of the building. Students selected traditional materials for the shading wall and there was geometry exploration for a modular design which would be repeated to fit the size of the shaded wall designed. Thereafter students produced their building and shaded walls in Revit and there were VR sessions to view the designs. Lastly, a cradle-to-gate life cycle analysis was conducted to evaluate the impacts of the design choices, Figure 1.

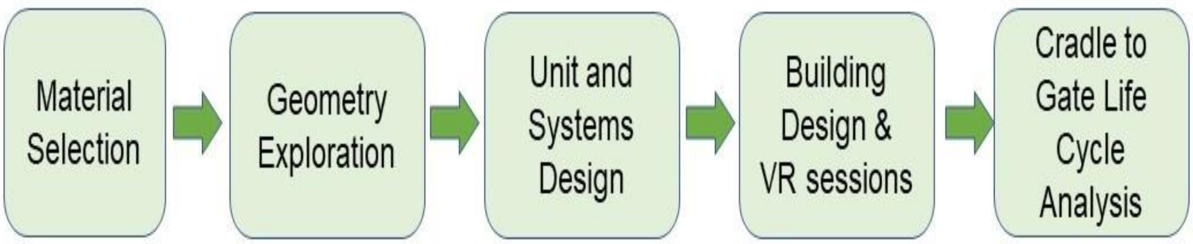


Figure I: Research methodology
Source: Author (2024)

Results

For the strategy development part students were asked to name three sustainable strategies they could apply from the class readings and library list, Figure 2. The choices included a windmill, thermal storage, rainwater collection, sustainable materials, renewable energy, orientation, use of roof light pipes to increase natural light, use of glass and glass coating to increase energy efficiency, smart glass, passive heating, recycling, waste control, green plants, and solar panels. Some of the concepts

Integrated recycling and green plants. For the strategy development exercise, students were asked to name three sustainable strategies they could apply from the class readings and library list, Figure 2.

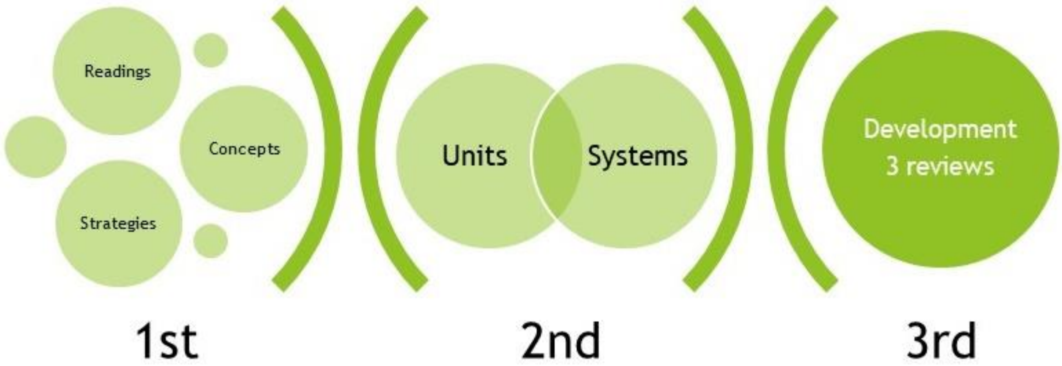


Figure 2: Design Process
Source: Author (2024)

In the Fall 2023 Building Design course, the students' definition of sustainability was as follows– 1) the ability to function for a long time without negative impact 2) routine 3) the ability to maintain 4) the ability to make something last forever 5) energy efficient practices 6) green building 7) the ability to work well 8) longevity 9) using minimal resources 10) ability to keep track consistently.

The lectures commenced with class reading focused on sustainability. Sustainable design choices by the students included a windmill, thermal storage, rainwater collection, orientation, renewable energy, use of sustainable materials, use of light pipes, coating the glass to increase energy efficiency, smart glass usage, passive heating, soundproofing of the classroom near railway, recycling and waste control, and lots of green areas including green walls.

After the class readings focused on sustainability, the design stage commenced with the concept development, Figure 3. The sketches included play with forms and green plants in the building. Three examples of concepts by the students include 1) a bright, colorful, art, fun, and expressive sketch. This initial sketch combined forms from an apple, a keyboard, a Dorito, and a dinosaur, Figure 3a. 2) an atrium design with a café, the goal was to bring nature inside and develop a greenhouse-type roof, Figure 3b. 3) an array of books that open up representing the idea of the task of designing an educational office building, Figure 3c.

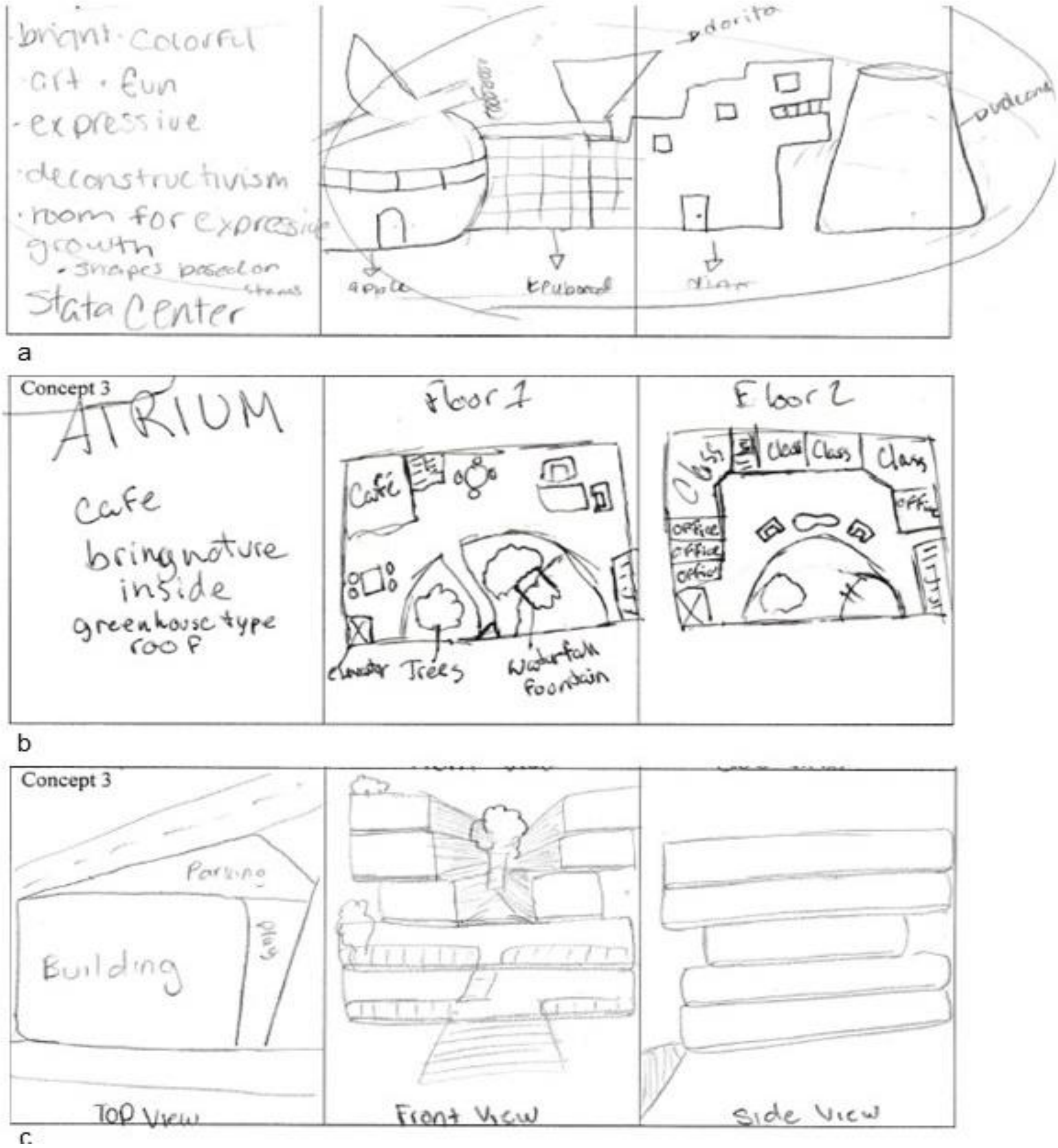
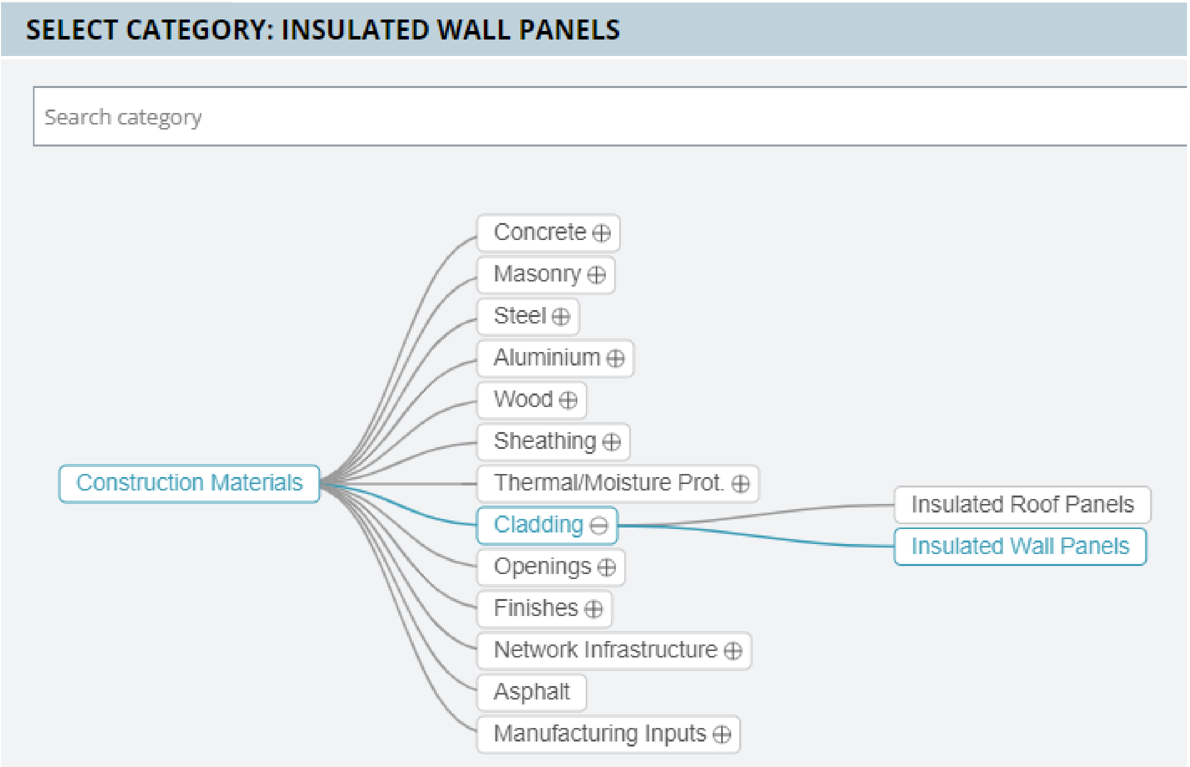


Figure 3: Concepts
Source: Student (2024)

The sustainable assessment focuses on material selection for the south-facing walls of the design project, Figure 3. Materials could be chosen from the Embodied Carbon in Construction Calculator (EC3) tool a free cloud-based tool that allows benchmarking, assessment, and reductions in embodied carbon, focused on the upfront supply chain emissions of construction materials Table II.



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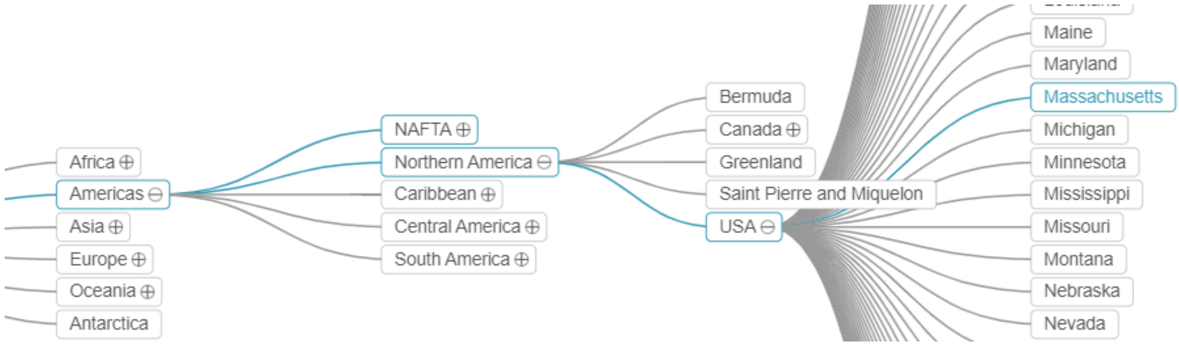

b

Figure 4: Embodied Carbon in Construction Calculator
Source: Author (2024)

Table II: Student material selection for the shading system

SN	Product Name	Mass per m³ (kg)	Density ()	Reported GWP/m³ (kgCO2e)
1	Classic sawn	500	500 kg/m³	42.18
2	Softwood lumber	458.13	1010 lb/m³	55.56
3	US redwood lumber			50.89
4	Clay			
5	Drywall			
6	Wood			
7	Concrete			
8	Steel			
9	Cement			

Table III: Default material for insulated panel walls in EC3 tool

SN	Product Name	Declared Unit (DU)	Thickness range min (m)	Reported GWP/DU ($kgCO2e$)
1	Metal Composite Material (MCM) Panels	1080 ft^2	0.004	3629
2	Aluminum exterior cladding	100m^2		11170
3	Insulated Metal Panels	100m^2		14370
4	Roll Formed Metal Wall and Roof Panels	100m^2		1652
5	Roll Formed Aluminum and Steel Cladding	100m^2		2491

The chosen products were compared to the default industry insulated wall panels in the EC3 tool, Table III. The first product of a metal composite material panel was declared in square feet (1080 ft^2) while others were declared as 100 square meters. The two quantities are equivalent therefore a direct comparison could be made, Figure 5. One product had a declared thickness and the study assumed the same thickness for other products to compare them with the student selections that were declared by volume.

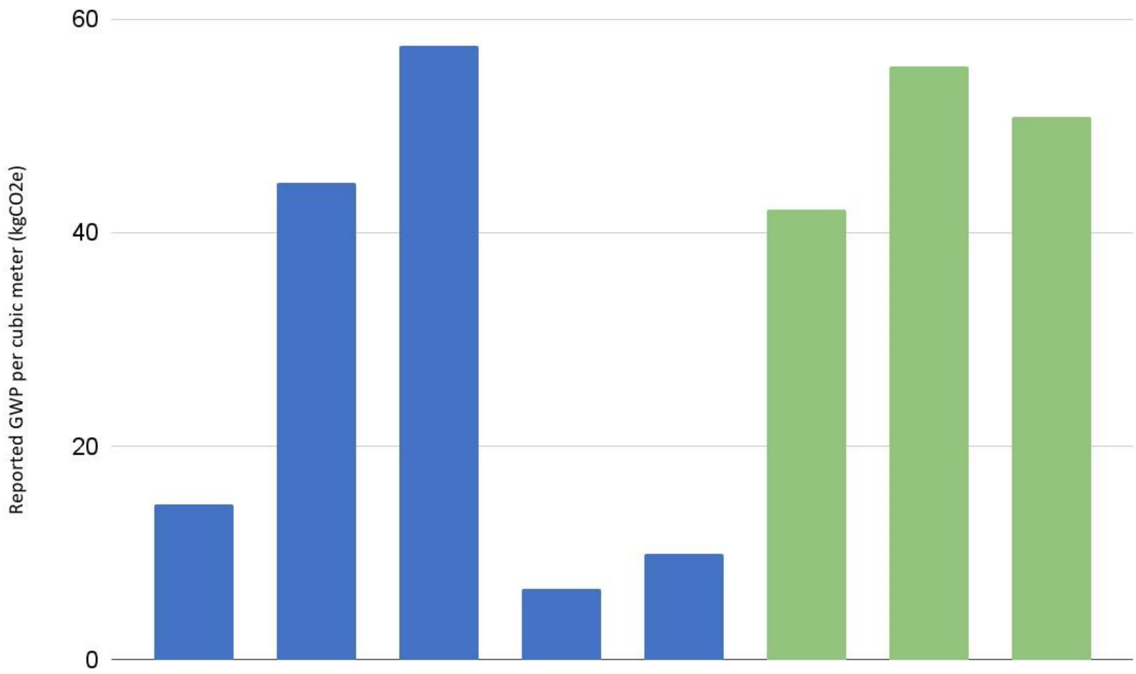

Figure 5: Comparison of selected materials using the Embodied Carbon in Construction Calculator, student selection in green.

Source: Author (2024)

Students were given forms for sketches of three possible units of their façade systems, Figure 6. Subsequently, they selected materials for their designed shaded wall systems in Figure 7.

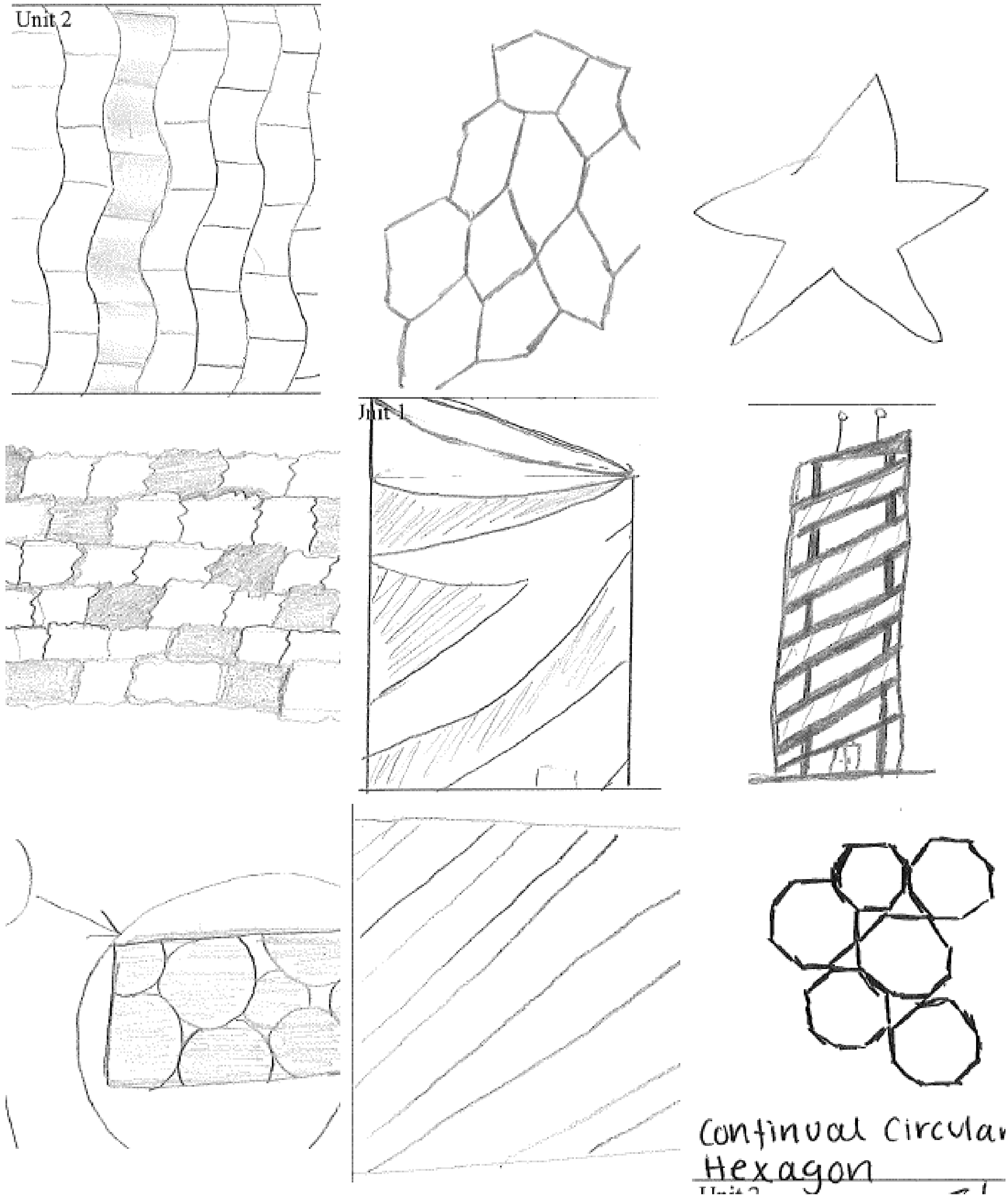

Figure 6: Units
Source: Students (2024)

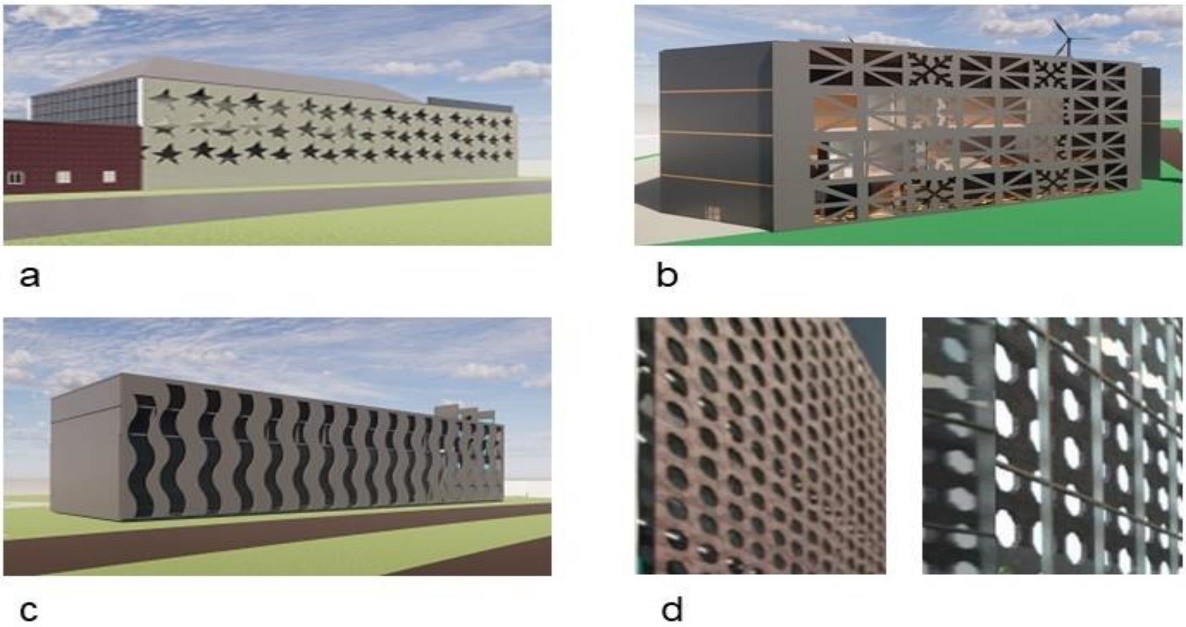

Figure 7: Shading systems
Source: Students (2024)

VR sessions

Students assessed their projects as users and spent an average time of 5 minutes for 18 sessions in the VR environment, Figure 8. The range of time spent was 2 – 10 minutes. Students voluntarily critiqued their design when immersed in the building environment. The most mentioned areas for improvement were the walls (8), windows (7), staircases (6), and building pads (6). Other areas included furniture, ceilings, and handrails. In their report at the end of the semester, team members responded to questions on a user experience survey, and six students responded to inquiries on the VR sessions. Students strongly agreed that the VR sessions were innovative, new, interesting, exciting, attractive, practical, efficient, dependable, motivating, and enjoyable. They agreed that it was organized, clear, pleasant, good, valuable, easy to learn, creative, and understandable. A few students strongly disagreed that the sessions were friendly, dependable, easy, and easy to learn. Thirteen out of twenty students participated in the VR session and nine out of ten teams were represented in the VR sessions, one student declined to participate sessions.

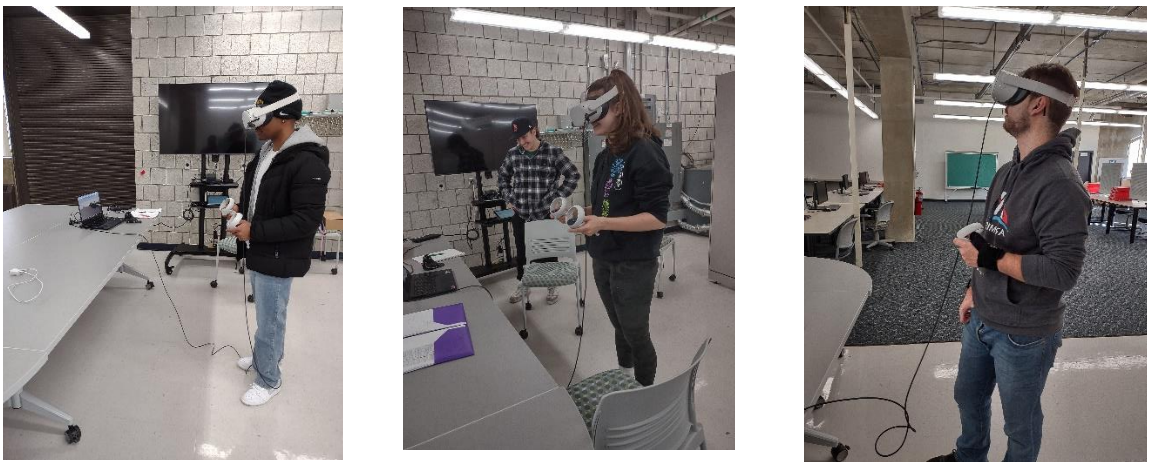

Figure 8: VR sessions during the semester
Source: Author (2024)

Cradle-to-Gate life cycle analysis

Four shading systems in Figure 7 were analyzed using the United States Environmental Protection Agency's Waste Reduction Model (WARM) Version 16. Data on the scrap metal from the city from 2010 to 2020 provided an annual average scrap metal amount of 82,558 kg, Figure 9. Dimensions of the student shading walls are shown in Table IV. The metal was compared by selecting the recycling process as the baseline generation and management of the waste material while the alternate management scenario for the scrap metal was source-reduced. This method proposed the direct reuse of the metals as shading system parts without recycling. The study assumed a thickness of 0.004m for all panels.

The best two products did not declare their weight for comparison with the WARM model. However, the Metal Composite Panels (MCP) provided a mass of 756 kg for 100 m^2 of product. The GWP after uncertainty adjustment per 100 m^2 was 3629 kgCO2e. Therefore, MCP represented virgin materials for the four designs and the environmental impacts were compared with utilizing the salvaged scrap metal in the city.

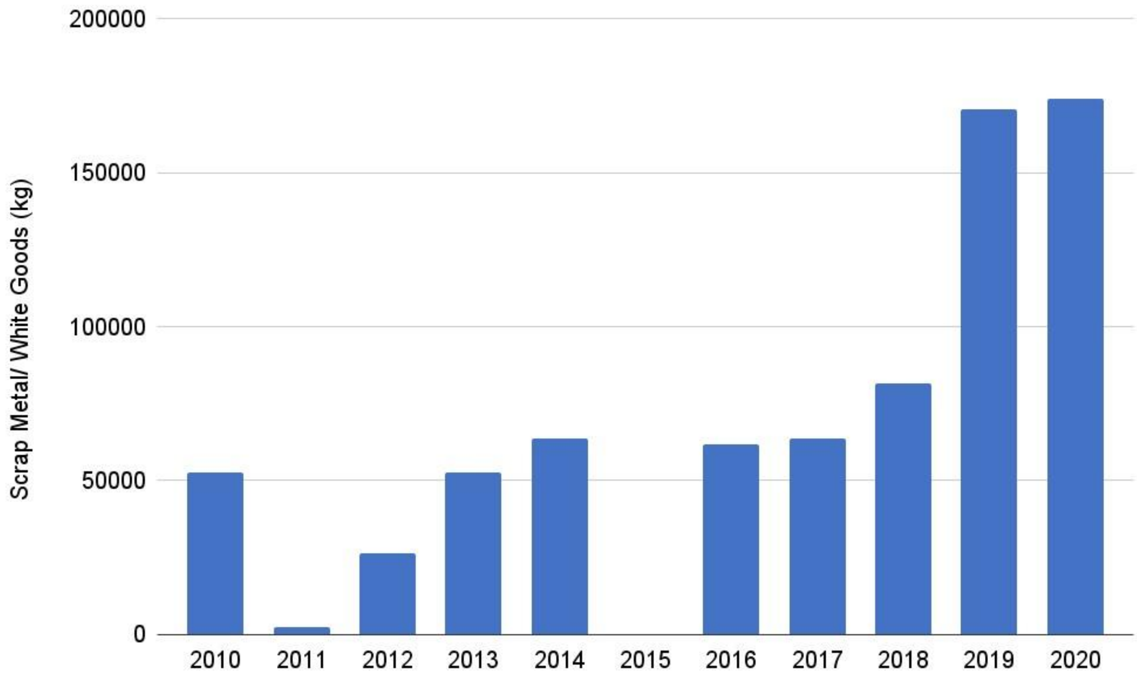

Figure 9: Scrap Metal/White Goods data from the city
Source: Author (2024)

Table IV: Sizes of students' shading systems and impacts when Metal Composite Panels are used as primary materials

SN	Height (m)	Width (m)	Area (m^2)	Mass (kg)	EC3 GWP (kgCO2e)
a -1	21.36	96.97	2071.63	15,661.5	75,179
b- 2	24.85	47	1118.18	8.453.5	40,579
c - 3	22.73	101.21	2300.28	17,390	83,477
d- 4	21.21	49.32	1046.14	7,908.8	37,965

Table V: Results from WARM for comparison between virgin materials and reusing metal

Design	Mass (tons)	Avoided GWP (MTCO2e)	Avoided GWP (kgCO2e)	Avoided energy (mBTU)	Avoided energy (mJ)
1	17.3	12.84	12,840	271.41	286,352.71
2	9.3	6.9	6,900	145.9	153,932.65
3	19.2	14.25	14,250	301.23	317,814.47
4	8.7	6.45	6,450	136.49	144,004.57

WARM results showed that possible avoided emissions and energy of the designs when virgin materials were substituted with salvaged material from the city, Table V. Avoided emissions due to material reuse for Design #1 were equivalent to annual emissions from 3 passenger vehicles or consuming 5,435.26 litres of gasoline or consuming 532 cylinders of propane. The range of avoided emissions was 6,450 to 14,250 kgCO2e. The range of avoided energy was 144,004.57 – 317,814.47 mJ. Design #4 was the most sustainable, Figure 10.

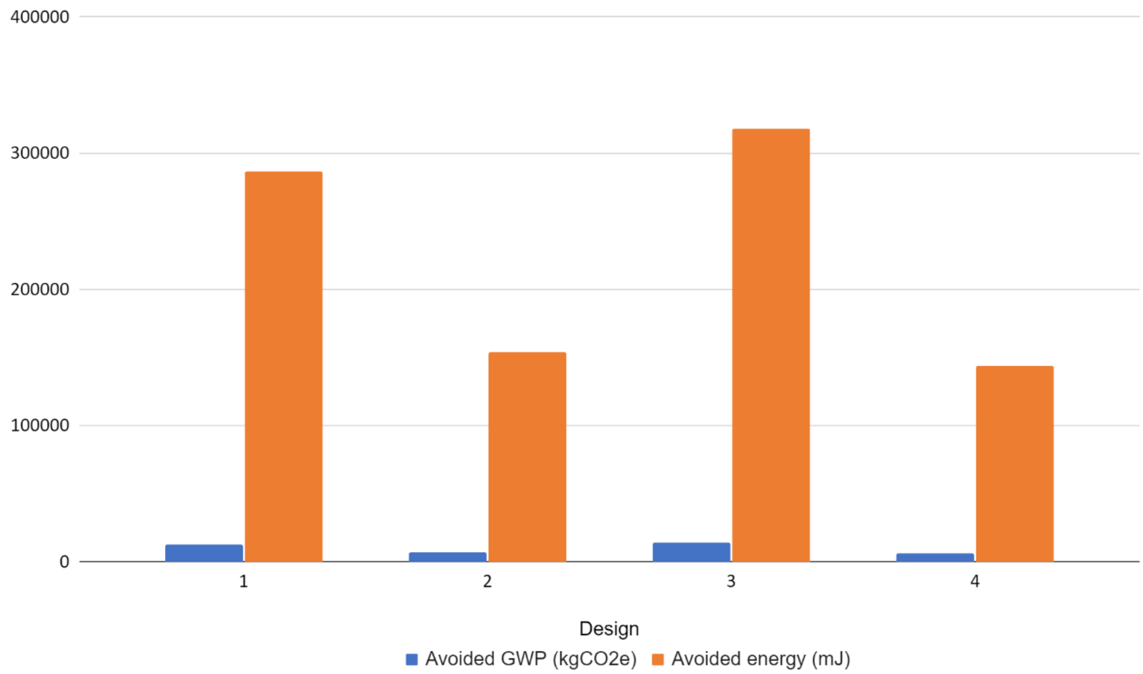

Figure 10: Avoided emissions and energy due to reuse of scrap metals
Source: Author (2024)

Discussion

In the presented study, students' project in a building design course was structured to enable sustainable material selection and VR engagement in the design process. The EC3 tool was selected as the material source for global warming potential comparisons. Default external cladding materials had lower GWP than student selections while the maximum GWP was found in the default selections too. This study demonstrates a workflow for sustainable design, material selection, and VR usage in a design studio. The results of this study demonstrate that default materials in the EC3 tool could be selected for building use based on design intent. The cradle-to-gate analysis showed that reusing scrap metal for the shading systems could avoid emissions and energy used in recycling. Additional exercises for considerations while selecting materials are needed to better understand how design choices influence GWP and energy.

Conclusion and Further Research

The workflow for sustainable material selection included material selection, geometry exploration, unit and systems design, design iterations with virtual reality sessions, and a cradle-to-gate life cycle analysis. The results of the study demonstrate that default materials in the Embodied Carbon in Construction Calculator (EC3) could be more sustainable than designer choices. Recommendations include conducting a material selection activity as a studio exercise. Although the declared units in the EC3 appear in different units, they could be equivalent and represented in imperial and metric units. Cradle-to-gate life cycle analysis showed that there were positive impacts of substituting materials with scrap metal from the city. The range of avoided emissions was between 6,450 and 14,250 kgCO2e and the range of avoided energy was between 144,004.57 and 317,814.47 mJ. Four design projects were compared focusing on shaded wall designs in their projects. Designs #2 and #4 were the most sustainable due to their sizes. Further tests of the proposed workflow are needed, especially towards designing for sustainability.

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Identifying the Features of Sustainable Electronic Procurement Beneficial to Sustainable Construction Project Delivery

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Abstract

The development and progress of a country heavily relies on the construction industry, which creates the necessary infrastructure to support all other sectors. This is demonstrated by the significant number of resources that are invested in the construction industry each year. Procurement activities play a key role in managing construction projects, from the planning stage to the execution and closure. However, traditional paper-based procurement practices are still prevalent in Ghana, resulting in numerous challenges. In light of these challenges, a study was conducted to investigate the factors that influence the adoption of sustainable electronic procurement solutions and their contribution to sustainable project delivery. To achieve this objective, the study employed a quantitative research methodology and purposive sampling to obtain data from 40 out of 70 contractors and consultants in Accra using questionnaires. Cronbach's Alpha was utilized to evaluate the consistency and dependability of the Likert Scale which was deemed reliable. Kendall's Coefficient of Concordance was applied to measure the level of agreement among the participants in their rankings, but the outcome indicated a lack of consensus among respondents. The rankings were sorted using RII to identify the most important benefits and the top three benefits are High efficiency, Cost savings in procurement process and Reduction in order fulfilment cycle time. This study contributes to the expanding understanding of electronic procurement and its relationship to sustainable construction, filling a gap in the literature. The outcomes of the research will inspire further investigation in this field.

Keywords: Electronic procurement, Sustainable construction, Built environment, Benefits, Technology

Introduction

The construction industry is critical to the development of any country, particularly developing countries, through creating jobs and supporting other industries by defining the infrastructure upon which economic growth and development are achieved. (Abdul Nabi and El-adaway, 2020;

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Ebohon and Rwelamila, 2001; Pärn and Edwards, 2019). Countries worldwide allocate a substantial portion of their national budgets to procurement, with Ghana dedicating 50-70% of its expenditure, post personal emoluments, primarily to infrastructure development (Hastings et al., 2016; Ofori, 2012; Osei Tutu et al., 2011). The procurement process, which includes all activities connected to the delivery of goods, services, and consulting required to accomplish the project's objectives, is an essential part of every construction project because inefficient procurement processes can lead to loss of investment which is unfavourable for economic development. (Martins, 2009; Ofori and Fuseini, 2020).

The imperative of sustainability in construction has risen to the forefront, necessitating comprehensive consideration across all facets of project delivery, including procurement. Procurement stands as a pivotal determinant in construction sustainability, delineating the processes, materials, and contractual terms that shape construction endeavours. Infrastructure expenditure constitutes a significant portion of budgets across all economies, serving as a linchpin for national functionality and yielding enduring economic advantages (Knight et al., 2012). Structured procurement processes are instrumental in allocating funds for diverse infrastructure projects, encompassing public housing, civil engineering endeavours, energy infrastructure, and information systems (Owusu et al., 2021). Despite its critical role, the construction sector in Ghana has encountered challenges, with studies suggesting that procurement inefficiencies may contribute to suboptimal performance. Notably, delays in procuring both construction services and consultancy services have been identified, prolonging the timeline for contract finalization (Anvuur et al., 2006). Such inefficiencies during project execution often translate into compromised quality and project delays, stemming from deficiencies in transparency, fairness, and accountability within the procurement process.

E-procurement integrates technology into various procurement processes such as purchasing, bidding, auctioning, and negotiating goods or services. Its implementation offers numerous advantages including cost reduction, prevention of unauthorized purchases, informed decision-making, and enhanced value (Panayiotou et al., 2004; Ronchi et al., 2010). Despite these benefits, e-procurement remains underdeveloped, particularly within the construction sector. While several studies have highlighted the advantages of electronic procurement, limited focus has been placed on its application in construction. For instance, Toktaş-Palut et al. (2014) examined the benefits and barriers of electronic procurement adoption using a case study of a stationery retail store, identifying 15 benefits. Similarly, Addo (2019) explored the challenges associated with electronic procurement adoption in the Ghanaian public sector, shedding light on its benefits. Furthermore, Yevu (2022) developed a model to assess factors influencing electronic procurement adoption in the Ghanaian construction industry, identifying 61 adoption drivers. Despite existing literature, there remains a gap that this study aims to address by elucidating the benefits of green electronic procurement in advancing sustainable construction practices.

Literature Review

Electronic Procurement

As the internet becomes increasingly important, companies are taking advantage of electronic procurement to streamline their procurement processes and improve efficiency. E-procurement involves using digital technology and the internet to manage the procurement process, allowing organizations to be more productive (Ramkumar and Jenamani, 2014). E-procurement involves utilizing information and communication technology (ICT) to manage the procurement process, as well as the relationships with vendors for obtaining goods, services, and construction works (World Bank, 2003). Electronic procurement is a thorough overhaul of the conventional procurement process, not only the application of new technologies to old methods (World Bank, 2011). Standardizing management practices, standards, and practices promotes better accountability and openness. It also attempts to create an integrated and simple procedure by removing the challenges and flaws of the conventional procurement approach (Costa et al., 2013).

Electronic procurement systems, include various tools that aid in the various stages of the procurement process for a project. These tools are tailored to automate and digitize the specific processes required for a project and are directly connected to the tasks and responsibilities involved in procurement (Yevu, 2022). Electronic procurement can be divided into five main applications namely: E-informing, E-reverse auctioning, E-ordering, E-tendering, and E-sourcing (Singh et al., 2020). Knudson (2003) also groups electronic procurement under six different stages, namely e-sourcing, e-tendering, e-informing, e-MRO (maintenance, repair, and operating materials), ERP (enterprise resource planning) and e-collaboration. According to Yevu (2022), Electronic procurement processes include e-Notification, e-Submission, e-Evaluation and e-Award, – e-Invoicing and e-Payment but these tools can be integrated to produce a system depending on the function.

Electronic Procurement in Ghana

The procurement procedures and processes in Ghana have undergone several modifications, primarily aimed at minimizing or eradicating corruption in the public procurement system, achieving value for money, enhancing efficiency in the procurement process, and other related objectives (Asare and Prempeh, 2017). The initiation of procurement reforms in Ghana started with the creation of the Public Procurement Act, 2003 (Act 663) which established a high level of sanity in the procurement environment (Ameyaw et al., 2012; Asare and Prempeh, 2017). In 2016, the Act was revised to enhance its implementation by adding sustainability as a procurement process objective. The Act serves as a practical guide for public institutions in Ghana, but it also impacts the private sector's procurement process as the government is the primary purchaser of infrastructure in Ghana (Yevu, 2022).

As per the PPA Procurement E-Bulletin 2010, the Ghanaian government is presently taking steps to improve its interactions with the public through the e-Ghana initiative. Several initiatives have been undertaken to support the implementation of e-procurement in Ghana, including the e-Ghana project, which aims to provide internet infrastructure to all government offices in the country. The Ministry of Communications has also set up Community Information Centers to improve public access to the internet (Addo, 2019). Additionally, the World Bank has allocated a budgetary provision of two million US Dollars towards the establishment of e-Procurement under the e-Ghana project (Public Procurement Authority, 2010). Consequently, to effectively implement this program, e-Procurement methods are vital tools that must be integrated to enhance transparency, fairness, open competition, accountability, and security of the procurement process (Addo, 2019). It is noted that a well-functioning e-procurement system necessitates a strategic plan to effectively handle all the procedures involved. The involvement of government leadership is also crucial at both the bureaucratic and policy levels during all stages of the implementation process.

Sustainable Construction Procurement

The construction and development of the built environment is a significant contributor to environmental degradation due to the high levels of natural resources consumed and pollutants generated (Hussin et al., 2013). The building industry requires a significant amount of energy, which is utilized in the production of building materials, transportation of those materials to the construction site, construction process, operation of the completed building, and eventual demolition and disposal (Owusu-Manu et al., 2022). The term "sustainable construction" was coined to convey the construction industry's duty to promote sustainability by implementing environmentally friendly, socially responsible, and economically viable practices in the design, development and maintenance of buildings and infrastructure (Zhou and Lowe, 2003). Raynsford (2000) defines sustainable construction as “the set of processes by which a profitable and competitive industry delivers built assets which enhance quality of life and offer customer satisfaction, offer flexibility and the potential to cater for user changes in the future, provide and support desirable natural and social environments and, maximize the efficient use of resource".

Sustainable procurement is the incorporation of procurement requirements and parameters that promote economic growth, environmental protection, and societal progress by improving service and product quality and utilizing resources more efficiently (Ramkumar and Jenamani, 2014). Sustainable procurement is defined as the pursuit of long-term development goals through the purchasing and supply process, considering social, environmental, and economic factors (Walker and Brammer, 2012). Consideration for sustainability in construction procurement takes place at all stages of the procurement process from identification of the need to the fulfilment of the need and review of the procurement process. The World Bank (2019) report highlights the importance of incorporating sustainability factors throughout the procurement process. In the identification stage, key sustainability issues, opportunities, and risks should be identified and prioritized based on various factors such as borrower's policies, community needs, and environmental and social impact assessments. During the analysis stage, these sustainability needs should be incorporated into the procurement strategy. In the requirements stage, the sustainability priorities identified previously should be integrated into the specifications. At the sourcing stage, tenders should be evaluated based on the sustainability requirements outlined in the tender document. During contract implementation, the contract administrator should ensure that the sustainability priorities outlined in the contract documents and procurement strategy are met. Finally, a review should be conducted to assess the delivery of sustainability priorities, the impact, and any lessons learned.

Benefits of Electronic Procurement

The advantages of E-procurement are well-documented both in literature and real-world application. Exploring the benefits of employing electronic procurement tools in business operations is a thoroughly researched subject aimed at optimizing internet utilization and furnishing compelling evidence to encourage adoption. These benefits manifest in heightened productivity and reduced expenditures. Eakin (2003) suggests that continuous monitoring and evaluation of key performance indicators is crucial for the successful implementation of E-procurement and achievement of desired outcomes. To determine ongoing benefits, it is important to identify the key factors that drive savings and measure them. The main drivers for e-procurement include benefits related to transactions, payments, management information, and cost savings. Eei et al. (2012) classified electronic procurement benefits into tangible and intangible. Tangible benefits refer to measurable improvements such as cost savings, faster completion of tasks, and increased revenue, while intangible benefits refer to less quantifiable improvements such as improved customer satisfaction and stronger business relationships. Eakin (2003) also classifies e-procurement benefits into hard, soft, and intangible. Hard benefits are benefits that are directly measurable, essential for delivering increased value to shareholders and thus gain approval, like cost savings and process efficiency improvements. Soft benefits are indirect benefits whose impact on cash flow may be challenging to measure precisely. Intangibles are benefits that are not directly measurable in financial terms like cultural change.

According to Trkman and McCormack (2009), electronic procurement can improve a company's competitiveness by making processes more efficient and reducing costs. This can lead to additional benefits such as lower purchasing expenses, faster order completion, lower prices paid for goods, and lower staffing expenses. Addo (2019) conducted research on the Ministry of Finance and identified the main advantages of electronic procurement in the public sector, which include increased transparency, which leads to better accountability and less corruption. Other benefits identified were a decrease in bureaucratic procedures, decreased transaction costs, a wider range of suppliers, and better information sharing. Yevu (2022) also studied electronic procurement and identified 61 different drivers of electronic procurement, which were grouped into 7 categories. The study identified 26 specific benefits of electronic procurement, such as reduced costs, improved communication, increased transparency, and increased client satisfaction. These benefit drivers were defined as the gains, advantages, or improvements that electronic procurement brings. Toktaş-Palut et al (2014) investigated the effects of barriers and benefits of e-procurement on its adoption. The study identified 15 benefits of electronic procurement including cost savings, increased efficiency, minimization of errors among others. The most significant of the benefits identified was integrated information sharing.

The implementation of electronic procurement also supports sustainable development. Chan and Owusu (2022) found that one of the benefits is the reduction of paperwork and paper advertisements, which promotes environmental sustainability by decreasing the use of paper made from trees. The main advantages of electronic procurement include increased transparency in spending, cost-effectiveness, improved productivity, regulated purchases, reduced errors, and decreased opportunities for corruption.

Research Methodology

In this research, the approach adopted was pragmatism, which allows for flexibility in selecting the methods, techniques, and procedures that best fit the research goals. The study employed a realist perspective on ontology, believing that reality exists independently of human perception. This approach is consistent with a value-free perspective on values. This study employed a quantitative research strategy, which involves collecting data through methods such as questionnaires, surveys, and experiments. This allows for statistical analysis of the data and the ability to generalize about the target population (Hou et al., 2020). The choice of this approach was made because it allows for the collection of a large amount of data and is useful for understanding relationships between variables and identifying patterns or trends (Owusu-Manu et al., 2022). Additionally, the focus of this study on collecting opinions from general contractors and consultants also influenced the choice of a quantitative approach to handle the large volume of data. Despite any potential limitations, this method has been proven to be effective over time and is suitable for this study.

In this study, a quantitative survey design and a deductive methodological approach were used together. In a deductive approach, a hypothesis is generated based on an existing theory and a research plan is formulated to test it. This approach allows for testing a framework that aligns with the conceptual framework and is consistent with a quantitative research strategy. his study employed a survey design to gather data to support logical inferences. An extensive desk study was conducted prior to the survey to inform its design. The standardized measuring and sampling methodologies used in a survey design increase the reliability of observations and make replication of the study easier. The population of this study comprised contractors and contractors in Accra due to their proximity to the researchers. Purposive sampling was used in this study. This method involves using subjective judgment to select participants who are most suitable or available to meet the research objectives. It enables the researcher to identify the necessary information and select participants who can provide it. In this study, purposive sampling was chosen to target individuals who are likely to be involved in construction procurement. The participants for the study were selected based on their knowledge of construction procurement and their willingness to participate. A non-probability technique was used to determine the sample size, which was 70 in total, consisting of 30 consultants and 40 contractors located in Accra. In total, 40 questionnaires were collected which corresponds to a response rate of 57%. According to Beauvais et al. (2014), a response rate of 50% to 70% is considered favourable. Additionally, Tallent-Runnels et al., (2006) indicated that a response rate of 30% to 40% is adequate.

Results and Discussions

Participants were requested to respond to initial inquiries and inquiries pertaining to their personal information. This portion was designed to verify the accuracy of the data collected for the study and to assist respondents in becoming more comfortable with the primary questions of the survey, which address the research objectives. Respondents were asked to indicate their profession (refer to Table 1).

Table 1. Respondent's demographic data

Variable	Frequency	Percentage (%)
	Respondent's Profession	
Quantity Surveyor	22	47.8
Site Supervisor	1	2.2
Commercial Manager	1	2.2
Project Manager	3	6.5
Civil Engineer	9	19.6
Geomatic Engineer	2	4.3
Account Officer	1	2.2
Safety Officer	1	2.2
Total	**40**	**100%**
	Operating Sector	
Contractor	26	65.0
Consultant	14	35.0
Total	**40**	**100%**
	Years of experience	
Not exceeding 5 years	31	77.5
6-10 years	9	22.5
Total	**40**	**100%**
	Respondent's familiarity with EP	
Yes	28	70.0
No	12	30.0
Total	**40**	**100%**

The table illustrates that 22 of the respondents (47.8%) are quantity surveyors; 1 of the respondents (2.2%) works as a site supervisor same for commercial manager, account officer and safety officer who also had 1 apiece; 3 of the respondents (6.5%) are project managers; 9 of the respondents (19.6%) work as civil engineers; and 2 of the respondents (4.3%) work as geomatic engineers.

Respondents were also asked to indicate the sector in which they work in: 26 of the respondents (65%) work with contractors; 14 of the respondents (35%) work with consultants. The survey asked participants about their years of experience and provided options for them to select from, including less than 5 years, 6-10 years, 11-20 years, and over 20 years. Based on Table 1, no participant had more than 10 years of experience. Out of the respondents, 31 individuals had less than 5 years of experience, representing 77.5% of the responses, while the remaining 9 respondents had 6-10 years of experience, accounting for 22.5%. The participants were requested to state if they have knowledge about electronic procurement methods. They were given two options, namely "Yes" and "No". According to Table 1, 28 of the respondents, which accounts for 70%, affirmed that they are familiar with electronic procurement methods. The remaining 12 respondents, making up 30%, said they are not familiar with electronic procurement methods.

Reliability Test

Before the survey, a review of the literature was carried out, which found 22 benefits of electronic procurement for sustainable construction. Participants were asked to use a Likert Scale to assess the significance of these factors in achieving sustainable project delivery. To determine the accuracy and coherence of the scale used, a reliability test using Cronbach's Alpha was conducted. This was carried out to determine whether the tool would produce consistent results in multiple tests. The outcomes of the Cronbach's Alpha reliability test are presented in Table 2.

Table 2. Reliability Test

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.974	.975	22

Item-Total Statistics					
Benefits of EP	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
High efficiency	86.75	272.756	.818	.	.973
Cost savings in procurement process	86.57	268.763	.863	.	.973
Reduction in order fulfilment cycle time	86.92	272.430	.772	.	.973
Decreased bureaucracy	86.65	276.849	.677	.	.974
Improved collaboration	86.82	271.020	.851	.	.973
Improved communication	86.73	275.076	.755	.	.973
Better management of suppliers	86.80	273.651	.754	.	.974
Increased productivity	86.70	269.959	.823	.	.973
Increased transparency	86.70	272.626	.808	.	.973
Increased accountability	86.70	271.805	.864	.	.973
Reduction in corruption	86.90	275.528	.645	.	.974
Reduction in staffing	87.45	272.100	.664	.	.975
Elimination of paperwork	86.87	273.394	.685	.	.974
Regulation of purchases	86.90	273.272	.781	.	.973
Improved accuracy	86.85	269.003	.830	.	.973
Enhanced record keeping	86.67	272.071	.820	.	.973
Increases competition	87.10	273.374	.763	.	.973
Easy access to information	86.60	269.169	.877	.	.972
Reliable processes	86.82	270.199	.879	.	.972
Increased supplier base	86.82	272.404	.830	.	.973
Enhanced decision making	86.70	269.036	.810	.	.973
Compliance with rules and regulations	86.90	270.400	.784	.	.973

The table shows the Cronbach's Alpha test results with a coefficient of 0.974 which indicates a reliable and consistent scale. Table 2 also shows the Item Total Statistics, and this shows the Cronbach's Alpha coefficient if a particular factor is removed from the scale. From the table it can be observed that the scale would be reliable if any of the factors are removed from the scale.

Relative Importance Index

Respondents were asked to rate 22 benefits of electronic procurement according to how important they are to sustainable project delivery. The results are presented in Table 3.

Table 3. RII of Benefits of Electronic Procurement

Benefits of EP	N	Sum	Mean Statistic	Mean Std. Error	Std. Deviation	RII	Ranking
Cost savings in procurement process	40	175	4.38	0.159	1.005	0.875	**1st**
Easy access to information	40	174	4.35	0.154	0.975	0.87	**2nd**
Decreased bureaucracy	40	172	4.30	0.144	0.911	0.86	**3rd**
Enhanced record keeping	40	171	4.28	0.148	0.933	0.855	**4th**
Increased accountability	40	170	4.25	0.142	0.899	0.85	**5th**
Increased transparency	40	170	4.25	0.147	0.927	0.85	**6th**
Increased productivity	40	170	4.25	0.159	1.006	0.85	**7th**
Enhanced decision making	40	170	4.25	0.167	1.056	0.85	**8th**
Improved communication	40	169	4.23	0.141	0.891	0.845	**9th**
High efficiency	40	168	4.20	0.144	0.911	0.84	**10th**
Better management of suppliers	40	166	4.15	0.150	0.949	0.83	**11th**
Improved collaboration	40	165	4.13	0.148	0.939	0.825	**12th**
Reliable processes	40	165	4.13	0.148	0.939	0.825	**13th**
Increased supplier base	40	165	4.13	0.144	0.911	0.825	**14th**
Improved accuracy	40	164	4.10	0.163	1.033	0.82	**15th**
Elimination of paperwork	40	163	4.08	0.166	1.047	0.815	**16th**
Reduction in corruption	40	162	4.05	0.160	1.011	0.81	**17th**
Regulation of purchases	40	162	4.05	0.147	0.932	0.81	**18th**
Compliance with rules and regulations	40	162	4.05	0.164	1.037	0.81	**19th**
Reduction in order fulfilment cycle time	40	161	4.03	0.154	0.974	0.805	**20th**
Increases competition	40	154	3.85	0.150	0.949	0.77	**21st**
Reduction in staffing	40	140	3.50	0.179	1.132	0.7	**22nd**

Cost savings was ranked as the most important benefit with a mean score of 4.38 and an RII of 0.875. It can be stated that the most important advantage of implementing electronic procurement is the reduction of expenses in the procurement process. Since the construction industry requires significant investment, stakeholders are highly interested in minimizing costs. Eei et al., (2012) identified cost savings as a benefit of electronic procurement to SMEs in Malaysia. Panayiotou et al., (2004) measured a 20% savings on cost per tender emanating from relocation of human capital. *Easy access to information* was ranked 2nd with a mean of 4.35 and an RII of 0.86. The ease of access to information is important to the success of every procurement process (Yevu and Yu, 2020). Eei et al., (2012) also identified easy access to information as an intangible benefit to the adoption on electronic procurement.

Decreased Bureaucracy was ranked 3rd with a mean of 4.30 and an RII of 0.86. Bureaucratic processes pose a significant challenge in the construction sector of Ghana. Such processes have been identified as a key factor leading to delays and financial distress within the industry. Costa et al., (2013) asserts that the introduction of ICT in public procurement is an important contribution towards a transparent and less bureaucratic society. *Enhanced record keeping* was ranked as the 4th most important benefit of electronic procurement. The conventional procurement process relies on a record-keeping system that is susceptible to unreliability, as all records may be lost in the event of a fire or flood. Electronic procurement, on the other hand, is a superior alternative that maintains an electronic version of all records. Increased Accountability was ranked 5th with a mean of 4.25 and an RII of 0.85. The process of public procurement is often associated with corruption and other improper activities. To address this issue, enhancing accountability and transparency can be effective in decreasing procurement irregularities and fostering trust in the procurement system. A study by Yevu (2022) ranked 'improved audit trail and accountability' as the 3rd most important benefit of electronic procurement indicating a high driving influence in the Ghanaian construction industry. All other benefits had a mean greater than 4 which indicates that they are all significant.

Kendall's Coefficient of Concordance

The Kendall's Concordance Coefficient W is a value ranging from 0 to 1, with 0 indicating complete disagreement and 1 indicating perfect agreement, where all participants ranked all variables in the same manner (Gearhart et al., 2013). The null hypothesis declares that the rankings of objects produced by the variables are not related to each other. The null hypothesis is significant when $p > 0.05$ but from Table 4, $p < 0.05$ therefore, the null hypothesis can be rejected.

Table 4. Kendall's Coefficient of Concordance

Test Statistics	Value
N	40
Kendall's W[a]	.083
Chi-Square	69.651
df	21
Asymp. Sig.	.000

a. Kendall's Coefficient of Concordance

Kendall's Wa indicates the level of agreement between the respondents. A value nearing 1 signifies strong consensus among respondents, while a value closer to 0 indicates a lack of consensus. From the table, the Kendall's Wa = 0.083 which indicates a low level of agreement among the respondents. This could be due to the relatively small sample size, difference in expertise among respondents or a random chance.

Theoretical, Practical and Policy Implications

The paper's findings have theoretical implications for the procurement literature and sustainable construction theory. The paper highlights how electronic procurement can improve the procurement process in sustainable construction. Specifically, the paper highlights that electronic procurement can improve the transparency, accountability, and efficiency of procurement, leading to a reduction in environmental impact. The paper also highlights that electronic procurement can promote sustainable construction practices by providing better access to environmentally friendly products and services. Therefore, the paper's findings can provide a theoretical framework for further research on the impact of electronic procurement on sustainable construction practices.

The paper's findings also have practical implications for the construction industry. The paper highlights that electronic procurement can lead to significant cost savings by reducing the time and effort required to procure materials and services. Additionally, electronic procurement can provide real-time data on the procurement process, enabling construction companies to identify and address inefficiencies in the procurement process quickly. The paper also highlights that electronic procurement can enable construction companies to track the sustainability performance of their suppliers, allowing them to make informed decisions about supplier selection. Therefore, the paper's findings can provide practical guidance to construction companies on the benefits of adopting electronic procurement practices.

The paper's findings also have policy implications for policymakers. The paper highlights that electronic procurement can be an effective tool for promoting sustainable construction practices. Policymakers can encourage the adoption of electronic procurement practices by providing incentives, such as tax breaks or subsidies, to construction companies that adopt sustainable procurement practices. Additionally, policymakers can mandate the use of electronic procurement in public sector construction projects to promote sustainable construction practices. Therefore, the paper's findings can provide policymakers with guidance on how to promote sustainable construction practices using electronic procurement.

Conclusion and Further Research

The objective of the study was to identify the underlying features of green electronic procurement to sustainable project delivery. This objective was achieved by exploring the benefits of electronic procurement that are advantageous to sustainable project delivery. A review of existing literature was carried out to discover 22 benefits of electronic procurement. Participants were requested to rate these benefits based on their significance in achieving sustainable project delivery using a Likert scale. From the rankings of the variables from the RII test, the top five ranked benefits in order of importance are *Cost savings in procurement process, Easy access to information, Decreased bureaucracy, Enhanced record keeping,* and *Increased accountability.* The results show that electronic procurement is a valuable tool that can help to achieve sustainability in the construction industry. The findings also suggest that the implementation of electronic procurement can help construction companies to meet their environmental and social responsibilities, while improving their bottom line.

Despite the positive outcomes of the study, there are some limitations to consider. First, the research focused solely on the benefits of electronic procurement to sustainable construction, while other factors may also play a role in achieving sustainability. Second, the study was limited to a specific contractors and consultants in Accra and may not be generalizable to the whole Ghana. Third, the sample size chosen was relatively small compared to the population.

Future research could build on these findings by examining the challenges associated with the implementation of electronic procurement in sustainable construction. Further investigation into the factors that influence the adoption of electronic procurement in the construction industry could also be beneficial. In addition, research could explore the potential environmental and social impacts of electronic procurement on sustainable construction, including its effects on greenhouse gas emissions, waste reduction, and worker safety. Finally, it would be valuable to examine the long-term outcomes of electronic procurement in sustainable construction to determine its sustainability over time.

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Systematic Review of Major Carbon Emissions Trading Systems Worldwide

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Abstract

Carbon emissions trading is crucial to meeting carbon neutrality goals and carbon peak achievement. The aim of this study was to undertake a review of major carbon emissions trading schemes worldwide. Systematic literature review methodology was adopted to obtain documents from Scopus which were then synthesised. From the findings, the major carbon emission trading schemes that were reviewed were System, Safeguard mechanism, Australia, Regional Greenhouse Gas Initiative (RGGI), US, California's cap and trade sector, US, and UK emissions trading systems. This systematic review has theoretical, empirical, practical, and wider implications. Remarkably, a study that thoroughly reveals and reviews the various trading schemes is lacking and this study fills the gap. The study also contributes to climate change mitigation agenda.

Keywords: Systematic review, carbon, emissions trading, climate change

Introduction

Carbon emission trading is a significant measure of efficiently controlling carbon dioxide emissions (Tang et al. 2015). It encompasses carbon emissions reduction and economic development. Carbon trading contributes to emission reduction by providing firms with potential advantages regarding technological innovations, ensuring reduction in energy consumption, investing in energy saving technologies and ensuring environmental-economic dividends (Lan et al., 2022).

Emissions trading is a huge innovation to put a price on emitting greenhouse gasses including N2O, CO2, HFCs, CH4, SF6, PCFs among others. Carbon emissions trading is been embraced by many regions and countries due to its role in transforming the energy sector as well as stimulating the overall economies of countries (Chen and Lin 2021). Several regions and countries globally have embraced the practice of emissions trading (Chai et al. 2022). The International Carbon Action Partnership (ICAP) 2021 Global Carbon Progress Report indicated that 24 carbon emission trading systems were under implementation as of 2021, and they cover greenhouse gas emissions accounting for sixteen percent of worldwide total.

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Carbon emission trading is not just a market-based instrument but also policy and crucial to meeting carbon neutrality goals and carbon peak achievement (Lan et al., 2022). Governments and other stakeholders are involved in these sustainability projects. The main focus of carbon trading is to put a price on environmental emissions and transform it into paid factor of production with the aid of market forces (Lin & Huang, 2022). Carbon trading policies through institutions have led to carbon markets receiving a lot of attention as an effective measure of dealing with climate change (Blay Jnr et al., 2023; Kukah, Jnr, et al., 2022). The aim of this study is to conduct a review of major carbon emissions trading schemes worldwide.

Literature Review

The underlying concept behind carbon emissions trading is to provide incentives for companies/nations to cut down on their carbon emissions so as to have leftover permits they can sell (Chi et al., 2022). The wealthier and bigger companies/nations efficiently subsidise the efforts of the poorer and high polluting companies/nations by purchasing their credits (Dibie, 2014). With time, these wealthier companies/nations are incentivized to also reduce their emissions, so they do not have to purchase as many carbon credits in the market. The recently agreed-upon framework referred to as Article 6 at the Glasgow COP26 conference held in November 2021 stipulates that, countries creating carbon credits deposit 5 percent of proceeds they generate into a fund to aid developing nations tackle greenhouse gas emissions (Waglé & Wignaraja, 2022).

Carbon trading is also a cost-effective and efficient way for industries to meet their international targets regarding carbon reduction (Kukah, Jin, et al., 2022; Kukah et al., 2023). Through carbon trading scheme, the construction industry is stimulated as a sector, and this leads to potential competitive advantage among other sectors and on the global level (Agyekum et al., 2023; Agyekum et al., 2021). In Australia, GBCA (2020) posits that if the current trend of growth in greenhouse gas emissions continues, producers and consumers will be penalised in the long run.

Methodology

Systematic literature was adopted for this study. In line with existing guidelines, existing literature were searched for and synthesised. Analysis of prior theoretical and empirical evidence from peer reviewed articles, regardless of the year of publication was undertaken in this study. This paper comprehensively provides a large outcome of evidence on the area going beyond varying scope and empirical methods and reducing potential biases in literature.

Scopus was chosen as the database for this literature review due to its advantages over other databases. Scopus has a broader range than most databases and has 20 percent more documents than Web of Science and a higher index rate than Google Scholar and PubMed (Kukah, Owusu-Manu, et al., 2022). The Scopus search was based on the title, abstract and keywords (T-A-K). Search query was: TITLE-ABS-KEY ("carbon trading" AND "carbon emissions trading" AND "carbon trading systems" AND "carbon trading schemes"). Initial search produced 326 document results. In the next stage, inclusion criteria were applied in filtering the search outcomes.

Articles that were not in English were excluded as this study is being undertaken in English language. There was no restriction in article types and hence documents included books, journal articles, conference papers and government reports. Subsequently, abstracts, titles and full texts were further screened to ensure they were relevant to the themes of carbon trading, carbon emissions trading, carbon trading systems and carbon trading schemes. There were no limitations in publication date. After the filtering stage, 78 document results were obtained. These articles were the basis for analysis. Qualitative analysis and synthesis were undertaken using content analysis. Content analysis has the advantage of combining quantitative analyses as well as retaining the rich original meanings using qualitative analyses (Akomea-Frimpong et al., 2022; Akomea-Frimpong et al., 2023). The content analysis for this study was done manually by thoroughly reading each paper. This was followed by extracting the relevant texts, words, keywords, statements, and variables.

Findings and Discussion

In this section, a systematic review is undertaken on the major carbon trading systems. Table 1 below summarises the trading systems. The names of the trading systems are provided including their location, the sector(s) in which the schemes operate, who owns the trading systems, and some challenges they encounter.

Table 1: Major carbon emission trading systems worldwide

Trading system; Location	Sector(s)	Who owns trading system	Mandatory/Voluntary	Challenges	References
Emissions Reduction Fund (ERF), Australia	Generic	Clean Energy Regulator	Voluntary-allows businesses, councils, state governments and land managers to participate	Future status of carbon trading programmes being uncertain	van Oosterzee et al. (2020)
Safeguard mechanism, Australia	i. Electricity ii. Mining iii. Oil and gas production iv.Manufacturing v. Transport	Clean Energy Regulator	Mandatory for facilities with direct scope emissions of more than 100,000 tonnes per year	i. Overallocation ii. Conflicts with other programmes and administrative directives	Newell and Pizer (2012); Ciesielska-Maciągowska et al. (2021)
New South Wales Greenhouse Gas Reduction Scheme, Australia	Electricity sellers, retailers, and generators	Scheme closed in 2012. Was owned by NSW government	Mandatory	Lack of abatement additionality	Perdan and Azapagic (2011)
EU ETS	i. Power and energy sectors ii. Aviation sector	European Union	Mandatory	i. Poor clarification of the cap-setting process ii. Absence of reliable emissions data iii. Low liquidity levels iv. Carbon leakage due to the differences in policies among member states v. Lack of credible emissions inventories vi. Uncertainty of future quotas vii. Poor institutional capacities	Oke et al. (2017); Lin and Jia (2019); Wettestad (2011); Fischer and Fox (2009); Xiong et al. (2017); Choy and Ho (2018); Ng and Luk (2013)

Regional Greenhouse Gas Initiative (RGGI), US	Power plants	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and Virginia states	Mandatory	Inadequate preparation time	(Raymond, 2016); Koriko (2021)
California's cap and trade sector, US	i. Electricity sector ii. Transportation fuel	California Air Resources Board (CARB)	Mandatory	Price management variations	Xiong et al. (2017)
China Emission trading system	i. Power generation sector ii. Industries with high pollution intensity	Chinese Ministry of Ecology and Environment	Mandatory	i. Lack of effective monitoring ii. Absence of consistent legal framework for stringent noncompliance penalties iii. Oversupply of quota iv. Difficulties in compliance v. Issuance of too much carbon allowance during pilot programs	Munnings et al. (2016); Tsai (2020); Song et al. (2017); Choy and Ho (2018); Ciesielska-Maciągowska et al. (2021); (Fawcett & Parag, 2017); (Zhou & Li, 2019)
UK emissions trading systems	i. Power generation ii. Aviation sector iii. Manufacturing	UK government	Mandatory	Prices of emission allowances are subject to constant fluctuations	Ciesielska-Maciągowska et al. (2021)
Tokyo cap and trade, Japan	Large buildings and commercial facilities	Tokyo Metropolitan Government (TMG)	Mandatory	Previous voluntary schemes were effective hence no need for mandatory scheme	Nishida and Hua (2011)
New Zealand Emissions System	i. Agriculture ii. Liquid fossil fuels iii. Waste	Environmental Protection Authority (EPA)	Mandatory	i. Underdevelopment of technology application ii. Absence of hard limit on emission systems	Bullock (2012); Leining et al. (2020)

European Union Emissions Trading Scheme (EU ETS)

The EU ETS is acknowledged as the world's first multi-national trading scheme/system (Stuhlmacher et al. 2019). It officially started in 2005 and has been implemented in phases. However, it had earlier been designed by the European Union in the early 2000s in achieving targets for greenhouse gas emissions reduction and achieving the Kyoto protocol (Bel and Joseph 2015). Since 2005, the European Union Emissions Trading System has experienced tremendous progress. In its first commitment period from 2005 to 2007, there were 2.2 billion tons of carbon dioxide (CO2) emission allowances that were allocated to twelve thousand (12,000) emission installations of twenty-seven (27) EU member countries. These emission installations could trade their excess emission allowances on exchanges or via over the counter (OTC) markets within the European Union. As of 2005, trading CO2 of the EU trading scheme was 260 million tons and increased to 1.44 billion in the year 2007 showing massive development (Zhang and Wei 2010). This development reflects the fact that market participants were continuously learning in this emerging financial market (Zhang and Wei 2010). This development also provided a huge motivation and favourable expectations in the second commitment period from 2008 to 2012 as well as the post-Kyoto years (beyond 2012).

China Emission Trading System

In addressing climate change challenges and facilitating a low-carbon economy, China at the end of 2011 issued pilot ETS (Tan et al. 2022). Beginning from June 2013 through to April 2014, China promulgated emission trading system pilot schemes in seven provinces and cities (Huang et al. 2022). The provinces were Hubei and Guangdong while the cities were Shanghai, Beijing, Chongqing, Tianjin, and Fujian (Yan et al. 2020). There were eight main sectors that were covered by these pilot schemes and comprised: iron and steel, chemical industry, electricity, building materials, aviation, petrochemicals, paper making and non-ferrous metals (Wang and Lin 2016). There were diversities in the carbon emission prices among the ETS pilot regions of China and this can be attributed to the significant differences in their industrial structure, economic development level and CO2 emission intensity (Chang et al. 2017). In the year 2020, cumulative transaction volume of CO2 in each of the pilot market reached 445 million tons with transaction volume exceeding CNY 10 billion (He and Song 2022).

By the ending of 2017, China brought in place the National Carbon Emission Trading Market Construction Plan. The long-awaited national emissions trading for China started on July 16, 2021 (He and Song 2022). The program is intended to involve 2225 firms in the power sector. It has been designed to aid the country attain its goal of reaching carbon neutrality in the year 2060. It hopes to be the largest carbon market in the world.

Safeguard mechanism, Australia

Safeguard mechanism belongs to the federal policy frameworks in Australia aimed at managing the country's carbon emissions (Power 2018). It operates alongside other emission schemes which encourage entities to minimise their carbon emissions through the issuance of carbon credits (Swann 2020). This enables polluters to purchase carbon credits or invest in projects that reduce carbon so as to minimise net pollution (Maraseni and Reardon-Smith 2019). Federal government also purchases the credits through auctions via Emissions Reduction Fund (Power 2018). The Emissions Reduction Fund (ERF) is Australia's policy tool against climate change. It has the goal of achieving Australia's greenhouse gas emission reduction targets of 5 percent below year 2000 levels. It also aims at 26 to 28 percent below 2005 levels by year 2030. The fund is administered in Australia by Clean Energy Regulator.

Regional Greenhouse Gas Initiative (RGGI), US

Regional Greenhouse Gas Initiative (RGGI) is the foremost mandatory cap-and-trade-scheme in US to reduce carbon dioxide in the power industry (Yan 2021). There are eleven US states that partake in the RGGI. They are Connecticut, Maryland, New Hampshire, Delaware, Virginia, New Jersey, Maine, Vermont, Massachusetts, Rhode Island and New York. New Jersey left the scheme in 2012 but re-joined in the year 2020. Pennsylvania is expected to join the scheme in late 2022 (Yang et al. 2021).

The RGGI scheme was established in the year 2005 (Ramseur 2019). It administered its first auction of CO2 emission allowances in the year 2008. In the base period of 2006-2008, annual average emissions of CO2 decreased by 48 percent (Friesen et al. 2022). The member states of the scheme set a target of further minimising emissions 30 percent below the 2020 emission level by the year 2030. The RGGI scheme mandates fossil fuel power plants that have capacity more than 25 megawatts to obtain allowance for every tonne of CO2 they emit yearly (Chan and Morrow 2019). Power plants that are located within the region can comply through purchase of allowances from quarterly auctions or offset projects. From the years 2009 to 2017, RGGI member states made a net benefit of $4.7 billion from the trading scheme (Declet-Barreto and Rosenberg 2022).

California's cap and trade sector, US

California's cap and trade scheme which started in the year 2013 is a major policy by the Californian state in reducing their greenhouse gas emissions (Borenstein et al. 2019). This carbon trading programme is the fourth largest globally. Apart from contributing to emissions reductions, this cap-and-trade scheme has brough about insights on managing economy-wide trading systems (Calel 2020). The target of the California carbon trading scheme is to minimise greenhouse gas emissions to 1990 level by year 2020; by 40 percent below 1990 level by year 2030 and by 80 percent below 1990 level by year 2050.

The California state also set a target of attaining 100 percent carbon-free electricity in the year 2045 and carbon neutrality in the economy by 2045. The entities covered in the California cap and trade scheme include large industrial plants, large electric power plants and fuel distributors such as petroleum and natural gas (Houle et al. 2015).

UK emissions trading systems

On the 1st of January 2021, the UK emissions trading scheme (UK ETS) replaced the participation of the UK in European Union Emission Trading Scheme (EU ETS) (Patnaik 2022). The UK was instrumental when EU ETS was developed and hence the UK ETS serves as a continuity of carbon trading for UK firms (Lovcha et al. 2022). UK ETS regulators have the responsibility of ensuring compliance with UK ETS regulations. Their responsibilities also encompass the issuance and compliance of emission plan for aviation and permits for installations. The UK ETS operates on cap-and-trade principle whereby cap is set on the total amount of gases which can be emitted by a sector/industry covered by the trading scheme (Pan 2022). This serves as a limit of cCO2 that can be emitted and as the gases reduce with time, it significantly contributed to attaining the UK's Net Zero target by 2050 as well as other carbon minimisation commitments (Tickel et al. 2022). In the cap, participants in the trading system receive free allowances. They can also buy emission allowance on the secondary market or through auction where they can trade with other participants. The UK ETS covers mainly energy intensive sectors, aviation, and power generation. If an activity is carried out which is covered by the trading scheme, a greenhouse gas emissions permit is required. Emissions monitoring plan is required from aircraft operators while small emitter permit is required by installations.

Conclusion

This study presented a critical review of selected relevant papers on carbon emission trading worldwide. The major trading schemes reviewed were European Union Emissions Trading Scheme (EU ETS), China Emission Trading System, Safeguard mechanism, Australia, Regional Greenhouse Gas Initiative (RGGI), US, California's cap and trade sector, US, and UK emissions trading systems.

This systematic review has theoretical, empirical, practical, and wider implications. Remarkably, a study that thoroughly reveals and reviews the various trading schemes is lacking and this study fills the gap. Theoretically, this paper constitutes the first exclusive assessment and review of the generic and major carbon trading schemes. Theoretically, this paper extends knowledge on the checklist of carbon trading systems. Practically, the challenges identified during the review for the trading schemes will serve a guide for policy makers in carbon trading. Policy wise, this study is beneficial to climate change mitigation as steps are taken to minimise the impact of the greenhouse gas emissions. This study will inherently serve as a foundation for future studies.

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Challenges of Implementing Construction Automation and Robotics: A Review

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Abstract

The construction industry faces adverse effects of low productivity and occupational injuries, particularly related to the low level of automation and robotics as compared to other industries. As such, identifying the challenges of implementing construction automation and robotics (CAR) would enhance productivity, safety, and operation in the construction industry. However, a review on identifying the challenges of implementing CAR is lacking. Therefore, this study aims to adopt a systematic literature and science mapping approach to analyze research publications and identify the challenges of implementing CAR. A bibliometric literature analysis was conducted to retrieve articles from Scopus database. A further qualitative systematic analysis was conducted to identify the challenges of implementing CAR. Fourteen challenges were identified and categorized into 4 main criteria, namely: technological challenges, economic challenges, industry-intrinsic challenges, and workforce challenges. This study would help other researchers and stakeholders understand the main challenges limiting the adoption of CAR in the construction industry. In addition, the reported findings would support the research needs in this field to improve automation in the construction industry.

Keyword: Challenges; Construction automation; Robotics; Bibliometric; Review

Introduction

The construction industry is exposed to many occupational risks such as reduced production levels, fatal and non-fatal injuries, and there is a gap in automation levels between the construction industry and other sectors like automobile, manufacturing, etc (Pereira et al., 2022). Due to the dynamic nature of the construction environment, the application of construction automation and robotics (CAR) is low, resulting in inefficient adoption of digitalization in the

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construction industry (Young et al., 2021). Although some construction activities are manually conducted, and without the use of digital approaches or expertise, practitioners face difficulties in terms of high costs, project progress, and worker health (Nikas et al., 2007). Confronted with the age of workers and sustainable infrastructure, it is necessary to promote CAR to reduce costs, injuries, and safety (Delgado et al., 2019).

In the face of these challenges, CAR is expected to overcome the limitations of traditional construction methods (Bock, 2015). CAR is becoming more widely acknowledged as a cutting-edge technology that may lay the foundation for prefabrication, sustainability, net-zero carbon emissions as perceived in other sectors (Pan et al., 2018). However, large-scale, practical deployment of CAR has yet to take place. Despite the low rate of CAR adoption, practical studies on CAR technologies that might be used on construction sites are ongoing. Examples of CAR technologies include 3D printing robots (Kim et al., 2015), exoskeletons (Antwi-Afari et al., 2021), etc.

Several previous studies have been conducted on CAR. Xiao et al. (2022) reviewed articles on construction robotics through a mixed quantitative-qualitative review method, identifying recent achievements in algorithms, collaboration, and tasks in construction robotics. Bock and Linner (2016) established a framework for the classification of CARs through a systematic review and identified directions for future development. Paulson (1985) summarised existing CAR technologies in Japan and proposed a highly structured and better-controlled construction environment for the wider application of CAR. Guamán et al. (2022) explored the impact of construction materials as well as the application and development of 3D printing technology through a systematic review. Son et al. (2010) reviewed sensing technologies, highlighting their importance in the CAR field and examined the barriers and applications of robotics in construction.

CAR can mitigate and improve construction resources. However, its implementation faces some challenges related to ownership, maintenance, cost, practicality, knowledge, etc (Huang et al., 2022). In addition, many researchers have studied the challenges of implementing CAR in specific countries like the United States (Pradhananga et al., 2021). Overall, previous studies based on questionnaires and traditional literature reviews provided relevant findings on specific barriers and development strategies for the adoption of CAR technologies. Although automation and robotics have great potential for the construction sector, challenges related to its implementation have not been thoroughly identified. In addition, there is a lack of a state-of-the-art review on the challenges of implementing CAR. Therefore, this research aims to conduct a systematic and science mapping review to identify the challenges of implementing CAR. The findings of this study would help develop strategies to mitigate these challenges for CAR implementation.

Research methods

This study adopted a mixed approach, consisting of a quantitative review (bibliometric analysis) and a qualitative review (systematic analysis). The mixed method approach was chosen primarily because it allowed for a comprehensive analysis of the field increasing the depth of understanding as well as reducing the influence of subjective judgments (Heyvaert et al., 2016; Zhang et al., 2024). The bibliometric approach can help to discover relationships, connections, and trends in the field through visualizations (Cai et al., 2020; Ye et al., 2024). In this study, VOSviewer was used for bibliometric analysis. Conversely, the systematic approach was used to identify unexplored challenges, effectively demonstrating the gaps and advancing the field (Oraee et al., 2017). The mixed method approach was divided into 4 stages (1) search for publications (2) exclusion criteria (3) bibliometric analysis (4) systematic analysis.

Search for publications (Stage 1)

The first stage was to search for publications and determine the data search strategy. This study used the Scopus database because it has a higher indexing rate and broader publication coverage than other databases (Meho and Rogers, 2008). Table 1 shows the search string.

Table 1. Keywords and literature search string and results

Search string	Results
(TITLE-ABS-KEY (automation OR robotics) AND TITLE-ABS-KEY (challenges OR barriers OR difficulties OR issues OR problems OR limitations OR obstacles) AND TITLE-ABS-KEY (construction OR construction industry OR building industry OR construction management OR construction company) AND (LIMIT-TO (PUBSTAGE, "final")) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT TO (SUBJAREA, "ENGI")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j"))	145
Manual screening based on the results of CAR challenges	70

Source: Created by authors

Exclusion criteria (Stage 2)

The second step in this study was the exclusion criteria. Since the main purpose of this study was to review the literature on CAR challenges, it was necessary to filter all articles that were outside the scope of the study. The research area and document type were limited to "engineering" and "articles", respectively. The language was restricted to English, and four articles written in other languages were excluded. Next, the titles and abstracts were screened to identify articles that were relevant to the studied topic. For example, these articles (e.g., Damani et al., 2021; Pereira et al., 2022; Ibañez-Guzmán and Malcolm, 2002) focused on the challenges of automation in the automotive industry or the logistics industry. After the exclusion criteria, 70 articles, as of February 25, 2023, were found to be relevant and used for further analyses.

Bibliometric analysis (Stage 3)

In the third step, a science mapping method was used to analyze the challenges of implementing CAR. A science mapping method may consist of bibliometric and scientometric analyses. Bibliometric analysis can be considered a technique mainly used to analyze the impact of research and to understand the evolutionary process of the field (Martinez et al., 2019). Therefore, this study used bibliometric analysis to provide visualization of the CAR challenge research areas. Several science mapping tools such as Gephi, CoPalRed, IN-SPIRE, CiteSpace, Science of Science, BibExcel, and VOSviewer can be used to visualize and analyze bibliometric networks (Cobo et al., 2011, Kumar and Choukimath, 2015; Mu and Antwi-Afari, 2024). VOSviewer was chosen for this study because it is a free software tool for visualizing and analyzing scientific literature data, can be applied to larger networks, and has special text mining capabilities (Van EcK and Waltman, 2014). By using VOSviewer as a science mapping tool, keywords co-occurrence analysis was conducted and visualized.

Systematic analysis (Stage 4)

This stage is a targeted, comprehensive, and intuitive review of all included articles. For the comprehensive review, this step was used to identify and categorize the challenges that hinder the implementation of CAR. Based on this, an in-depth discussion was conducted to provide insight into the application of CAR technology and to provide direction for further research.

Results

Selection of relevant peer-reviewed journals

Table 2 shows the relevant peer-reviewed journals regarding the challenges of implementing CAR during the studied period. Notably, only the top ten journals in terms of the number of articles are shown in Table 2. As indicated in Table 2, the top five peer-reviewed journals are Automation in Construction, Journal of Construction Engineering and Management, IEEE Transactions on Automation Science and Engineering, Industrial Robot, and IEEE Robotics and Automation Letters. These journals represent 44.7% of the total number of publications. The highest number of relevant articles was published in Automation in Construction. In addition, it was found that the peer-reviewed journals were very diverse, with nearly 30% of the articles published in only one journal, indicating that the field of study is very broad in scope with many industries involved.

Table 2. Selection of relevant peer-reviewed journals

Journals	Number of articles	% Total publications
Automation in Construction	26	25.2
Journal of Construction Engineering and Management	8	7.8
IEEE Transactions on Automation Science and Engineering	4	3.9
Industrial Robot	4	3.9
IEEE Robotics and Automation Letters	4	3.9
Journal of Computing in Civil Engineering	3	2.9
Journal of Building Engineering	3	2.9
Journal of Intelligent and Robotic Systems: Theory and Applications	3	2.9
Sustainability (Switzerland)	2	1.9
International Journal of High-Rise Buildings	2	1.9

Source: Created by authors

Keywords co-occurrence analysis

Keywords indicate the core content of the published articles. Keyword co-occurrence analysis was performed to construct the knowledge domain of challenges for implementing CAR. Using “author keywords” and “fractional counting” in VOSViewer, as well as setting the minimum occurrence of keywords at 2, 48 out of 309 keywords were initially selected. Further screening was done to remove broad phrases like “automated construction”, “automation in construction”, “industry 4.0”, and “construction 4.0”, etc. The second phase of text mining was performed on keywords to exclude general terms and integrate semantically consistent keywords. Other keywords with similar semantic meanings, such as “robots” and “robot” were combined. Finally, a network diagram of keywords co-occurrence analysis as presented in Figure 1 yielded 42 keywords. The font size indicates the frequency of keywords that have been studied in the selected literature samples. As shown in Figure 1, “automation”, “robotics”, “construction industry”, and “construction 4.0”, had larger nodes, indicating that these keywords appeared more frequently in the studied domain. At the bottom left of Figure 1, “artificial intelligence”, “digital twins”, and “slam” indicate the continuous development of artificial intelligence technology. On the right side of Figure 1, “3D printing” and “additive manufacturing” show the research areas for new technologies in building automation. The keywords in Figure 1 can be grouped into clusters. Keywords within the same cluster have a stronger internal link. For example, “modular building” is frequently discussed alongside “prefabrication” in the same cluster. The distances and connecting lines between the keywords illustrate their interrelationship. For example, “3D printing”, “additive manufacturing”, and “prefabrication” are closely related.

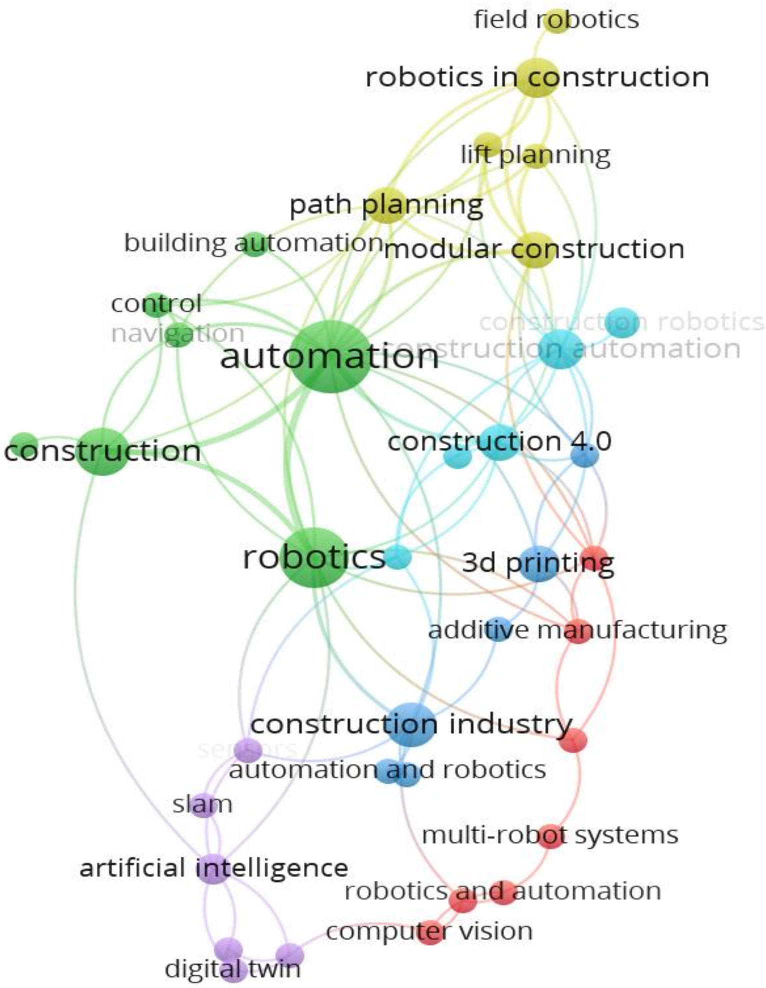

Figure 1. A network of co-occurring keywords related to challenges for implementing CAR.

Source: Created by authors

Table 3 shows the list of selected keywords and relevant network data. As shown in Table 3, “automation”, “robotics”, and “path planning” are the most frequent keywords among all the selected keywords, indicating that they are widely studied in this field. It is worth noting the link strength of the keywords. For example, “automation” and “robotics” had a total link strength of 30 and 22, respectively, indicating that these two keywords are strongly related to other keywords in the studied domain.

Table 3. List of selected keywords and relevant network data

Keywords	Occurrences	Average publication Year	Average citations	Average normalize citations	Total link strength
Automation	16	2011	8.31	0.83	30
Robotics	11	2006	31.72	1.45	22
Path planning	4	2008	13.75	1.04	15
Construction	7	2001	25.85	0.95	14
Modular construction	4	2020	10.00	1.28	14
Construction automation	5	2021	20.60	1.43	11
Construction 4.0	4	2021	6.75	1.16	10
Lift planning	2	2021	13.50	0.89	10
Mobile crane	2	2021	13.50	0.90	10
Construction industry	6	2015	5.16	0.44	8
Artificial intelligence	3	2013	36.33	0.35	7
Navigation	2	1999	15.50	1.23	7
Off-site construction	2	2021	80.50	3.94	7
Mobile robots	2	2021	6.00	0.39	6
Prefabrication	2	2022	25.50	3.12	6
3D printing	4	2019	38.00	1.81	5
Additive manufacturing	2	2018	86.00	2.69	5
Sensors	2	2020	0.50	0.03	5
Autonomous vehicles	2	2021	79.50	2.44	4
Cybersecurity	2	2021	12.00	0.79	4
Digital twin	2	2022	28.00	1.85	4
Edge computing	2	2022	0	0	4
Computer vision	2	2020	8.00	0.25	3
Robotics and automation	2	2020	8.00	0.25	3
UAV	2	2021	34.5	2.15	3
BIM	2	2021	34.00	1.56	2
Multi-robot systems	2	2022	0	0	2
Slam	2	2019	27.50	0.87	2
Steel beam assembly	2	2013	38.00	1.34	2
Bolting robot	2	2013	16.50	0.76	1

Source: Created by authors

Discussion

This section presents a qualitative discussion of the challenges of implementing CAR. After a detailed systematic review, the articles were coded into their respective challenges, where each challenge is categorized and presented in Figure 2, showing the frequency of challenges in the selected articles.

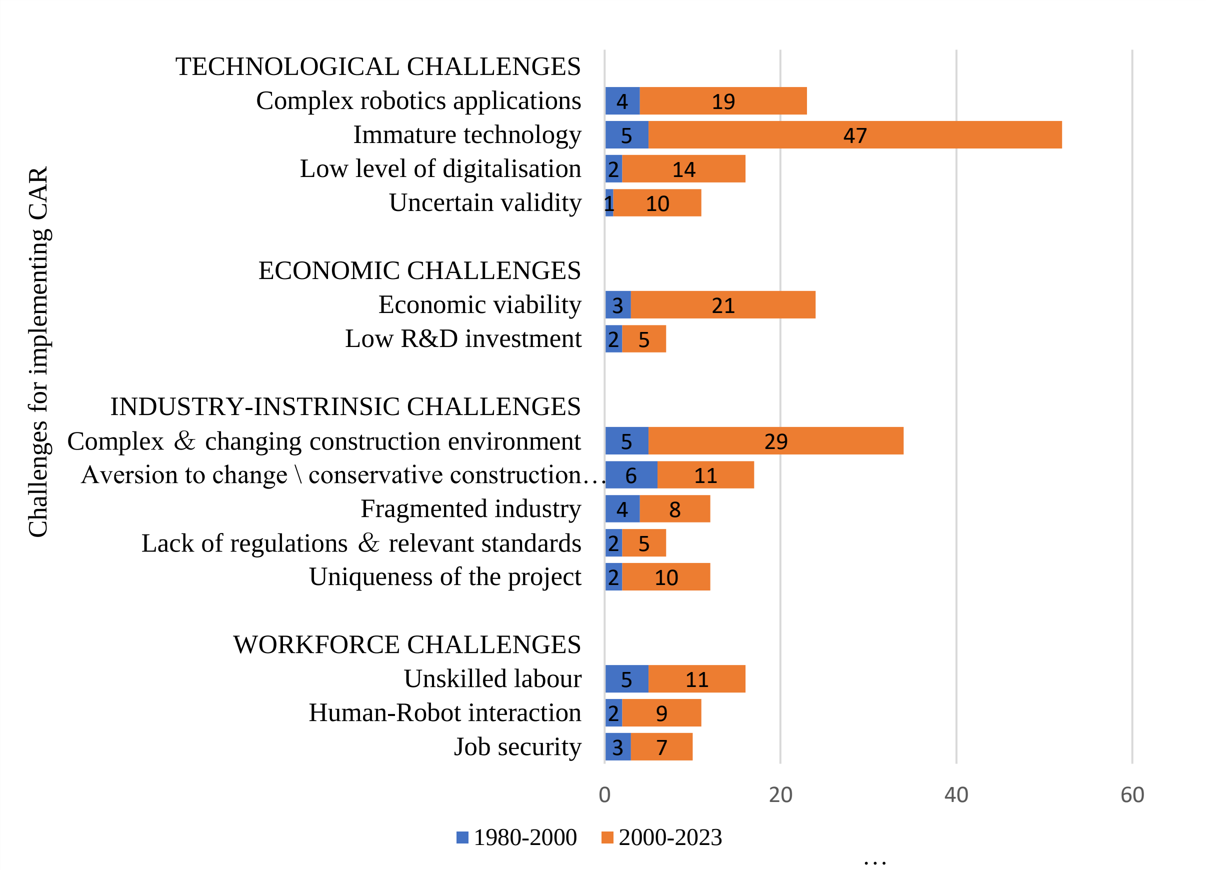

Figure 2. Challenges of implementing CAR from 1980 to 2023.

Source: Created by authors

As shown in Figure 2, there are fourteen key challenges of implementing CAR. They were grouped into four main categories, namely (1) technological challenges, (2) economic challenges (3) industry-intrinsic challenges, and (4) workforce challenges. The figure shows the number of times each challenge was mentioned in the selected literature samples (i.e., 70 articles). As shown in Figure 2, most of the literature in the last 20 years had begun to lean towards studying CAR challenges, with far more articles published from 1980-2000. In addition, most of the literature from 2000-2023 focused on CAR technological challenges. Specifically, 55 out of the 70 articles mentioned technological challenges, and it was revealed that nearly 80% of the challenges were mentioned in the last 20 years. Similarly, it was found that most articles published between 1980 and 2000 mentioned "aversion to change" as a challenge, with six articles published in that period, accounting for 35% of the total. The low number of publications in this period is mainly because research related to CAR challenges is in its infancy and the construction industry may be conservative about new technologies. In the last 20 years, the CAR field has been more inclined to research CAR technological and industry-intrinsic challenges. For example, "immature technologies" and "complex and changing environments" were the most mentioned challenges in the included articles. In addition, the importance of addressing the challenges of implementing CAR has been emphasized in the literature over the last 20 years, and researchers in the construction industry are beginning to realize the importance of applying CAR.

Conclusions

This study aims to adopt a systematic literature and science mapping approach to analyze research publications and identify the challenges to implementing CAR. The results showed that Automation in Construction and Journal of Construction Engineering and Management are the most influential journals that published many articles in the studied domain. The most frequently mentioned keywords were "automation", "robotics", "construction industry", and "construction 4.0". Fourteen 14 challenges were identified and categorized into 4 groups including (1) technological challenges, (2) economic challenges, (3) industry-intrinsic challenges, and (4) workforce challenges. Theoretically, unlike previous isolated bibliometric and systematic analyses, this study uses a hybrid approach to combine bibliometric and systematic analyses to overcome the barriers to independent research. As such, it provides researchers with a comprehensive and easily accessible reference point to understand the specific challenges hindering the implementation of CAR. Moreover, the findings have practical implications, as they would allow construction stakeholders to develop strategies to address the identified challenges. Despite the contributions, there are limitations to this research. First, the search strategy was conducted in a single database (i.e., Scopus), which may affect the coverage of publications in the studied domain. Second, the exclusion criteria were limited to journal articles written in English. Future studies are recommended to extend this study by using other electronic databases (e.g., Web of Science, Science Direct, PubMed) and include conference papers and those written in other languages.

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A Review of the State of the Art on Health and Safety Management in Ghana

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Abstract

The construction industry plays an important role in contributing to the economy and development worldwide. The state of affairs concerning health and safety in the construction industry needs attention. In most countries, the industry is the second largest contributor to Gross Domestic Product (GDP) after agriculture. However, despite the importance of the construction industry for the national economy, the activities in the industry sadly pose serious health and safety risks to workers and users of construction facilities. The study therefore aims to examine the health and safety management practices relating to construction operatives. A comprehensive review was conducted using Scopus, Web of science, Litmaps and Research Rabbit databases to examine the health and safety management practices of construction operatives in the last two decades. Content analysis was conducted using the 17 documents retrieved from the database search. The study identified behaviour and attitude of workers towards safety, communication, training and safety programmes as the main findings. The study provides practical knowledge to construction stakeholders in minimising health and safety risk to construction operatives to ensure sustainability. It will also help the scientific community to know what still needs to be done to further advance knowledge on health and safety management practices.

Keywords: Health, Safety, Construction industry, Construction operatives, Health and Safety Practice

Introduction

The construction industry is known to be a significant employer (Agyekum et al., 2022). The industry contributes largely to the global market. The Bureau of Labour Statistics (2017) noted that in the United States of America (USA), construction workers account for about 4.3% of the labour force, while on the average the United Kingdom (UK) employ about 10% into the construction industry. Despite its major contributions to GDP globally, the industry is prone to accidents due to its multiple activities. Accident records in this industry is the highest compared to other industries. (International Labour Organisation, 2018).The sector is estimated to account

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Duker, D. A., Badu, E., Adesi, M., and Adade-Boateng, A. O. (2024). A Review of the State of the Art on Health and Safety Management in Ghana. *In: Owusu-Manu, D., Adesi, M. and Acheampong, A. (Eds) Proceedings of the 1st International Conference on Environment, Social, Governance and Sustainable Development of Africa (ICESDA-2024),* 26-29 March 2024, Kwame Nkrumah University of Science and Technology (KNUST)-Kumasi, Ghana, Green Communities International, 202-215.

for over 100,000 fatalities annually (International Labour Organisation, 2015). It also accounts for all work-related fatalities between 30 and 40% (Luo *et al*., 2022; Sunindijo and Zou, 2012).

The industry therefore performs poorly in terms of health and safety as a result of these fatalities (Agyekum *et al*., 2021). Developing countries even have worse Health and Safety records (Manu et al., 2018). Unfortunately, these accidents are mostly unreported (International Labour Organisation, 2017). Construction workers therefore are at a constant risk of work related ill-health.

Some of these adverse health risks include musculoskeletal injuries (related to hand-arm movements sometimes affecting the back, knee and hip problems due to lifting and carrying), respiratory diseases such as asthma, skin infections and other associated injuries. The adverse effects of these problems include work absenteeism, schedule delays, increased medical expenses as well as loss of income and productivity and sometimes, early retirement (Yu *et al*., 2021; Umer *et al*., 2017a).

One of the most vulnerable workers in the industry is the operative who works mostly in dangerous positions (King, 1990). Ignorance to health and safety practices is one of the biggest challenges for construction operatives. Majority of construction operatives do not know about the significance of health and safety practices in their day to day life on site and their rights to health and safety. This causes them not to take health and safety issues seriously (Oni *et al*., 2019). Majority of them (i.e., construction workers), particularly, the unskilled labourers have little or no knowledge about safety. This may be due to the nature of construction work which may require the services of these labourers for brief periods of time (Oni *et al*., 2019). Some are employed for just a day and this might be challenging for employees (to possess the necessary knowledge about health and safety). Owing to the persistently high number of adverse health risks, (e.g., accidents and fatalities), health and safety has remained an utmost issue of concern within the construction industry (Ajayi *et al*., 2021).

Health is the process of safeguarding the minds as well as the bodies of people from illness resulting from mishandling materials, procedures and processes involved in the workplace. Safety involves the process of preventing bodily harm to people (Meenakshi, 2019). In order to improve the health and safety of the workforce, it is imperative that health and safety management practices are implemented.

Health and safety management is vital in the construction industry in enhancing the industry's future. The objective of health and safety management is to carry out tasks in a safe manner while concentrating on reducing accidents (Oni *et al*., 2022; Zhou *et al*.,2012). This includes a variety of programmes designed to monitor and reduce occupational risks within the industry while implementing protective and mitigating actions (Oni *et al*., 2022).

Numerous studies have been conducted on construction safety regulations, procedures, and enforcement. However, the main areas of focus have been worker attitudes and behaviour, work environment conditions, causes of accident and the availability of health and safety training (Adebayo and Emoh,2019; Zhou *et al*.,2014; Ajayi *et al*.,2021; Umeokafor *et al*., 2014; Abubakar and Tsanyawa, 2021)

This paper presents a review of pertinent literatures to highlight the various health and safety management practices for operatives on site. The study aims to provide a systematic review of research conducted over a period of ten years (2013-2023) on the health and safety management practices for construction operatives in the construction industry. The main goals of the review are (i) to look into health and safety management practices for operatives in the construction industry, (ii) to look at publication trends and (iii) suggest future directions for further research. The conclusions from the review can provide insights into what has been done and what still needs to be done to further advance knowledge on health and safety management practices. This study will help the scientific community to know what still needs to be done to further advance knowledge in health and safety.

Literature Review

Occupational health and safety is the study of potential risk to the safety of operatives that arise in or from the workplace and are anticipated, acknowledged, assessed and controlled (Adebayo and Emoh, 2019). Predominantly, occupational health and safety is of utmost importance for all industries, including the construction industry. However, the major concern for most people has been the accidents, injuries and fatalities workers are exposed to, which is quite prevalent in this industry. Notwithstanding, some measures have been put in place to combat these recurring incidents but they are not enough. The construction industry is tagged as one of the most accident-prone industries due to the number of accidents and fatalities being recorded. This is particularly true in developing countries. The table below (Table 1) shows statistics of accidents and fatalities in some countries.

Table 1: Construction accidents and fatalities in some countries

Country	Description of the status of construction safety
United State of America	The construction sector accounted for over 800 worker related and 5,333 fatal occupational injuries in 2019 (Bureau of Labour Statistics, 2020)
United Kingdom	An average of 143 deaths and 1.4 million related ill-health per year between 2015/2016 – 2017/2019 (Health and Safety Executive 2020)
China	There were 1,752 deaths in the industry within the first half of 2018 (Ministry of Emergency Management of the People's Republic of China, 2019
Qatar	Between 2012 and 2014, over 500 construction site deaths in Qatar were reported to be of Indian descent (Gibson, 2014b)
Nigeria	236 construction workers of different trades reported high level of accidents and fatalities (Okoye,2018)
Australia	The construction industry in Australia had the highest work-related illness rate (59 per 1000 employed persons) in 2017-2018 (Australian Bureau of Statistics, 2018)

Source: Adapted from Zhou *et al*. (2012)

The componential aspects of the construction industry are dynamic, transient, and intricately interrelated, in contrast to other industrial work environments (Borys, 2012, Albert *et al*., 2014, Arslan *et al*., 2019). At different phases of the construction process, the size and type of facilities, plant, machinery, and equipment change (Edwards *et al*., 2003). Due to weather conditions and the proximity of fast-moving traffic, site layout is unique and unpredictable for horizontal construction projects; however, working at heights and/or with subterranean utilities for both horizontal and vertical construction projects changes the working environment into different risk and hazard exposure levels (Guo *et al*., 2015, Sadeghpour and Andayesh, 2015).

On construction sites, there has been a noticeable increase in unsafe practices. It is not uncommon for project sites to disregard the necessary health and safety protocols and neglecting to take preventive measures such as wearing safety gear. According to Awwad *et al*. (2016), poor assistance from safety managers, lack of a suitable monitoring system, and a low level of safety knowledge, all adversely affect the implementation of health and safety procedures. Workers' knowledge and comprehension of health and safety at work enhances safety of workers on construction sites (Shamsuddin *et al*., 2015). The relationship between individuals and organisations involved in construction projects is also project-based and short-lived due to the high turnover and regular work team rotation of the work force (Swallow and Zulu, 2019).

Construction operatives sometimes referred to as trade workers are constantly being exposed to various degrees of hazards and fatalities due to the nature of the work they do and their level of involvement. Some are, however, exposed to more health and safety challenges than others due to the fact that the content of risk of each worker's assignment differs from trade to trade. Construction operatives work in teams or group which consist of skilled, semi-skilled and labourers with different degrees of job experience and awareness of health and safety matters. Some operatives are more exposed to accidents than others. In 2015, Choi reported that in the USA, the trade groups who were highly prone to site hazards and accidents in the construction industry were carpenters, labourers, operators and steel/iron workers. It was reported that operatives whose tasks involved lifting, such as the masons and their labourers were exposed to injuries like musculoskeletal disorders/injuries. The vulnerability of these operatives to hazards, injury and accidents reflect their level of involvement in delivering construction works. It has been reported that the main causes of accidents are as a result of poor management practices (i.e. inadequate supervision), inadequate safety management systems, pressure to meet production targets, communication issues (i.e. between shifts, personnel and management), excessive working hours, which results in mental fatigue, inadequate reporting systems, complacency, violations/ non-compliance behaviour, improper maintenance of tools and equipment, updates to equipment without the knowledge of the operator among others.

Safety management, according to Kirwan (1998), is concerned with real procedures, responsibilities, and duties related to staying safe. Typically, it is implemented using various safety management techniques as well as the organization's safety management system (Agyekum *et al*., 2018). Safety management procedures of construction industries vary from nation to nation because of the cultural variations in both developed and developing countries (Ali et al., 2009; Ismail et al., 2012). According to Choudhry *et al*. (2008), a business must adopt safety procedures that satisfy the changing demands of the construction sector if it wants to stay competitive. Implementing good health and safety management practices reduces the number of injuries to operatives and personnel in the workplace through control and prevention of workplace hazards. It reduces production interruptions, material and equipment damage, the risk of major accidents, cost of insurance as well as the cost of absenteeism. It also minimises legal cost of accident litigation, fines, expenditures on emergency supplies, accident investigation time and the loss of expertise and experiences (Choudry *et al*., 2008). In order to fully benefit from safety and health, construction and client organisations must use excellent safety management procedures such as health and safety training induction programmes for new workers, implement health and safety plans, effective communication on site with government and client support.

This review makes it clear that health and safety precautions are required in the workplace to protect workers' health and safety well-being in order to: preserve and enhance work quality and productivity. This may further minimise labour turnover and absenteeism, reduce indiscipline and accidents, boost employee morale and motivation, lower operational costs and spoilage, and protect workers' physical and mental health. But in order for this to happen, a strong system and programme for managing health and safety issues needs to be implemented. These safety plans include having a written safety policy, allocating and organising responsibilities for these issues, educating staff, making sure there are first aid facilities, as well as providing the necessary procedures and documentation (Eze *et al*.,2020)

In the past, workplace safety concerns have received greater attention than health issues, but as work environments began to change, health issues also become an area of concern. In recent years, there has been a growing recognition of the connection between well-being and the workplace (Aditya *et al*., 2018). Workplace well-being is defined as the characteristics of the workplace that promotes healthy behaviour, improve health outcomes and strengthen workplace culture (Radzi et al., 2023). Laine and Rinne (2015) defined well-being as an employee's holistic mood and emotions related to their job which includes physical, mental, and social aspects of health. Well-being involves every aspect of working life, including the quality and the safety of the environment as well as how workers feel about their jobs (International Labour Organisation, 2022). A poor workplace well-being leads to project failures and decreased productivity. Approximately 73% of construction workers do not have adequate support from well-being issues based on a survey (Radzi et al., 2023). This assertion links to health and safety management practices where workers do not have adequate support from their superiors and which leads to low productivity. Workplace well-being issues on construction sites, which adversely affect productivity, include bullying and harassment, work pressure, emotional and physical demands (Rouhanizadeh and Kermanshachi, 2021). They found that the effective ways that can enhance workplace well-being issues and reduce their negative effects include having the support of supervisors and communication among co-workers. Poor working conditions such as dirt, natural lighting, ventilation and noise as well as the organisational structure may affect maintaining excellent workplace well-being in construction work compared to white-collar jobs (Eaves *et al*., 2016). Some well-being issues such as stress and anxiety account for more absenteeism than accidents, flu and other diseases.

Past studies indicate that physical, psychological and social well-being are the primary factors for a good workplace well-being. Some physical factors affecting workplace well-being include healthy food, comfort at the rest area, workload and transportation facilities for construction workers. Psychological factors include general safety and health monitoring, worker facilities, project progress, insurance for construction workers, workers' welfare, salary package, working hours, working environment, timeline of salary payment and planning of the project. Social factors include communication between workers, worker work monitoring, collaboration between top management and workers, project leadership and relationship between top management and workers. These three factors positively affect workplace well-being. The well-being of workers cannot be simply solved by training and giving them more resources to care for themselves but by creating a supportive workplace atmosphere where stress and emotional exhaustion caused by role uncertainty and ambiguity is minimised. By comparison, construction workers are more at risk (i.e., a shorter life expectancy) and with poorer health and well-being outcomes (Du Plessis *et al*., 2013; Chung *et al*., 2019; HSE, 2019).

Research Methodology

A literature review study is not merely a report on the references. Instead, this type of study synthesizes the results from individual studies to produce a coherent and integrated argument about one research subject. A systematic review uses clear, detailed methods to find, select, evaluate and combine a set of research studies on a well-defined topic. Unlike the narrative review, systematic review makes the findings less vulnerable to the biases of a single researcher (Robson *et al*., 2007). It provides a clear-cut and reproducible research framework (Martinic *et al*., 2019). The systematic review method has been used extensively in the medical field, but in recent years, it has gained widespread interest in other disciplines, including construction management (Mok *et al*., 2015). This study adopted the systematic review as a methodological approach to review the existing health and safety management practices to discover useful findings and identify knowledge gaps for future research. The search is aimed at compiling the right publications related to health and safety management practices for construction operatives. A preliminary search was conducted where journals which had the highest number of papers were targeted for a secondary search which was used to select literature based on publication types and criteria. The papers were coded and analysed to have an overview of health and safety management practices for construction operatives. The search was limited to articles relating to the construction industry. The process is shown in the figure below.

Table 2: Search results in the four databases

Database	Scopus	Litmaps	Research rabbit	Web of Science
No. of Papers	3	16	4	2

Scopus and Web of science

A total of seven (7) peer reviewed journal articles published between the years 2013-2023 were retrieved from the keywords on health and safety management practices for construction operatives were selected and analysed. The desktop search was conducted using four databases including Scopus, Litmaps, Research rabbit and Web of Science. The comprehensive desktop search was undertaken using the title/abstract/keyword field of the database. Scopus is one of the most influential and widely used research databases (Hasan *et al*., 2021; Markus, 2011). The keyword/title entered in the search field was 'health AND safety AND management AND practices AND for AND construction operatives'. The search was limited to include results only related to construction. The strategy to restrict the search to construction provided meaningful and relevant results. Eight documents were retrieved from the database in relation to the keywords which were entered. The types of documents received were six articles, one review paper and one conference paper from Scopus. Three peer reviewed articles were retrieved from Web of Science out of which two were used after screening. Duplicates were unavoidable among the papers due to adopting overlapping databases and applications. The duplicates were removed and a total of three papers remained.

Litmaps and Research Rabbit

Another tool which researchers can use to gain insights in their field and to identify gaps in knowledge is the Litmap mapping tool, which means 'Literature map.' It is a visual tool that shows the relationships between different concepts in literature (Sulisworo, 2023). It is an application tool that can be used to track the growth of research ideas. The keywords entered into the search were health and safety management practices for construction operatives. Five articles were retrieved out of which one key paper was used as the seed article. From the seed article, 21 articles were retrieved and screened to suit the research topic and the years which were being used for the study. Out of the 21 articles, 16 were used for the study. Litmaps assists in focusing the researchers' paper search by using keywords, citations, or both. It also notifies users when new articles related to the map are released. The ability to visualise literature maps with important articles from desired study in a variety of visualisation modalities is made possible by Litmaps (Amanpreet *et al*.,2022). Since the size of the node is inversely correlated with the log of the citation count, papers with higher citation counts have larger circles. Researchers can see the connections between various research topics by using the Map Mixer (Amanpreet *et al*., 2022).Research rabbit is another cutting edge online tool for "citation based literature mapping". It is similar to Litmaps where a seed paper is used to draw out papers which are pertinent to the topic. The same keywords were used in search of articles relating to health and safety management practices for construction operatives. Eight articles were retrieved out of which four were used for the review after screening.

Keywords, abstract and title of the papers selected were used to select the literature. The keywords entered into litmaps were HEALTH AND SAFETY MANAGEMENT PRACTICES FOR CONSTRUCTION OPERATIVES. Five journal articles were retrieved. The articles were screened and 4 articles were within the year range which is 2013-2023. These articles were in line with the keywords. From the five articles, one paper was used as the seed article (Ajayi *et al*., 2022) out of which 21 peer reviewed articles were retrieved. These were also screened, out of which 12 articles were in line with the keywords and the year range. A total of 16 publications were retrieved from Litmaps.

Results

Citations

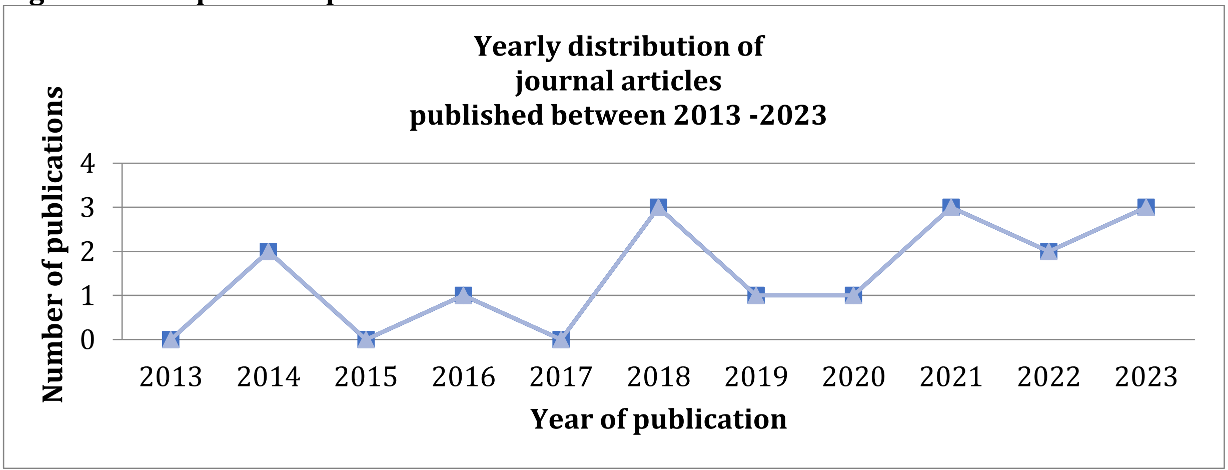
In selecting the literature, the following information was looked at: year of publication, country where the study is being conducted and publications with the highest impacts.

Year profile of publications

An examination of yearly publications might help researchers determine how much interest there is in a particular field. From the papers selected, the earliest ones concerning health and safety management practices were written in 2014 by Sherratt (2014) and Shin *et al.,* (2014). Sherrat's article was published in Construction management and Economics Journal. The study focused on using zero as policy and a target to bring change to health and safety management on UK construction sites. Shin et al.(2014) in his study set out to create a system dynamics (SD) model of workers' mental processes in order to examine feedback mechanisms and the ensuing dynamics pertaining to workers' safe behaviours and attitudes.

From the year 2013 to 2020, the number of significant papers published annually was fewer than ten. Generally, the number of relevant papers has been increasing gradually since 2021 making the overall trend on health and safety management practices surge. In total, eight papers have been published between 2021 -2023 giving an indication of the growing awareness and attention being paid to health and safety management practices.

Figure 1: Year profile of publications



Publications by Country

This study focus was based on the areas where the research took place. The continents represented were Europe, Asia, North America, Australia and Africa. From observation, many of the studies involving the construction industry were from the United Kingdom (Sherrat, 2014;Oswald et al.,2020, Ajayi et al., 2022; Oswald et al.,2018; Bayramova, 2023; Sherrat and Raiden, 2023). In general, nine countries were covered in the papers selected. Almost 40% of the studies were conducted in the United Kingdom (U.K), followed by the United States of America which was about 20%. Other recognised countries include China, Saudi Arabia, Nigeria and Australia. Asia is rising in the area of health and safety management practices. Publications from Africa were few.

Publications with the highest impact

Practitioners and researchers can learn about important knowledge sources in the field by studying information on the most quoted publications on health and safety management practices. The citation analysis was conducted on seventeen documents to find the most frequently cited works in the field of health and safety management practices. Table 3 presents the top five (5) documents with the highest impact in health and safety management practices in the construction industry showing the presence of early development and broad expansion within the field of research. Shin et al (2014) aimed to develop a system dynamics (SD) based model of construction of construction workers' mental processes that can help analyse the feedback mechanisms and the resultant dynamics regarding workers safety attitudes and safe behaviours. The developed mode was applied to examine the effectiveness of three safety improvement policies which were incentives for safe behaviours, increased levels of communication and immersion in accidents. Guo *et al.*(2018) had the second highest citation impact. The others are Schwatka and Rosecrance (2016), Choi and Lee (2018) and Basahel (2021).

From the diagram, the bigger node indicates a higher citation and the smaller node shows a lower citation. Shin et al. (2014) had the highest citations (348), which was followed by Guo *et al*. (2018) with 145 citations. Schwatka *et al*. (2016) had been cited 110 times whilst Basahel (2021) had 60 citations.

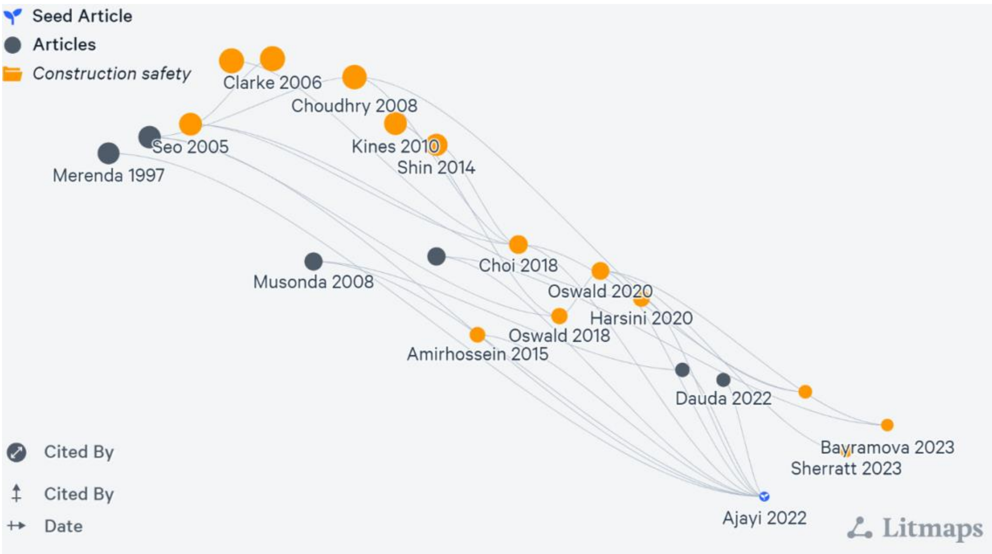


Figure 2: Publications with highest impact

Table 3: Publications with the highest impact

Author	Year	Title	Journal	Citations
Shin et al	2014	A system dynamics approach for modelling construction workers' safety attitudes and behaviours	Journal of Accident Analysis and Prevention	348
Guo et al	2018	A system dynamics view of a behaviour-based safety program in the construction industry	Safety science	145
Schwatka and Rosecrance	2016	Safety climate and safety behaviours in the construction industry: The importance of co-workers commitment to safety	IOS Press	110
Choi and Lee	2018	An empirically based model of the socio cognitive process of construction workers' safety behaviour	Journal of Construction Engineering and Management	81
Basahel	2021	Safety leadership, safety attitudes, safety knowledge and motivation towards safety-related behaviours in electrical substation construction projects	International Journal of Environment	60

Research Topics

The subjects on health and safety management are broad and varied. In screening the 17 publications, twelve topics emerged. Some of these topics looked at the impact of the workers' characteristics which were safety attitude, safety behaviour and safety cognition. Others were focused on the organisation which included safety programmes, compensation culture, safety climate, safety wears, and site safety practice, health and safety plan and safety leadership. Other topics were safety perception and cost safety. Among the research topics, safety behaviour and attitude were the topics which were frequently studied.

Discussion

Health and safety management research trends

Topics relating to health and safety management are changing with the times. Researchers focused on the characteristics of site workers such as their cognitive behaviour, unsafe behaviour, perception, attitude, safety wear use, cost safety, compensation culture and safety programmes. System dynamics was also used to explore the workers' attitude and behaviour towards safety. Currently, the trend of health and safety management research is much more diversified. Twelve topics were focused from 2013-2023. This shows how research is using diverse means to address health and safety management issues to improve health and safety management in the industry.

Behaviour and attitude of workers

Much of the studies was focused on workers' behaviour and attitude towards safety (Ajayi *et al*., 2022; Ajayi *et al*., 2021; Choi and Lee, 2018; Shin *et al*., 2014, Guo *et al*., 2018; Xu *et al*., 2021; Schwatka and Rosecrance, 2016; Basahel,2021). Ajayi *et al*.(2021). In addressing the behavioural safety concerns on Qatari Mega projects, it was observed that human factors like unsafe behaviours are the major contributors of accidents and fatalities in Qatari projects. They found that the major factors which contributed to unsafe behaviours included lack of safety knowledge, improper safety gear usage, making production a priority over safety and poor safety disposition due to workplace conditions. They employed six strategies for entrenched safety behaviour. These included a proactive approach towards safety monitoring by the management, effective communication and feedback, provision of adequate equipment, safety education and training, safety enforcement and appraisal and safety policy efficiency. Liu et al. (2023) defined antecedents as the factors which influence the cognition of construction workers. He established four levels of a comprehensive model of the antecedents of construction workers' safety cognition which were social factors (e.g. country, industry, and family), organisational factors (safety climate, leadership and culture), work situational factors (site condition, task characteristics) and individual factors (psychological and physiological factors, work skills). Choi and Lee (2017) developed in their studies, a model which was used to carry experiments in examining how the socio-cognitive process interacts with safety management interventions (i.e. strictness and frequency of management feedback and project identification). The outcome of the study revealed three interventions, all of which contributed to decreasing the incident rate. These interventions included promoting workers' project identification which would be an effective strategy in the modest risk site condition, combining other interventions after achieving the medium strictness of management feedback in the high risk site condition and other interventions which would not be effective without very strict management feedback in the low-risk site condition. Good behaviour and attitude enhances good safety practice for any organisation.

Communication

Communication is another theme that emerged from the review. Communication has the likely solution to confront problems by professionals and practioners (Naiman *et al*., 2022). Channels of communication need to be improved because ineffective communication between managers and workers hinders productivity and efficiency at work (Abubakar and Tsanyawa, 2021; Adebayo and Emoh, 2019). This is as a result of realising only a little difference in their rate of safe behaviour despite the increased communication between the workers. Communication is a social factor in well-being which when incorporated into the health and safety management practices will enhance the efficiency of the workers.

Training

Training is a potential solution in tackling the problem of safety by professionals and practioners. Some studies (Naiman *et al*., 2022; Abubakar and Tsanyawa, 2021; Adebayo and Emoh) have found that there is a low level of engagement in safety training programmes. Workers have difficulty in adapting to safety practices such as the use of safety wears, safety knowledge, which hinders efficiency and productivity at work. It is important that site and safety managers provide adequate training for operatives in the industry. Operatives can be trained on safety knowledge, accident prevention programmes, the right use and importance of Personal Protective Equipment (PPE) and compliance to safety rules and regulations on site.

System Dynamics

Most of the methods used in the studies relied on survey design and interviews (Adebayo and Emoh, 2019; Naiman *et al*.,2022; Ajayi *et al*.,2021; Xu *et al*.,2023). These methods could not provide more contexts about the unsafe behaviours of the workers but one method which stood out was the system dynamics model which researchers used to predict the behaviour of the workers. Researchers were able to know situations (e.g. work pressure and safety experience) on site which have significant effect on the attitude of the workers.

Safety management programmes

Organisations can also target programmes where their policy could be on zero target (Sherrat, 2014) in their health and safety management. This can motivate workers to be committed and work safely. This will encourage management to improve on the site safety practices. Organisations can also have programmes which will enhance the safety of workers. A 'new view' perspective of site safety practice which makes a useful contribution to the understanding of construction site safety. Safety on site is basically linked to the work conditions on site, which is usually physically demanding and requires working safely, avoiding accidents and working safely. The new view perspective of site safety recognises site workers' as a solution to safety and not a problem. If workers are seen as the solution, they will see themselves as part of the stakeholders of the organisation and they will be involved in ensuring high productivity and performance in the organisation.

Conclusion and Further Research

Though there have been improvements over the years, accidents, fatalities and injuries continue to affect the construction industry. In answering this, the number of peer-reviewed articles published and a range of research topics have been increasing to help the industry improve upon its health and safety management practices. Diverse topics, however, and the number of papers helped researchers and practioners to have an overview of the field. A comprehensive literature review evaluated 17 peer-reviewed papers published in various journals which have high reputation in the field of health and safety management in the construction industry. Analyses of these articles were carried out from year profile of publications, publications by country and publications with the highest impact. The review identified twelve topics, which included safety cognition, safety attitude, safety perception, safety behaviour, safety programmes, health and safety plan, safety wears, safety climate, compensation culture, cost safety, safety leadership and site safety practice. Discussion arising from the results included behaviour and attitude of workers, training, communication and system dynamics. Researchers can further look into improved remuneration and well-being of workers. Remuneration is more likely to have a great impact on how the workers will follow safety measures and other necessary measures that may increase productivity. The study provides practical knowledge on how to minimise health and safety risks in construction to ensure sustainability. The study will also help the scientific community to know what still needs to be done to further advance knowledge on health and safety management practices.

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Perception of Ghanaian Construction Employers' Safety Awareness

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Abstract

The construction industry is considered one of the most exposed to workplace safety risks. The establishment of codes of standards for safety has not minimised the rate of accidents on construction sites in a developing country like Ghana. The study sought to assess the perceptions of construction employers' safety awareness on construction sites in the Central Region of Ghana. Out of one hundred and twenty (120) questionnaires administered, only eight-six (86) questionnaires were returned which represents seventy-two percent (72%) of the response rate. The data collected were analysed using Statistical Package for Social Science (SPSS) version 20 and Relative Importance Indices (RII) to rank the variables of construction employers' safety awareness. Findings show that introducing safety compliance rules on construction sites and adequate safety equipment for employees were the most influential factors to construction safety awareness sites and existing measures for construction safety awareness, respectively. Further findings show that existing safety measures on construction sites help reduce costs on construction projects. It was concluded that safety regulations and rules, safety practices, and laws must be enforced at the beginning of a project. Employees must observe and abide by all safety rules and regulations on construction sites.

Keywords: Construction, hazard, safety awareness, site management

Introduction

Construction site safety is a critical concern in construction-related activities to safeguard construction site workers from potential risks and hazards (Laryea and Mensah, 2010). Safety management in developing countries faces challenges such as poor infrastructure, communication issues due to low literacy levels, unregulated practices, traditional working methods, lack of equipment, extreme weather conditions, improper equipment use, and corruption (Muiruri and Mulinge, 2014). The distinction between health and safety is often blurred, with both terms used

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together to emphasise the well-being of individuals in a workplace setting (Ofosu et al., 2016). Any breach in safety measures can have far-reaching consequences, impacting decisions at various levels within the system, with effects that may remain dormant until specific operational circumstances activate their damaging potential (ICAO Safety Management Manual, 2013).

In Ghanaian society, there is a lack of emphasis on the safety of construction workers on site, exposing many workers to high risks of accidents and resulting physical disabilities (Amponsah-Tawiah & Dartey-Baah, 2011). Construction safety encompasses procedures aimed at preventing immediate dangers to the public near construction sites, emphasising the importance of providing adequate facilities to maintain the health and well-being of individuals in the construction industry (Safeopedia, 2018; Health and Safety Executive's HSE, 2021). Safety requirements are crucial for organisations, with even five or fewer employees urged to adopt safety measures to mitigate risks and ensure a safe working environment (OSHA, 2011). While hazards on construction sites are inherent and cannot be eliminated, the associated risks can be reduced through effective control and implementation of safety principles (Al Hajeri, 2011).

A hazard is broadly defined as a condition or object with the potential to cause harm, including death, injuries, equipment or structural damage, material loss, or impaired function performance (ICAO Safety Management, 2013). The study sought to assess the perceptions of construction employers' safety awareness on construction sites in Cape Coast Metropolis, Ghana. The preceding section discusses construction workers' safety awareness.

Literature Review

Employer responsibility for safety

Construction safety measures should primarily concern employers, employees, governments, and project participants (Kheni, 2008). According to OSHA instructions (2011) and Langan (2012), construction safety measures should primarily concern employers. This means that employers are responsible for identifying and addressing hazards, training employees on how to work safely, and ensuring that all employees use the proper personal protective equipment (PPE).

Hazard identification and training

OSHA instructions (2011), HSE (2021), and HSC/E (2007) all emphasise the importance of hazard identification and training for construction workers. This includes training on identifying hazards, assessing risks, and controlling risks. Site-specific induction training is also important to help workers familiarise themselves with the specific hazards of a particular construction site (HSC/E, 2007). A typical construction site may require workers to wear a hard hat, coveralls, safety footwear, gloves, eye protection, and high measures used in construction sites.

Personal protective equipment (PPE)

HSE (2021), Yanka (2012), and IJCIET (2017) all agree that PPE is an important part of keeping construction workers safe. PPE can include hard hats, coveralls, safety footwear, gloves, eye protection, and respiratory protection. Choosing the right PPE for the job and using it properly is important. The selection and proper use of PPE are critical. It is not enough to provide PPE; workers must be trained to use it correctly, and the equipment must be suitable for the specific tasks and risks present at the construction site (Majchrzycka, 2020). Moreover, PPE must be properly fitted to be effective, which is a particular concern for female construction workers who often face challenges in accessing PPE that accommodates their anthropometry (Onyebeke et al., 2016). The effectiveness of PPE in preventing occupational injuries is evident in studies that have shown a significant difference in the use of PPE between workers in foreign-owned and locally-owned companies, with the former demonstrating higher usage rates (Yankson et al., 2021). Additionally, interventions that include the distribution of PPE and training on its use have been shown to increase PPE use among workers, potentially preventing occupational injuries (Contreras & Buchanan, 2011).

Site Security

HSE (2013) highlights the importance of site security to protect pedestrians and other public members from construction hazards. This may involve measures such as fencing the construction site, posting warning signs, and controlling access to the site. Warning signs play a pivotal role in communicating hazards and safety instructions to both workers and the public. These signs should be designed and installed in compliance with recognised standards, such as the American National Standards Institute (ANSI) Z535, to ensure they are universally understood and effective in conveying critical safety information (Jensen & McCammack, 2003; Amaliyah & Widajati, 2021; Rachman et al., 2022). Controlling access to the site is another essential security measure. It involves establishing designated entry and exit points and possibly incorporating access control technologies to monitor and manage the flow of people and vehicles into and out of the site. This can prevent unauthorised entry and reduce the likelihood of theft, vandalism, and accidents (Zhou & Ding, 2017).

Emergency management

Emergency Management Health and Safety Code/Executive (HSC/E) (2007) underscores the criticality of having a comprehensive emergency plan in place. Such a plan is essential to ensure the safety and well-being of individuals in the event of an emergency. The plan should encompass detailed procedures for evacuating the site, which is crucial for ensuring that all individuals can be moved to safety in an orderly and efficient manner (Munoz, 2017). It should also include established protocols for contacting emergency responders promptly, as rapid response is often vital in mitigating the effects of an emergency (Choi et al., 2022). Furthermore, the plan must address the provision of medical attention to injured workers, which is a fundamental component of an effective emergency response, ensuring that those who are injured receive immediate and appropriate medical care (Lueth, 1957). The importance of such planning is echoed in the literature, which suggests that emergency medical services (EMS) must have disaster plans that specify triggers for invoking crisis standards of care, including education of staff and simulations of system compromise (Mahon & Rifino, 2024). Moreover, the integration of Information and Communication Technology (ICT) can enhance preparedness by providing emergency personnel and the affected public with critical information during evacuations (Giannoumis et al., 2020). Training in first aid, mass casualty incidents, and access to personal protective equipment (PPE) have been identified as factors that positively influence perceptions of preparedness among emergency responders (Holgersson et al., 2016). Additionally, the need for close cooperation among various institutions and the revision of response manuals to include complete information for backup institutions is emphasised (Choi et al., 2022).

Methodology

The study population consisted of five building construction companies on various projects within Cape Coast Metropolis during the fieldwork in June 2021. The selected population was based on the unavailability of data on the number of respondents in the Central Region of Ghana, with a confidence level of 95% and a limit of error of 5%. The sample size of one hundred and twenty (120) was obtained through the census sampling technique (Bryman & Bell, 2007; Mason, 2006). Sets of questionnaires were designed based on the set objectives of the study to enquire about the safety awareness of employees on construction sites within Cape Coast Metropolis (Naounm, 2007). Questionnaires were administered personally to contractors, consultants, managers, and clients on construction sites in the Central Region of Ghana with the assistance of two field workers. Out of one hundred and twenty (120) questionnaires administered, only eight-six (86) questionnaires were returned which represents seventy-two percent (72%) of the response rate. The collected data were subjected to data display, data reduction, and verification. Finally, the data collated was edited, coded, and analysed (Saunders et al. (2007). Statistical Package for Social Science (SPSS) version 20 was used for the analysis, and the results were presented in Tables (using percentages and frequencies). Relative importance indices (RII) were used to rank the critical factors of safety awareness. The preceding section presents the findings of the research.

Results

The majority (75- 62.5%) of the respondents were Diploma certificate holders who were contractors (56 - 46.7%) with (6-10) years working experience (39-32.5% followed by Master's degree (32-26.7) who were consultants (30 – 25.0%) with 11-15 years working experience (29 - 32.5%). The least (1 - 8.0%) were Bachelor's degree holders who served as site managers (11- 9.2%) with 16 -20 years of working experience (10 – 8.3%).

Table 1 shows that the majority of the respondents ranked 'introduction of safety compliance rules on construction sites' 1st, with an ***RII of 0.832*** and a ***Mean value of 4.16,*** as the most influential factor in construction safety awareness. This is followed by the 'provision of all protective equipment to employees on-site', which was ranked 2nd, with a ***RII of 0.828*** and a ***Mean value of 4.14***. The least ranked factor among the ten (10) factors of construction safety awareness was 'the provision of safe storage, handling, and disposal of hazardous substances on construction sites, with an ***RII-0.78*** *and* ***Mean value of 3.9****.*

Table 1: Factors of Construction Safety Awareness

FACTORS OF CONSTRUCTION SAFETY AWARENESS	*W*	*M*	*RII*	*R*
Provision of adequate Personal Protective Equipment (PPEs) at the workplace.	187	3.74	**0.748**	**4th**
Effective use of PPE on site.	96	1.92	**0.384**	**7th**
Provision of first aid on construction sites.	195	3.9	**0.78**	**9th**
Provision of fall protection equipment to employees on sites.	207	4.14	**0.828**	**2nd**
Availability of safety plan for employees on sites.	210	4.2	**0.84**	**8th**
Availability of safety emergency procedures on sites.	197	3.94	**0.788**	**3rd**
Provision of safe storage, handling, and disposal of hazardous substances on construction sites.	190	3.8	**0.76**	**10th**
Availability of fire safety at all units of the construction area.	179	3.58	**0.716**	**6th**
Introduction of safety compliance rules on construction sites	208	4.16	**0.832**	**1st**
Recognition and rewards schemes for hardworking employees for complying with safety regulations.	181	3.62	**0.724**	**5th**

***W**-Weight, **M**-Mean, **RII**-Relative Importance Index, **R**-Ranking*

Table 2 shows that the majority of the respondents ranked 'adequate safety equipment to employees' 1st as the most influential factor for the existing measures for construction safety awareness, with an ***RII*** of ***0.944*** and a **Mean** value of ***4.72***. The 2nd highest ranked factor for construction safety awareness is 'surety of audits and inspections on the construction sites' with an ***RII-0.932*** and ***Mean*** value of ***4.66***. The last factor among the ten (10) factors of construction safety awareness was 'provision of first aid to workers before hospitalizing them' with an ***RII*** of ***0.700*** and a ***Mean*** value of ***3.5***.

Table 2: Existing Measures for Construction Safety Awareness

EXISTING MEASURES FOR CONSTRUCTION SAFETY AWARENESS	*W*	*M*	*RII*	*R*
Adequate safety equipment to employees.	236	4.72	**0.944**	**1st**
Organizational and safety policy for employees.	192	3.84	**0.786**	**7th**
Ensure safety audits and inspections.	233	4.66	**0.932**	**2nd**
Wearing of PPE by employees on sites.	212	4.24	**0.848**	**4th**
Employees' compliance with safety regulations.	227	4.54	**0.908**	**3rd**
Organizing seminars on safety measures for construction employees.	208	4.16	**0.832**	**5th**
Periodic changing of PPE for employees.	201	4.02	**0.804**	**6th**
Creation of a safe working environment for workers	193	3.86	**0.772**	**8th**
Insurance schemes for workers in case of accident	165	3.3	**0.660**	**9th**
Provide first aid to workers before hospitalizing them	175	3.5	**0.700**	**10th**

W-Weight, **M**-Mean, **RII**-Relative Importance Index, **R**-Ranking

Table 3 shows that the majority of the respondents ranked 'helps in the reduction of cost on construction projects' 1st, with ***RII*** of ***0.956*** and a ***Mean*** value of ***4.78*** as the most important measure for safety on the construction site. 'Contribution to the increase of productivity' has been indicated as the 2nd most important safety measure, with a ***RII of 0.872 and a Mean value of 4.36***. The least ranked factor among the ten (10) factors of construction safety measure on site was 'it gives the company a good reputation in the aspect of safety', with an ***RII*** of ***0.700*** and a ***Mean*** value of ***4.44***.

Table 3: Importance of Safety Measures on Construction Site

IMPORTANCE OF SAFETY MEASURES ON CONSTRUCTION SITE	*W*	*M*	*RII*	*R*
Contribute to accident prevention on construction sites.	206	4.12	**0.824**	**5th**
Help in the prevention of unnecessary injuries and illness.	188	3.76	**0.752**	**7th**
Contribute to ease at work and lead to the execution of projects on time.	202	4.04	**0.808**	**6th**
Contribute to an increase in the profit margin of the company.	178	3.56	**0.712**	**8th**
Gives the company a good reputation in the aspect of safety.	175	3.5	**0.7**	**10th**
It provides a sound mind for employees to execute their tasks.	222	4.44	**0.88**	**9th**
It contributes to increased productivity.	218	4.36	**0.872**	**2nd**
It helps to reduce the cost of construction projects.	239	4.78	**0.956**	**1st**
It creates a good working environment on-site	209	4.18	**0.836**	**4th**
It serves as a form of motivation for employees.	212	4.24	**0.848**	**3rd**

***W**-Weight, **M**-Mean, **RII**-Relative Importance Index, **R**-Ranking*

Discussion of results

Most respondents had diploma certificates ranging from 6-10 years of working experience with their respective companies. The introduction of safety compliance rules on construction sites was found to be the most influential factor in construction safety awareness sites. This finding concurs with the findings of Al Hajeri (2011) and the report from OSHA (2011). Adequate safety equipment for employees was also found to be the most influential factor under the existing measures for construction safety awareness. This finding concurs with the HSE (2021) and OSHA (2011) reports on providing safety facilities to construction workers. Regarding existing measures for safety on the construction site, most respondents indicated that they help reduce costs on construction projects. This finding concurs with the findings of several researchers (Yanka, 2012; Langan, 2012) and reports from HSE (2021) and IJCIET, 2017).

Conclusions and Recommendations

The study sought to assess the perceptions of construction employers' safety awareness on construction sites in Cape Coast Metropolis, Ghana. Construction employers must create awareness of the need for proper safety management procedures on construction sites by appointing safety officers to enforce the safety regulations and rules and work closely with site engineers and other workers, improving the existing safety programmes and changes to safety legislation. The implementation of safety practices and laws at each project stage must be enforced, and employees must be ensured to observe and abide by all safety rules and regulations on construction sites. The social implications include the need to prioritise the safety of construction workers, while the knowledge implications highlight the importance of understanding the factors influencing safety awareness in the industry. Industry implications involve implementing and enforcing safety measures to reduce accidents and costs on construction projects.

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A Portrait on The State of Vernacular Architecture In Ghana: A Systematic Review

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Abstract

This research presents an overview of the state of vernacular architecture in Ghana, employing a literature review methodology. It reveals concerning trends, including the rapid transformation and modernization of vernacular structures, posing threats to cultural heritage. The study highlights the inadequate documentation and preservation efforts, limiting policy formulation and integration into urban planning. Additionally, it identifies disjointed policy frameworks that segregate vernacular architecture, hindering its recognition and incorporation into development plans. Moreover, a critical gap in scholarly works raises questions about the existence and characterization of Ghanaian vernacular architecture, attributing this to the absence of theoretical frameworks. These findings underscore the need for enhanced documentation, policy coherence, and scholarly engagement to safeguard Ghana's rich cultural heritage embodied in its vernacular architectural traditions.

Keywords: vernacular architecture, literature review, theoretical framework, cultural identity.

Introduction

Vernacular architecture manifests a society's cultural practices, traditions, and materials specific to a particular region(Benkari et al., 2021; Pardo, 2023). It is a tangible representation of the society's rich heritage and identity(Samalavičius & Traškinaitė, 2021). African architectural typologies reveal a clear relationship between the environment, man, and their complex social system, despite historically being viewed as insignificant (Prussin, 1973; Schreckenbach & Abankwa, 1983). Moreover, these people adapted to their new geographic settings by diversifying their lifestyles, settling down, and developing distinctive housing styles suited to the savannah, the rainforest, and the coast(Bourdier & Trinh, 2011; Prussin, 1974; Schreckenbach & Abankwa, 1983).

Ghana is widely recognised for its rich cultural diversity and historical significance(Twumasi-Ampofo et al., 2020a). The architectural landscape of Ghana is distinguished by a diverse range of native building styles, methodologies, and resources that have undergone gradual development over a prolonged period(Agyekum et al., 2020a; Balaara et al., 2018a; Callistus Tengan et al., 2014; Prussin, 1969). The architecture of each region in the country

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is characterised by its unique features, shaped by the cultural, historical, and environmental factors particular to that area(Agyekum et al., 2020a; Balaara et al., 2018a; Bangdome-dery & Polytechnic, 2018). Vivid hues, elaborate woodwork, and intricate mud-brick edifices characterise the southern region's-built environment(Agyekum et al., 2020a; Oppong & Badu, 2013). In contrast, the northern regions exhibit unique earthen architecture featuring ornamental motifs(Balaara et al., 2018a; Callistus Tengan et al., 2014; Prussin, 1969). Notwithstanding its cultural and historical significance, the vernacular architecture of Ghana is currently facing a crucial turning point due to swift urbanisation, globalisation, and evolving socio-economic factors(Asante & Ehwi, 2020; Oppong & Badu, 2013). Nevertheless, the definition and characterization of vernacular architecture in the Ghanaian context continue to be challenging. This research aims to explore this issue by conducting a thorough literature review to examine current definitions and descriptions. This study aims to uncover the uncertainties surrounding vernacular architecture in Ghana by analysing numerous scholarly works and investigating the factors that lead to this lack of clarity.

Defining and characterising vernacular architecture is crucial in architectural scholarship, preservation, and cultural identity. Having precise definitions helps researchers and practitioners grasp the distinct characteristics of vernacular structures, making it easier to work on heritage conservation and sustainable development(Daneshgar Nejad et al., 2022). Furthermore, characterizations offer valuable insights into the socio-cultural contexts and environmental adaptations present in vernacular architecture, which can inform architectural practice and policy development(Pardo, 2023). Therefore, it is crucial to have a thorough grasp of vernacular architecture to safeguard cultural heritage and cultivate a greater respect for architectural variety(Palupi et al., 2021; Saha et al., 2021).

In Ghana, a lack of clarity in identifying and characterising vernacular architecture presents substantial obstacles to architectural discourse, preservation efforts, and sustainable development projects. Despite Ghana's rich architectural traditions and different cultural landscapes, the lack of a globally acknowledged definition and characterisation of vernacular architecture impedes efforts to recognise, preserve, and protect indigenous construction techniques. This uncertainty is emphasised by the complex interplay of cultural, social, and environmental elements that create architectural manifestations across Ghana's various regions. As a result, there is an urgent need to address the lack of clarity to create a more nuanced understanding of Ghanaian vernacular architecture and secure its preservation for future generations.

Methods and Materials

This study provides a theoretical evaluation of the status of vernacular architecture in Ghana through a comprehensive review of existing literature. It delves into various aspects of the subject, including the definition of vernacular architecture, its manifestation in Ghana, the materials and techniques employed in its construction, and the challenges it faces in contemporary architectural discourse. The utilisation of a literature review as a research methodology has been observed in vernacular architectural studies (Adenaike et al., 2020; Danja et al., 2017; Pardo, 2023). This research aims to provide a comprehensive and insightful examination of the state and existence of vernacular architecture in Ghana through descriptive analysis and interpretive inquiry. The study is a social phenomenon rooted in a historical and traditional narrative supported by constructivist and structuralist philosophy(Oliver, 2007; Rapoport, 1999). Integrating constructivism and structuralism as research philosophies can offer a comprehensive framework for comprehending the intricate interplay between individual experiences and the fundamental social structures that influence architectural practices (Rapoport, 1999).

This study utilises journals, a thesis, and books on vernacular architecture as significant data sources from credible electronic databases such as Google Scholar, KNUST D-Space, Science Direct and Research Gate and library. Many of the books (hardcopies) were accessed from the

KNUST Department of Architecture library. The critical word forms considered in this study include "vernacular architecture", vernacular architectural discourse', "vernacular architecture in Ghana", "vernacular architectural material and techniques in Ghana", "vernacular architectural preservation in Ghana" and challenges of vernacular architecture around the world and Ghana. Most of the documents reviewed are published in "The Journal of Science and Technology", *Journal of Art and Design", "Journal of Architectural and Planning Research. "Journal of African Cultural Studies"*, '*Contemporary Journal of African Studies*" "*International Journal of African and Asian Studies", "International Journal of Scientific & Engineering Research", and* other publications from "Elsevier", "Sage", and "Taylor and Francis", among others. The thesis and books were obtained from the KNUST D-space and the Department of Architecture library, as indicated in Table 1.

Table 1. Research materials and methods

Database (Electronic)	• Google Scholar • KNUST D-Space • Research gate • Science Direct
Database (Physical Library Search)	**KNUST-Department of Architecture Library**
Search Period	**1970-2022**
Keywords	• *Vernacular Architecture* • *Vernacular Architectural Discourse* • *Vernacular Architecture in Ghana* • *Vernacular Architectural Material and Techniques in Ghana* • *Vernacular Architectural Preservation in Ghana*
Duration Of Research	**2022-2023**
Key Documents Accessed	*Books on the vernacular architecture of Ghana* *Journal of Art and Design* *Journal of Architectural and Planning Research* *Journal of African Cultural Studies,* *Contemporary Journal of African Studies* *International Journal of African and Asian Studies* *International Journal of Scientific & Engineering Research* *Journal of Science and Technology (Ghana)* *Journal of the Society of Architectural Historians* *Journal of Architectural and Planning Research*

Vernacular Architecture

Vernacular architecture pertains to indigenous construction influenced by various factors such as geographical location, available resources, climatic conditions, cultural practices, and historical traditions(Benkari et al., 2021; Oliver, 2007; Pardo, 2023; Rapoport, 2006). It is typically erected by non-professionals who rely on knowledge passed down from previous generations and refined over time(Asquith & Vellinga, 2006a; Danja et al., 2017; Oliver, 1997, 2007; Rapoport, 2006). It is a design style considering a particular location or community's social, cultural, and environmental characteristics (Benkari et al., 2021; Mercer, 1975; Oliver, 2003; Rapoport, 1999). Chester & Starr (1942) argues that vernacular takes its roots from the word "Verna", which originates from the

Latin word "verus," which may be translated as either "true" or "real." In its Latin and Etruscan roots, "vernacular" refers to a word for anything indigenous, native, or domestic; this word was "Vernaculus" (Stevenson, 2010).

Using indigenous materials and building techniques is a common practice, resulting in decreased environmental impact linked to the transportation and acquisition of resources(Samalavičius & Traškinaitė, 2021; Vellinga, 2015). Furthermore, vernacular architecture frequently adapts to climatic conditions, employing natural ventilation, shading, and insulation to establish habitable environments(Auwalu, 2019; Pardo, 2023; Srivastava & Das, 2023). Moreover, Amos, (1969) differentiates "Vernacular architecture," which is what people construct for themselves, and "Traditional architecture," which is what is constructed for individuals by a trained "master builder" who is familiar with the raw material to be utilised their characteristics, and the regulations and standards to have complied.

An increasing appreciation for the history of vernacular architecture may be traced back to the heated discussions that arose due to England's industrialisation in the 19th century(Asquith & Vellinga, 2006a). The first publications dedicated to "vernacular architecture" consisted of photographs and technical investigations of local building types, classified according to build forms and architectural characteristics (Upton, 1990). Beginning in the 1960s, academics worldwide, not only in Western nations, have been undertaking studies on vernacular architecture(Asquith & Vellinga, 2006a; Benkari et al., 2021; Pardo, 2023). Again, Rudofsky's work and that of his colleagues sparked global attention in vernacular architecture among academics and practising architects following the publication of his book "Architecture without Architects," which accompanied an expo of the exact name at the Museum of Modern Art (MOMA) in New York(Asquith & Vellinga, 2006b). As a reaction to globalisation, which spread its industrialised uniformity worldwide, the current study on vernacular architecture achieved a new high in the 1980s, after Rudofsky's (1987) and Amos' (1969) contribution to vernacular architectural discourse.

Ghanaian context

This section reviews the literature to understand various scholars' definitions and characterisations of what constitutes vernacular architecture in Ghana.

Brief Geography of Ghana

Ghana, located on the west coast of Africa, is a lively and varied country celebrated for its extensive history, cultural legacy, and breathtaking landscapes. With a population of over 30 million (GSS,2014), Ghana is a melting pot of ethnicities, languages, and traditions, contributing to its reputation as one of the most culturally diverse nations on the continent. Côte d'Ivoire is situated west of another country, bordered by Burkina Faso to the north, Togo to the east, and the Gulf of Guinea to the south(Anquandah, 2013). Ghana comprises sixteen (Bono Region, Bone-East Region, Ahafo Region, Western Region, Western-north Region Ashanti Region, Eastern Region, Central Region, Northern Region, North-East Region, Volta Region, Savannah Region, Greater Accra Region, Upper West Region, Oti Region, Upper East Region) regions, with Accra being the administrative capital (GSS,2014).

Ghana is home to a diverse range of ethnic groups, each with their unique contributions to the country's rich cultural heritage. The Akan, Mole-Dagbon, Ewe, Ga-Dangme, and Guan are some major ethnic groups, each with distinct traditions and heritage(Aidoo & Botchway, 2021; Danso-Wiredu & Brako, 2021). The Akan ethnic group, which is the largest in the central and southern regions, consists of subgroups like the Ashanti, Fante, and Akuapem(Cox & Thompson, 2022). In the northern part of the country, the Mole-Dagbon people, including tribes like the Dagombas and Mamprusis, are the main ethnic group(Ahorsu, 2014). In the Volta Region, the Ewe ethnic group is prominent, with tribes like the Anlo and Avenor. The Ga-Dangme people in the

Greater Accra Region consist of the Ga and Dangme tribes(Greene, 2016). The Guan ethnic group in the Volta and Eastern Regions includes tribes such as the Avatime and Buem. Ghana boasts an impressive linguistic diversity, with more than 70 languages spoken. These include Akan dialects like Twi and Fante, Dagbani, Ewe, Ga, and Dangme (GSS,2014). English is the official language, promoting effective interethnic communication (GSS,2014).

Architectural Heritage of Ghana

The architectural history of Ghana can be described as having its origins in three key historical eras, namely pre-colonial architecture, colonial architecture, and post-colonial statehood architecture. These three eras will be discussed in the following sections of this study.

Pre-Colonial Architecture

The pre-colonial traditional architecture of Ghana is varied and abundant, showcasing the cultural, social, and environmental influences of several ethnic groups in the area. Indigenous Ghanaian communities had advanced building techniques and architectural styles tailored to local conditions and societal requirements before European colonisers arrived.

According to Schreckenbach & Abankwa, (1983a) and Agyekum et al., (2020b), the distinctive construction methods, materials, and designs that reflect the cultural and natural surroundings of the area define the architecture of southern Ghana. The people's customs, values, and way of life have gradually influenced this architecture(Prussin, 1974). It is further argued that the use of regional construction materials, including clay, wood, thatch, and stone, is one of the distinctive characteristics of the vernacular architecture of southern Ghana(Prussin, 1974; Schreckenbach & Abankwa, 1983). The fact that the construction materials are often taken from the nearby surroundings helps ensure little effect on the environment. In addition to being distinctive, Schreckenbach & Abankwa (1983) and Prussin (1974) assert that southern Ghana's traditional architectural styles reflect the locals' varied cultural activities and beliefs. The courtyard home and the compound house are the two most prevalent architectural types (Schreckenbach & Abankwa, 1983). Moreover, Whereas the compound home is a collection of structures organised around a central open area, the courtyard house is distinguished by an enclosed centre courtyard that serves as the family's meeting place(Prussin, 1974; Schreckenbach & Abankwa, 1983).

According to Prussin (1974), the use of traditional construction methods handed down through the centuries is another significant component of the vernacular architecture in southern Ghana. For instance, clay, sand, and water are combined to build earthen walls, which are then compacted into moulds to produce bricks(Schreckenbach & Abankwa, 1983). Furthermore, another significant component of southern Ghana's traditional architecture is thatched roofing(Prussin, 1974; Schreckenbach & Abankwa, 1983). Bravmann (1972) and (Schreckenbach & Abankwa, 1983) assert that they are constructed from dried grass or palm fronds piled and weaved together to form a robust and waterproof roof. Again, the area’s climate impacts the design of traditional buildings in southern Ghana(Schreckenbach & Abankwa, 1983). Given that temperatures and humidity levels might be high, buildings are designed to encourage natural ventilation, and this is made possible by using big windows, high ceilings, and open areas in the building design (Schreckenbach & Abankwa, 1983). Similarly, Prussin (1974) further asserts that religion and spirituality heavily influence traditional architecture design in southern Ghana.

Moreover, intricate carvings, paintings, and other architectural elements adorn many structures, reflecting the locals' religious convictions(Prussin, 1974; Schreckenbach & Abankwa, 1983). Building designs often employ traditional themes and symbols, such as the adinkra symbols, to express meaning and value (Schreckenbach & Abankwa, 1983).

According to Schreckenbach & Abankwa (1983), the environment, cultural customs, and accessible construction materials in Northern Ghana all contributed to the development of the region's distinctive vernacular architecture. The northern region of Ghana has a climate typical of savannahs, which means it is hot and dry for most of the year(Prussin, 1969). Ancient mud construction techniques are still widely used in Ghana's arid and northern regions, particularly in rural areas(Schreckenbach & Abankwa, 1983). Prussin (1969) and Schreckenbach & Abankwa (1983) further assert that in this region's north-eastern portion, the buildings are circular and organised as cells around an inner courtyard. Moreover, as a homogeneous material, the circular form of the load-bearing walls, mud achieves maximal compressive strength(Prussin, 1969). Prussin (1969) further argues that the roofs are either constructed in the shape of a cone and covered in thatch, or they are made of mud and have a parapet made of mud.

Similarly, Schreckenbach & Abankwa (1983) asserts that rectilinear constructions consisting of interconnecting cellular compartments are created with flat mud roofs in the western portion of the area, where most of the population is Muslim. In the regions around Lobi, which are in the upper west region of Ghana, these roofs are held up by a combination of posts, beams, and rafters(Schreckenbach & Abankwa, 1983). Prussin (1969) argues that in contrast to the mud walls in the other parts of the region, these do not hold any weight. Schreckenbach & Abankwa (1983), however, assert that the other parts of the region each have a unique hybridisation of the region's two primary design patterns. Moreover, Fulani communities also consist of circular huts built from grass-woven mats connected to poles and conical thatched roofs made from the same materials(Schreckenbach & Abankwa, 1983). Their roofs are covered with thatch. Again, many of the structures, however, in the district and regional centres of the region are constructed using cement-sand blocks, reinforced concrete structural framework, floor slabs, ceilings, and corrugated iron, aluminium, or asbestos-cement roofing sheets, all of which are laid atop a timber substructure(Schreckenbach & Abankwa, 1983).

Again, materials include laterite, clay-containing soils (extracted from pits near the construction site), and alluvial soil from riverbanks(Schreckenbach & Abankwa, 1983). Fine, sharp river sand or gravel as an aggregate is used. Traditional circular homes are without doors. Moreover, Once building the wall was finished, the builder used a cutlass to make an aperture that served as the entrance to the home(Prussin, 1969; Schreckenbach & Abankwa, 1983). Prussin (1969) further asserts that windows are absent from the conventional circular home. To ventilate, the "roof skin" is raised using a bent wooden piece in the shape of a knee that is put beneath the roof and on top of the mud wall just across from or above the entry aperture(Bangdome-dery & Polytechnic, 2018; Prussin, 1973).

The publication "Construction Technology for a Tropical Developing Country" provides crucial knowledge for the building designer(Schreckenbach & Abankwa, 1983). This is accomplished through thorough and detailed text and visually stunning illustrations, all presented within a relevant and meaningful framework. The elucidation of the climatic fluctuations and their consequent impact on the societal customs and practices of the tropical region’s populace is evident. The discourse delineates conventional methodologies for addressing construction predicaments and elucidates these approaches' advantageous and disadvantageous facets(Schreckenbach & Abankwa, 1983). Furthermore, it offers various alternative solutions, encompassing contemporary and conventional materials as deemed suitable(Schreckenbach & Abankwa, 1983). Regrettably, based on the preceding exposition and discourse about the vernacular architecture of Ghana, it appears that none of the works effectively characterises and definitively elucidate the vernacular architecture of Ghana.

Moreover, the scholarly work entitled "Architecture in Northern Ghana: A Study of Forms and Function" by Labelle Prussian explores the village pattern and household architecture of six distinct tribes inhabiting a geographically confined area characterised by high environmental stability and cultural homogeneity(Prussin, 1969). The present studies scrutinise the chosen cohort's diverse architectural styles and structural features to showcase their creative attributes(Prussin, 1969). This architecture's genesis is shaped by many factors, including the prevailing materials and technological advancements, the economic activities that underpin it, and the consequential by-products thereof.

Prussin (1969) has voiced her critique of prior research on Ghanaian architecture, citing a dearth of theoretical underpinnings and insufficient attention to the distinctions of architectural description. Again, many studies failed to account for the notable ecological variations within the Ghanaian context(Prussin, 1973). The study's findings, however, unveiled six archetypal configurations that could be deemed as the paradigm for the northern region of Ghana(Prussin, 1969). However, this study could not provide a clear definition or thorough characterisation of these architectural forms as they pertain to the vernacular architecture of the northern region of Ghana.

The preceding body of literature has endeavoured to explicate the architecture of the pre-colonial period from many vantage points. Notwithstanding the significance of vernacular architecture in Ghana, there is a dearth of scholarly research, documentation, and discourse on the subject matter. Therefore, the forthcoming section explores colonial architecture in trying to understand the various influences and techniques introduced during the period.

Colonial Architecture

The colonial architecture in Ghana showcases a captivating fusion of indigenous building methods and European influences, mirroring the nation's intricate history of colonisation and cultural interchange. The colonial architecture highlights a significant change in material specifications from thatch roofs to iron sheets, mud walls to Sandcrete and concrete walls, and the introduction of jalousie and louvred windows(Hove, 2018a; Hyland, 1995). Hyland, (1995) and (J. K. Osei-Tutu & Smith, 2018) asserts that during the colonial period in Ghana, previously called the Gold Coast, multiple European powers such as the Portuguese, Dutch, Swedish, Danish, and British arrived, each influencing the architectural landscape. The forts and castles on the coastline are among Ghana's most iconic colonial architecture features(B. Osei-Tutu, 2004). These structures functioned as trading posts, military outposts, and administrative centres for European powers involved in the transatlantic slave trade and the exploitation of the region's resources(Hove, 2018a). Notable examples are Cape Coast Castle, Elmina Castle, known for their impressive stone walls, large gates, and strategic positions along the coast(Hyland & Intsiful, 2003; Micots, 2010).

The forts and castles blend European military architecture and local building traditions. Colonial architecture in Ghana includes many types of buildings, such as government offices, churches, schools, private dwellings, and forts and castles(Hyland, 1995). They typically include strong stone walls and bastions for protection, along with courtyards, living spaces, and administrative offices(J. K. Osei-Tutu & Smith, 2018). During the colonial era, many structures in Ghana incorporated elements of European and indigenous African architecture, like decorative motifs, arched doorways, and courtyards, highlighting the diverse cultural influences of the time (Hyland, 1995; B. Osei-Tutu, 2004).

European colonial powers, mainly the British, imported architectural styles, including neoclassical, Victorian, and Georgian, which were modified to fit the local temperature and surroundings(Micots, 2010, 2017). Colonial-era buildings in Ghana typically include extensive verandas, high ceilings, and large windows for natural ventilation and offer respite from the tropical heat. Accra in Ghana showcases significant colonial architecture, functioning as a prominent administrative and commercial hub in the colonial era(Hess, 2000). The city contains many colonial-era structures, including the former Government House, now called Christiansborg Castle, which was the official residence of the British colonial administrators. The castle is constructed in the neoclassical style, showcasing massive columns, an intricate façade, and vast grounds that symbolise the dominance and control of colonial rule(Hove, 2018b).

Aside from public buildings, colonial architecture in Ghana also encompasses residential structures constructed for European settlers and local elites(Micots, 2017). The colonial-era mansions typically display elegant facades, spacious interiors, and landscaped gardens, reflecting the wealth and status of their owners. One example is the James Town district in Accra, characterised by colourful colonial-era houses lining narrow streets, forming a lively and diverse neighbourhood with a unique architectural style(Micots, 2015, 2017).

The colonial architecture of Ghana showcases the country's diversified past by combining European influences with local building traditions, resulting in a distinct and unique architectural style. Colonial-era architecture in Ghana, ranging from forts and castles to government buildings and mansions in cities like Accra, showcases the intricate blend of cultures, identities, and power dynamics that have influenced the country's-built environment throughout history. Ghana developed post-colonial architecture after independence to affirm its identity and reject colonial influences. The ensuing section will discuss how Ghana began a nation-building initiative to reflect its newfound autonomy and growth, which revived indigenous architectural traditions and modernism.

Post Colonial Architecture

Ghana's post-colonial architecture arose with independence in 1957, signalling a dramatic shift in architectural expression as the country tried to assert its individuality and break free from colonial influences(Jackson & Holland, 2016; Uduku, 2008). As Ghana embarked on a nation-building endeavour to represent its newfound autonomy and aspirations for advancement, indigenous architectural traditions resurfaced, and modernism received a renewed focus(Le Roux, 2003a). The Nkrumah administration's approach to urban development focuses on enhancing the administration's stature and promoting a sense of national identity. Jackson & Holland, (2016) and Galli, (2022) argues that the Nkrumah administration was primarily responsible for promoting modernism, even though the colonial administration had commissioned a plan for the capital's urban development and supported the construction of dwellings and commercial facilities designed in a "European style."

The Nkrumah government utilised a modified version of the International Style, developed by architects such as Mies van der Rohe, Walter Gropius, and Le Corbusier, to handle a diverse cultural setting in construction projects by British and American architectural firms(Jackson & Holland, 2016; Le Roux, 2003b). Maxwell Fry's design for the National Museum in Accra uses a prefabricated aluminium dome to combine the museum's diverse collection, symbolising how architectural modernity can bring order to various cultural aspects(Jackson & Holland, 2016). J. Cubitt, the designer of the Accra Technical Institute, and Kenneth Scott, known for his office buildings in Accra, both showcase a robust modern aesthetic with occasional nods to a tropical setting(Le Roux, 2003c). The structure constructed for the United States Embassy in Accra, designed by American architect Harry Weese, exemplifies the rationalisation of modernity by referencing a broad concept of local culture. Buildings like the State House, Nkrumah Ideological Institute, Ghana Bank, Ambassador Hotel, and Kingsway Department Store showcase a focus on volume, surface regularity over "axial symmetry," and a lack of ornamentation typical of the International Style (Le Roux, 2003c, 2004). The architectural monuments, commissioned by the government to celebrate national independence and built near Black Star Square, demonstrate this conceptual duality. Black Star Square, located on the coast between James Town and Christiansborg Castle, features an assembly ground encircled by four seating structures and highlighted by the grand arch of the Presidential seating stand (Le Roux, 2003a). Independence Arch is located directly across from the Presidential Stand, near the Christiansborg Crossroads, a massive structure celebrating Ghana's independence. The beautiful parks and plazas envisioned by Fry and Trevallion were swallowed during Nkrumah's presidency by a continuing compression of immigrants and commercial establishments in the business district, particularly along Liberia Road and Liberation Avenue. The Fry and Trevallion plan envisioned expenditures for "public squares, fountains, ornamental pools and statues," and a vast Parliament complex. However, the Nkrumah government allocated these expenditures to the building of the Organisation of African Unity, the refurbishment of Christiansborg Castle, the construction of the State House and the establishment of the Ambassador Hotel(Le Roux, 2003a; Roux, 2004).

The Ghanaian Armed Forces couped on 24 February 1966, transferring administrative authority to the National Liberation Council led by J. A. Ankrah. After the coup, limitations were imposed on the construction of architectural monuments(Hess, 2000). After Nkrumah died in exile in 1972, President Acheampong instructed for his body to be brought back to Ghana, where he received a state funeral in Accra. Several construction projects in Accra's central business centre, such as the Conference Centre for the Organisation of African Unity, were built in honour of President Nkrumah. In 1975, the Cataudella monument, which held significant symbolic importance for the administration, was relocated to the front of the Ghanaian National Museum(Hess, 2000).

During the post-colonial era, modernist architecture emerged in Ghana, known for its clean lines, geometric shapes, and practical design principles(Balaara et al., 2018b; Le Roux, 2004; Young, 2021). Architects Joseph N. B. Tagoe and Vladimir Djurovic influenced Ghana's modernist architecture by creating buildings that utilised innovative materials and construction methods to meet the demands of a quickly urbanising population(Hess, 2000). The National Theatre in Accra exemplifies modernist architecture in Ghana, showcasing its cultural ambitions and modernisation with its distinctive cylindrical shape and sweeping rooflines(Hess, 2000). During this time, urban areas such as Accra and Kumasi experienced growth, resulting in the development of tall structures, residential complexes, and shopping centres that showcased the increasing impact of contemporary urban planning and design concepts(Jackson, 2022; Jackson & Oppong, 2014). During the post-colonial period, Ghana's architecture tried to make a powerful statement about the country's significance and sense of self-worth. It was expressed in buildings like the Parliament House, the Supreme Court Building in Accra, the senior staff clubhouse, the Unity Hall, and the Great Hall at KNUST-Kumasi. All these buildings were designed to express the new democracy and statehood of the country. Most post-colonial structures in Ghana exhibit a modern and international architectural style, including the Flagstaff House Project in Accra, the Korle Bu Teaching Hospital in Accra, the Komfo Anokye Teaching Hospital, the Bolga Commercial Bank Building, and the Bolga Regional Library.

National Policies and Constitutional Issues on Vernacular Architecture

This section reviews the legal and regulatory frameworks that govern vernacular building practices in a country's architectural environment. This study delves into the impact of national policies and constitutional provisions on vernacular architecture, considering cultural heritage protection, sustainable development goals, and the interplay between tradition and modernisation in architectural planning and governance.

Cultural Policy of Ghana (2004)

Ghana's cultural policy, formed in 2004, emphasises its commitment to maintaining and promoting its rich cultural history as a critical component of national development, as outlined in Article 39 of Ghana's 1992 Constitution. The Ministry of Tourism and Culture developed this policy, providing a comprehensive framework for long-term conservation, promotion, and management of Ghana's unique cultural resources. It emphasises the significance of cultural variety in shaping national identity, social cohesion, and economic vitality. Particular attention should be paid to preserving both tangible and intangible cultural assets, as advocated by the policy. Drama, literature, and music are examples of intangible cultural heritage. On the other hand, tangible cultural heritage includes things like architecture, statues, paintings, traditional sacred gardens, monuments, and treasures of artistic value that are kept in private places, castles, and mausoleums.

Ghana's cultural policy emphasises the importance of protecting and conserving the country's cultural heritage. The policy details steps to protect cultural sites, artefacts, and traditions to ensure their conservation for future generations. Emphasis is placed on promoting Ghana's cultural heritage to local and international tourists to boost local economies and encourage cross-cultural interactions. The country's cultural policy does not address issues regarding the identification, definition, characterisation, preservation, conservation, and documentation of Ghana's vernacular architectural heritage.

Ghana National Building Regulation (GNBR)1996 (LI1630)

The GNBR is reviewed in this study to comprehend better the numerous legislative laws governing vernacular architectural buildings in Ghana. Article 63 of Act 462, the Local Government Act of 1993, required the minister in charge of works and housing to establish the GNBR through a legislative instrument, which must comply with the district assemblies in creating district building bylaws. The minister may work with the Local Government Minister. As a result, the regulations derive their authority from Legislative Instrument (LI) 1630, 1996, which governs building construction, alteration, or extension.

The national building laws concentrate on the many stages of the physical growth of buildings, beginning with the design stage and continuing through the construction stage, permit applications, and maintenance. The GNBR encompasses various aspects concerning building construction, such as building design, materials, structural integrity, fire safety, sanitation, accessibility, and environmental sustainability. The document outlines the standards, guidelines, and procedures that must be followed by developers, architects, engineers, contractors, and other stakeholders during all stages of building projects, from planning to occupancy. On the other hand, NBR does not consider the process followed for characterising, building, preserving, and protecting vernacular structures within the various districts.

One of the primary goals of the GNBR is to improve building safety and resilience to natural catastrophes such as earthquakes, floods, and hurricanes, as well as man-made dangers such as fires and structural collapses. The rule defines minimum requirements for structural design, foundation systems, building materials, and construction procedures to ensure that buildings can endure the stresses and forces they will face over time.

Furthermore, the GNBR deals with public health and sanitation concerns by establishing regulations for water supply, drainage, sewage disposal, and sanitation facilities in buildings. The document also covers provisions for accessibility and inclusivity, guaranteeing that buildings are planned and built to cater to individuals with disabilities and special needs, under international standards like the United Nations Convention on the Rights of Persons with Disabilities (CRPD).

Upon delving deeper into the policy documents regarding vernacular architectural structures in Ghana, it was discovered that the NBR is supported by the building development permit guidelines (BDPG,2015). To ensure the effective enforcement of these NBR, the town and country planning collaborates with three ministries: the Ministry of Local Government and Rural Development, the Ministry of Environment, science, technology and Innovation, and the Ministry of Lands and Natural Resources to develop the BDPG as outlined in the following section.

Building Development Permit Guidelines (BDPG), 2015

As stipulated in section 49(1) of Act 462, the instructions supplement the requirement that written permits be obtained from the district planning authority (DPA). Hence, the review of the BDPG is to understand the legislative instruments issues regarding the identification, definition, characterisation, preservation, conservation, and documentation of Ghana's vernacular architectural heritage. The Building Development Permit Guidelines (BDPG) of 2015 is a significant advancement in regulating building construction and development in Ghana, ensuring orderly developments in Ghanaian human settlements and sustainable developments with the various MMDAs (BDPG, 2015). Created by the Ministry of Local Government and Rural Development in partnership with different stakeholders, the BDPG offers a thorough framework for acquiring building permits and guaranteeing adherence to building regulations and standards nationwide.

The main goal of the BDPG is to simplify the process of acquiring building permits by creating precise norms and procedures for developers, architects, engineers, and other involved parties. The rules detail the necessary actions and documentation to apply for several construction licences, such as architectural drawings, structural designs, environmental impact assessments, and other pertinent permits or approvals from regulatory bodies. Section 2 of the rules outlines the many sorts of permissions that a developer must get. These include planning permits for zoning restrictions related to heights, accessibility, size, and development class. Development permits are also issued for construction, structural alterations, complete transformations, temporary structures, and demolition permits for redevelopment.

Section 3 details the process of submitting, reviewing, inspecting, and issuing development permits. Section 4 discusses the different requirements for permits issued by various agencies. Some agencies that issue permits include the Environmental Protection Agency (EPA) for environmental permits, the Ghana National Fire Service for fire permits, the Ghana Civil Aviation Authority for air safety permits, the National Petroleum Authority for petroleum permits, the Ghana Tourism Authority for tourism permits, Department of Urban Roads for traffic impact assessments, and others.

Considering everything mentioned above, it is evident that certain institutions lack the subsidiary requirements for different developments that affect aspects of vernacular architectural structures in terms of their clear definition and characterisation and their protection, preservation, and conservation of our cultural heritage, both directly and indirectly. This is demonstrated, for example, by the GMMB's glaring absence from the list of organisations in charge of safeguarding Ghana's architectural heritage.

Land Use and Spatial Planning Act, 2016

Regarding the governance and administration of land use and spatial planning in Ghana, the Ghana Land Use and Spatial Planning Act, 2016 (Act 925) marks a noteworthy turning point. Act 925 offers a comprehensive legal framework for guiding land use decisions, promoting sustainable development, and guaranteeing the effective allocation and management of land resources throughout the nation. The government enacted Act 925 to address the issues of rapid urbanisation, informal development, and unsustainable land use practices.

As a result, this act is being examined as part of the investigation into the procedures that should be taken to guarantee that vernacular architectural structures in Ghana are appropriately included in terms of their identity, definition, and the appropriate preservation and conservation of cultural heritages within the Ghanaian environment.

In ensuring the district assemblies are well decentralised to perform the spatial planning and human settlements management functions better, article 2 of the act established the land use and spatial planning authority. The authority aims to provide sustainable development of lands and human settlements through a decentralisation planning system and ensure judicious use of that land. Article 4 provides the authority's functions to control physical development in uncontrolled and less controlled but sensitive areas like forest reserves, natural reserves, wildlife sanctions, green belts, wetlands along the coast, rivers, lakes, mine sites and public parks, including open areas for sustainable development.

Article 33 of the Land Use and Spatial Planning Act 925,2016 reinforces the functions of the DPA as discussed in the Local Government Act 462,1993. Furthermore, article 72 of act 925, adds to the functions of the DPA.

"to prepare a local plan, where that authority intends in respect of an urban or urbanising area to establish legally binding regulations for (a) a land coverage for a construction on a plot in the zone; (b) the type of structure on the land; (c) the form and height of buildings; (d) tree preservation; (e) the preservation of buildings with a cultural heritage and historical structures; and (f) any landscaping or tree planting requirements" (LUSP Act 925, 2016).

The DPA is responsible for safeguarding and preserving the architectural heritage embedded in historical trees and buildings. The District Planning Authority must present the prepared local plan to the district spatial planning committee for approval, as stated in Article 74 (5). However, vernacular architectural structures have not been identified, defined, and characterised. Once more, the areas with these cultural heritages have not been thoroughly documented regarding their protection, preservation, and conservation.

Ghana Building Code (GhBC) GS1207:2018

The construction industry in Ghana is regulated by the Ghana Building Code (GhBC) GS1207:2018, a comprehensive set of rules and guidelines. According to section 1.3 of the code, the MMMDAs' works department is responsible for enforcing the code, so the GhBC establishes standards and guidelines for building design, construction, and occupancy that guarantee the safety, longevity, and sustainability of buildings throughout the nation.

One of the main goals of the Ghana Building Code is to improve building safety and resilience against various natural disasters and human-made hazards. The GhBC outlines the minimum standards for structural design, materials, and construction techniques to guarantee that buildings remain resilient against various stresses and forces throughout their lifespan.

In addition, the GhBC deals with public health and sanitation concerns by setting guidelines for water supply, drainage, sewage disposal, and sanitation facilities in buildings. The plan covers ventilation, lighting, and occupancy load calculations to guarantee suitable living conditions and minimise health risks related to overcrowding and inadequate indoor air quality. Overall, the Ghana Building Code (GhBC) GS1207:2018 is essential for overseeing and setting standards for building construction and development in Ghana. The GhBC plays a crucial role in establishing standards for building safety, public health, energy efficiency, accessibility, and environmental sustainability. This helps develop resilient, inclusive, and sustainable built environments that enhance the well-being and prosperity of Ghanaian communities.

The Ghana Building Code (GhBC) GS1207:2018 offers a detailed framework for overseeing construction in Ghana, focusing on contemporary building methods and materials. Nevertheless, the code frequently falls short of effectively dealing with the distinct features and building techniques linked to vernacular architectural structures. Architecture in Ghana reflects a rich history of traditional wisdom, utilising materials sourced locally and sustainable design methods to suit the region's climate, culture, and environment. However, the GhBC does not have specific provisions for protecting, preserving, and conserving these heritage structures, leading to a gap in acknowledging and safeguarding vernacular architecture's cultural significance and historical value.

Current Discourse on The State of Vernacular Architecture in Ghana

On a global scale, current literature evaluations on vernacular architecture have shown that their study has slowed down significantly(Benkari et al., 2021; Pardo, 2023). However, it is still very low in several regions, such as Africa, Oceania, and South America(Benkari et al., 2021; Pardo, 2023). Similarly, the preservation of Ghanaian vernacular architecture faces considerable challenges due to rapid urbanisation and modernisation(Anthony & Genevieve, 2014). The rise in urban migration, driven by Western architectural influences, has resulted in disregarding, and abandoning traditional construction methods(Addo, 2016; Oppong & Badu, 2012). Contemporary buildings frequently overshadow vernacular architecture's cultural and sustainable significance (Geest, 2011; Oppong & Badu, 2012; Twumasi-Ampofo et al., 2020b). Achieving a balance between contemporary development and the conservation of conventional architectural forms, methods, and materials is imperative.

Oppong & Badu (2012) further argue that the insufficiency of policies and regulations about safeguarding vernacular architecture in Ghana presents significant obstacles. The absence of established legal frameworks, in conjunction with inadequate comprehension of the significance of conservation, results in the degradation and destruction of conventional structures(Anthony & Genevieve, 2014; Oppong & Badu, 2012; Twumasi-Ampofo et al., 2020b). Developing all-encompassing policies that acknowledge and safeguard Ghana's architectural legacy is imperative.

The study revealed a dearth of documentation and research about vernacular architecture in Ghana. Insufficient resources and attention have been allocated to systematically document and analyse conventional building methods, materials, and design principles(Anthony & Genevieve, 2014; Dumouchelle, 2009). Anthony & Genevieve (2014) further argues that the documentation of comprehensive case studies is crucial for preserving Ghana's architectural heritage, as it enables the capture of its diverse and rich characteristics.

The marginalisation of vernacular architecture can be attributed to a lack of recognition and understanding of its cultural significance(Addo, 2016; Oppong & Badu, 2012; Twumasi-Ampofo et al., 2020b). Contemporary architectural pedagogy and discourse tend to precede Western architectural styles while disregarding the significance of indigenous architectural customs. The absence of recognition sustains the notion that vernacular architecture is obsolete or of lower quality(Anthony & Genevieve, 2014; Appeaning Addo, 2023). The dissemination of knowledge regarding vernacular architecture's cultural and environmental advantages is of utmost importance, particularly among professionals in architecture, urban planning, policymaking, and the wider public(Addo, 2016; Agyekum et al., 2020a).

The vernacular architecture of Ghana displays inherently sustainable characteristics that have the potential to contribute to environmentally conscious design practices(Balaara et al., 2018a). Integrating traditional knowledge and practices with modern innovations is increasingly being discussed to tackle sustainability challenges, such as climate change and resource depletion(Amos-Abanyie et al., 2021; Appeaning Addo, 2023; Oppong & Badu, 2012). Promoting and adopting contemporary design approaches can be enhanced by emphasising the sustainable aspects of vernacular architecture.

Conclusion And Recommendations

The review draws attention to the limited research that has been done on the vernacular definition and characterisation of Ghanaian vernacular architectural studies, mainly documentation, preservation, and policy frameworks and awareness. Through strategically mitigating challenges and promoting sustainable practices, Ghana can effectively ensure the perpetuation of its vernacular architecture.

Findings from the research highlight serious challenges to Ghana's vernacular architecture, emphasizing the urgent need for comprehensive effort to address these concerns. The rapid transformation and modernization of Ghana's vernacular architecture represent a severe threat to cultural heritage preservation(Dery & Assasie Oppong, 2014; Oppong & Badu, 2012; Twumasi-Ampofo & Oppong, 2016). As traditional structures are replaced by contemporary structures, unique architectural styles and techniques may be lost forever. Moreover, Anthony & Genevieve's (2014) and Addo's (2016) findings suggest that a deliberate approach is necessary to ensure the sustainability of earth-constructed dwellings. Failure to do so may result in the complete obsolescence of this technology, potentially disrupting the cultural norms and customs of affected populations(Anthony & Genevieve, 2014). The trend not only ruins tangible elements of Ghana's cultural identity, but it also undermines the connections between communities and their built environment.

Furthermore, a lack of effective documentation and preservation initiatives increases the fragility of vernacular architecture(Anthony & Genevieve, 2014; Dery & Oppong, 2014). Without comprehensive records and documentation, policymakers lack the information they need to formulate educated policies for preserving and incorporating vernacular architecture into modern development plans. As consequently, there is an urgent need for coordinated efforts to document and preserve extant vernacular structures, ensuring that their historical and cultural significance are acknowledged and safeguarded for future generations.

The study also sheds light on the fragmented relationship between policy frameworks and city planning, which exacerbates the issues that vernacular architectural structures face(Addo, 2023; Agyekum et al., 2020c; Dery & Oppong, 2014). Poorly coordinated policies overlook the importance of vernacular buildings in urban landscapes, resulting in their marginalisation and neglect in development schemes. To overcome this issue, policymakers must prioritize the integration of vernacular architecture into urban planning procedures, recognizing its significance in defining Ghanaian communities' cultural fabric and identity.

Furthermore, the topic of whether Ghanaian vernacular architecture exists is addressed due to a lack of theoretical frameworks for its identification, definition, and characterisation in academic publications. Without a firm theoretical framework, efforts to maintain and promote vernacular architecture are hampered, making it subject to further degradation and loss. As a result, it is critical that researchers do extensive research to develop theoretical frameworks that validate the importance of Ghanaian vernacular architecture and guide future conservation efforts.

In conclusion, assessing the current state of vernacular architecture in Ghana brings to the fore the regional distinctions and transformations, cultural significance, and challenges of preservation and conservation. Consequently, the present study advocates for the urgent need for further research to tackle the definition and characterisation of Ghanaian vernacular architecture in addressing the following concerns: awareness and appreciation of vernacular architecture, policy interventions and advocacy, documentation, and research to preserve Ghana's vernacular architectural legacy.

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Adoption of Sustainable Construction Practices: The Institutional Theory Perspective

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Abstract

In the achievement of the Sustainable Development Goals (SDGs), it is important to consider the contribution of the construction industry. Due to the massive impact of the construction industry on sustainable development, numerous studies have focused on sustainable practices within the industry. Studies on the adoption of sustainable construction practices tend to focus on awareness, barriers, and drivers. This study proposes institutional theory as a basis to influence construction firms to adopt sustainable construction practices. The study evaluated the impact of coercive, normative, and mimetic institutional pressures on the adoption of sustainable construction practices in Ghana. The study adopted a quantitative research method using data from 103 survey questionnaires and analyzed with PLS-SEM. The findings of the study showed the criticality of coercive and mimetic institutional pressures to the adoption of sustainable construction practices. The outcome of this study provides empirical evidence on institutional theory as critical to the adoption of sustainable construction practices. This outcome provides a much more proactive approach to dealing with sustainability issues within the Ghanaian construction industry.

Keywords: Institutional theory, Sustainable construction practices, Ghana.

Introduction

In 2015, members of the United Nations (UN) unanimously agreed to commit to the achievement of Sustainable Development Goals (SDGs) by 2030 (United Nations (UN), 2015). The SDGs aim to achieve economic, social, and environmental sustainability with universal coverage. In the achievement of the SDGs, it is important to consider the contribution of the construction industry. According to Durdyev and Ismail (2017), the construction industry makes a very significant contribution to sustainable development by achieving basic objectives of development. For instance, with regard to economic sustainability, the construction industry creates employment for the general populace. A trend analysis of the construction industry's contribution to GDP showed a rise from 3.4% in 1962 to 11.10% in 2015

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(Makoye et al., 2022). It was also evident in the Ghana Statistical Report (2019), which indicated that the construction industry contributed 7.1% to the Gross Domestic Product (GDP) of Ghana. The Ghanaian construction industry has experienced a steady growth from 26.6% in 2014 to 26.9% in 2015. Concerning social sustainability, the construction industry aids in satisfying basic social needs like the provision of infrastructure and the provision of accommodation (Durdyev and Ismail, 2017). For environmental sustainability, the detrimental effect of the sector on the environment due to CO2 emissions, solid waste production, raw materials consumption and water pollution cannot be overlooked (Serpell et al., 2013, Energy Information Administration (EIA). 2012).

Due to the massive impact of the construction industry on sustainable development, numerous studies have focused on sustainable practices within the industry which has led to the development and incorporation of numerous concepts within the construction industry. This includes business ethics (e.g., Frederiksen, 2010; Hemingway and Maclagan, 2004), strategic management (e.g., Orlitzky et al., 2011), stakeholder management (Parmar et al., 2010), and political theory (e.g., Scherer and Palazzo, 2011; Scherer et al., 2014). Nevertheless, studies have shown that the status of sustainable construction in developing countries is not promising (Durdyv et al., 2018). It has been observed that most companies develop reactive strategies towards sustainability and regularly use their sustainability strategy/policy as window dressing or greenwashing (Banerjee, 2008; van Tulder and van der Zwart, 2006).

This study proposes institutional theory as an approach to influence construction firms in improving their sustainability efforts. Institutional theory postulates that legitimacy is the basis for the survival and development of an organization (Meyer and Rowan, 1977). The organization's cognition of legitimacy creates institutional pressure, thereby affecting organizational behaviour (Suchman, 1995). From the perspective of institutional theory, socially responsible behaviour is an important measure for organizations to gain legitimacy (Martinez et al., 2016; Campbell, 2007). According to Zhu and Sarkis (2007), managers make decisions under pressure from external stakeholders. This is referred to as institutional pressure. DiMaggio and Powell (1993) indicated three (3) main sources of institutional pressures based on institutional theory. They included coercive pressure, normative pressure, and mimetic pressure. According to Zhu and Sarkis (2007), all institutional pressures (normative, coercive, and mimetic) have the capacity to influence the improvement of the sustainability efforts of construction firms. However, there is little evidence of the effect of institutional pressures on sustainable construction practices adoption. Studies on sustainable construction practices tend to focus on awareness (Durdyev et al., 2018), drivers (Pitt et al.,2009; Lam et al., 2010; Darko et al., 2017) barriers (Ahn et al., 2013; Serpell et al., 2013; Pham et al. 2020) among others. This study seeks to fill this gap by exploring the effect of institutional pressures towards the adoption of sustainable construction practices in Ghana.

Literature Review

This section focuses on the review of pertinent literature on sustainable construction and institutional theory. This led to the development of a conceptual framework for study.

Sustainable construction

Sustainable construction ensures that all construction activities are executed sustainably, from the initial phases to project completion. This involves making considerations for economic, social, and environmental factors (Ismail et al., 2017). Sustainable construction adopts a holistic process to restore the balance between the natural and the built environment. Abd Jamil and Fathi (2016), indicated that sustainable construction must be able to improve environmental objectives while achieving social and economic goals. Hence sustainable construction must focus on the reduction in building energy use during and after the construction process and throughout the life of the facility (Ismail et al., 2017).

Sustainable practices within the construction industry must take into account safety, efficiency, productivity, and waste minimization (Koranda et al., 2012). It must also include the ecological, social and economic factors of construction projects. The concept of sustainable construction has evolved over the years moving from issues related to inadequate resources and energy to more technical issues like materials, building components, construction technologies and energy-related design concepts (Balasubramanian and Shukla, 2017).

The implementation of sustainable construction requires effective actions as well as commitment from all stakeholders including government, service providers and the community as users. The requirements for implementing sustainable construction highlight the importance of budget allocation for education and training, a holistic approach to project management methodology and technology, all of which are supported by the interrelated roles and responsibilities of construction project stakeholders, to strongly ensure that construction projects are built based on sustainability principles. Nevertheless, given the requirements to attain sustainable construction, the implementation process can be a problematic one as it requires; innovation and technology enhancement (Shurrab et al., 2019); waste management strategy and practice (Djokoto et al., 2014); commitment to new ways of working, thinking and learning (Sfakianaki, 2015); holistic application of sustainable practices (Koranda et al., 2012); regulation for all green practices monitored for compliance (Shurrab et al., 2019); mitigation of water wastage (Waidysekaraa et al., 2017) and training and investment in resource-efficient building practices (Sfakianaki, 2015).

Institutional theory

According to Scott (1995), managers make decisions under pressure from external stakeholders. This is referred to as institutional pressure. DiMaggio and Powell (1993) indicated three (3) main sources of institutional pressures based on the institutional theory. They included coercive pressure, normative pressure, and mimetic pressure. A summary of the salient differences between the sources of institutional pressures is shown in Table 1.

Coercive pressures

According to Roxas and Coetzer, (2012), coercive pressures are generated by governmental and non-governmental agencies to force organizations the adhere to regulations and standards. Coercive pressures are exerted by those with power. For instance, government agencies are groups that have the power to affect the practices of an organization (Rivera, 2004). This form of pressure is felt by firms that face expectations socially or culturally. This is because organizations operate within a society, hence, there the existence of both formal and informal pressures felt from regulatory standards and other governmental agencies (DiMaggio and Powell, 1993). According to Rivera (2004), government agencies are perfect examples of how powerful groups may affect the processes within an organization. Coercive pressures are based on multifactor difficulties like internal behaviours (Roxas and Coetzer, 2012). Berrone et al. (2013), indicated that, for developing countries, coercive pressures may originate from international buyers like the European Union, and professional associations among others.

Normative pressures

Normative pressures occur because of organizations with the quest to be perceived as legitimate. Traditionally, these pressures happen because of external stakeholders with an interest in the processes of the organization. According to Dimaggio and Powell (1993), normative pressures happen because of the practice conducts and guidelines that presume that firms operate based on established conventions. Zhu and Sarkis (2005), indicated that normative pressure is basically shown by customers. Firms are expected to abide by norms and standards established for their processes. Normative pressures occur because of the need to abide by established guidelines that are aligned with the conventions of formal education and the professional community (DiMaggio and Powell, 1993). Due to social legitimacy, each firm is expected to consider or follow the standards, norms, and expectations of its external stakeholders. In general cases, demand from customers shapes a core normative pressure (Zhu and Sarkis, 2007).

Mimetic pressures

Mimetic pressures are the form of pressures that are felt as a result of organizations copying the actions of successful competitors within the industry they operate. Thus, some organizations copy their competitors based on their success in executing their daily activities. This can be termed as benchmarking. Thus, follow a successful competitor and become successful. Mimetic pressures are focused on modelling strategies of other successful organizations to avoid risk and secure legitimacy. According to DiMaggio and Powell (1983), organizations that are faced with mimetic pressures follow a management system that is set by leading organizations. According to Zucker (1987), mimetic pressures have a high probability of occurrence within a highly competitive and uncertain business environment.

Table 1: Summary of sources of institutional pressures

Coercive	Normative	Mimetic
Regulative	Norms	Cognitive
Rules laws and sanctions	Certification/Accreditation	Prevalence Isomorphism
Legally Sanctioned	Morally governed	Culturally supported

Source: Pishdad et al., (2012)

Hypothesis development and conceptual framework

This section focuses on reviewing the underpinnings for the proposed hypothesis leading to the establishment of a conceptual framework for the study.

Coercive institutional pressures and sustainable construction practices

Esfahbodi et al. (2017), indicated that most firms' adoption of sustainable practices is forced by government regulations. In most situations, organizations are subject to mandatory regulations from government laws and administrative documents and international regulations such as the Human Rights and International Labor Organization Convention Statement (Johnson et al., 2006). To avoid penalties for poor compliance with such regulations firms initiate sustainable practices. In this sense, governance pressure is the main driver for the adoption of sustainable practices (Esfahbodi et al., 2017). Dai et al. (2021), studied sustainable supply chain management and how it is affected by coercive pressures. Based on an empirical analysis of 172 Chinese firms, the study showed that coercive pressures in the form of governance pressures have a positive effect on the implementation of sustainable practices. In another study conducted by Kauppi and Hannibal (2017), on institutional pressures and sustainability. Interviews were conducted with senior managers and other publicly available secondary material were employed to show that, coercive pressures significantly affect the implementation of social sustainability. Masocha and Fatoki (2018) studied the effect of coercive pressures on sustainable practices in small businesses in South Africa. The study employed a survey approach where 222 self-administered questionnaires were used to collect data from SME owners and managers. Using a structural equation modelling approach, the study showed that, coercive pressures have a significant impact on all the dimensions of sustainable practices. With the lack of evidence of the impact of coercive institutional pressures on the adoption of sustainable construction, it is hypothesized that;

H1: Coercive institutional pressures have a positive impact on the implementation of sustainable construction practices.

Normative institutional pressures and sustainable construction practices

With increasing social awareness of environmental and social responsibilities, firms are usually required by end consumers to produce and deliver their products and/or services in an environmentally friendly and socially responsible manner, and thus they also require their suppliers to conduct business in this manner. As a result, customer requirements impose normative pressure to abide by environmental protection and social responsibility standards (Wu et al., 2012). Thus, customer pressure pushes firms to adopt environmentally friendly and socially responsible management practices (Gualandris and Kalchschmidt, 2014) to improve their environmental and social performance (Ates et al., 2012). Dai et al. (2021), studied sustainable supply chain management and how it is affected by coercive pressures. Based on an empirical analysis of 172 Chinese firms, the study showed that normative pressures have a positive effect on the implementation of sustainable practices. In another study conducted by Kauppi and Hannibal (2017), on institutional pressures and sustainability. Interviews were conducted with senior managers and other publicly available secondary materials were employed to show that, normative pressures significantly affect the implementation of social sustainability. Zeng et al. (2017), studied sustainable supply chain practices based on institutional pressures. Data was collected from 363 firms in China to show that normative pressures are positively and significantly related to the implementation of sustainable practices in the supply chain. In assessing environmental management accounting adoption, Latif et al. (2020), explored coercive, normative and mimetic pressures. Data was collected from the manufacturing sector in Pakistan using a questionnaire survey and it concluded that normative pressures have a significant and positive impact on the adoption of environmental management accounting. With the lack of evidence of the impact of normative institutional pressures on the adoption of sustainable construction, it is hypothesized that;

H2: Normative institutional pressures have a positive impact on the implementation of sustainable construction practices.

Mimetic institutional pressures and sustainable construction practices

Zeng et al. (2017), acknowledged the infancy of sustainable supply chain management in China, hence, they needed to learn from leading international competitors. Based on that, the Chinese firms were able to mimic successful international firms in sustainable practices (Zhu et al., 2013). Hence, Mani et al. (2015), indicated that competition exerts mimetic pressures from successful competitors in the implementation of sustainable practices. Dai et al. (2021), studied sustainable supply chain management and how it is affected by coercive pressures. Based on an empirical analysis of 172 Chinese firms, the study showed that mimetic pressures have a positive effect on the implementation of sustainable practices. Zeng et al. (2017), studied sustainable supply chain practices based on institutional pressures. Data was collected from 363 firms in China to show that mimetic pressures are positively and significantly related to the implementation of sustainable practices in the supply chain. In assessing environmental management accounting adoption, Latif et al. (2020), explored coercive, normative and mimetic pressures. Data was collected from the manufacturing sector in Pakistan using a questionnaire survey and it concluded that mimetic pressures have a significant and positive impact on the adoption of environmental management accounting. With the lack of evidence of the impact of mimetic institutional pressures on the adoption of sustainable construction, it is hypothesized that;

H3: Mimetic institutional pressures have a positive impact on the implementation of sustainable construction practices.

The conceptual framework as shown in Figure 1 shows the hypothesized relationship between the three institutional pressures and the implementation of sustainable construction practices. The institutional pressures comprised of coercive, coercive pressures, normative pressures and mimetic pressures.

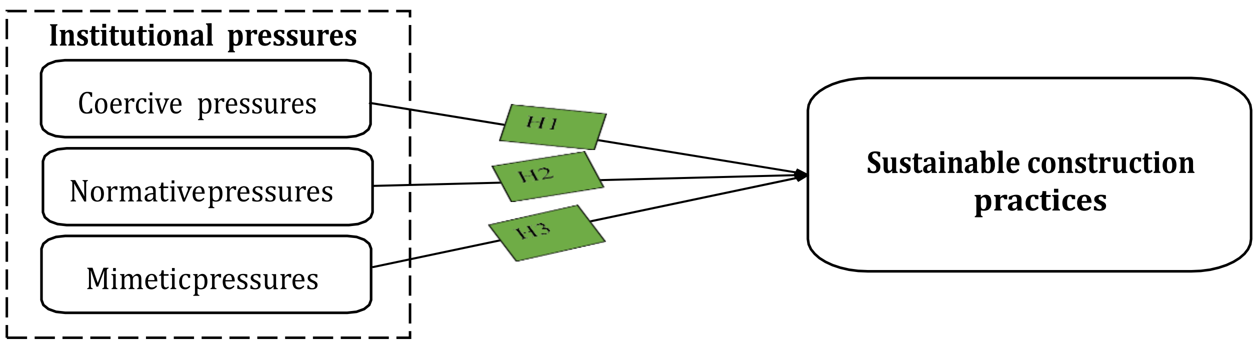

Figure 1: Conceptual framework

Source: Author's construct, (2023)

Research Methodology

Based on the literature review and conceptual framework a structured questionnaire was developed which consisted of two sections. The first section focused on the demographic variables including academic qualifications, years of experience and category of the construction firm. Section two focused on statements on institutional pressures and sustainable construction practice where participants' perceptions were rated on a5-point Likert scale that ranges from "*1 = Strongly disagree to 5 = Strongly agree*"

The questionnaire survey was conducted in Ghana among registered construction firms. A total of 223 questionnaires were distributed and 103 valid questionnaires were retrieved. The respondents had a good educational background as 45% had BSc qualifications and 50% had postgraduate qualifications. Only 5% of the respondents indicated HND. In terms of their professional experience, 29% had 1–5 years of experience, 43% had 6–10 years of experience, 19% had 11–15 years of experience, and 9% had 16–20 years of experience.

The data collected was analyzed with PLS-SEM. The choice of this tool was based on the fact it combines both econometric and psychometric views of the statistical modelling; it is preferable in testing the data of complex theoretical models; it supports non-normal data; and it is compatible with relatively small sample size (Hair et al., 2011; Rigdon, 2016; Sarstedt et al., 2016). The discussion of the PLS–SEM results was done following the guidelines and sequence suggested by Hair et al. (2014) and Sarstedt et al. (2016).This involves the evaluation of the measurement model and the evaluation of the structural model.

Results

Descriptive statistics

The descriptive information is summarized in Table 2. The results indicate that the respondents were generally indifferent to the adoption of sustainable construction practices as all mean values were < 3.50. Similarly, the respondents were indifferent to all the measures of institutional pressures as all mean values were < 3.50.

Table 2: Descriptive statistics

Variable type	Factor	Measurement index	Mean
Dependent variable	Sustainable construction practices	We make the most efficient use of construction resources	3.282
		We practice recycle, reuse, and reduce wastage	3.456
		Our construction method focuses on energy efficiency	3.320
		We emphasize the use of renewal energy during construction	3.252
		We focus on reducing the use of hazardous materials	3.485
		We focus on reducing environmental pollution during construction	3.320
		We focus on increasing efficiency and productivity	3.214
		We pay all governmental contributions like taxes	3.291
		We provide products and services that are beneficial to the community	3.252
		We focus on long-term profitability rather than short-term	3.282
		We focus on the health and safety of our workers	3.379
		We consider the social well-being of the community during construction	3.350
		We focus on improving the general education level of our workers	3.350
		We focus on eliminating all forms of discrimination	3.282
		We pay adequate salaries to our workers	3.369
Independent	Coercive	The government establishes sustainable requirements prior to the execution of construction projects	3.466
		Government attaches importance to sustainable performance in construction projects.	3.330
		Government responds quickly to deviations from sustainable expectations in construction projects	3.233
		The government value sustainable performance in the execution of construction projects	3.243
	Normative	The media reports any deviation in sustainable performance in the execution of construction projects	3.301
		The public is keen on ensuring construction projects meet their sustainable expectations	3.485
		Consultants of construction projects are strict on sustainability requirements for construction projects.	3.301
	Mimetic	Firms on construction projects are rewarded for good sustainability performance	3.194
		Peer project participants with good sustainability performance strongly	3.320
		Peer project participants attach great importance to the sustainability	3.146
		Peer project participants have created extra scrutiny due to their sustainability performance in executed construction projects	3.320

Structural equation model analysis

Assessment of measurement model

The assessment of the measurement model is preceded by a check on the factor loadings of the constructs. Based on Hair et al., (2014) recommended factor loading threshold of 0.70, it can be realized from the summary shown in Table 3**.** That, a satisfactory level of individual loadings was achieved. Subsequently, Cronbach alpha values were used to assess the reliability of the constructs. Acceptable levels of Cronbach Alpha values must be greater than 0.700 (DeVellis, 2003) and the results showed a satisfactory level of construct reliability. Additional checks were used in assessing the internal consistency and reliability of the constructs, namely composite reliability and average variance explained (AVE). Based on the threshold recommendation by Hair et al (2016), both composite reliability and AVEs were deemed satisfactory. The final measurement model assessment was done with the Fornell's Larcker criterion which shows the discriminant validity of the constructs. The results (Table 4) showed that the discriminant validity of the measurement model at both indicator and construct levels was sufficient**.**

Table 3: Factor loadings, Cronbach alpha, composite reliability and AVE

Indicators	**Loadings**	**Cronbach's**	**Composite**	**AVE**
Coercive pressures	-	0.941	0.958	0.851
CP1	0.904			
CP2	0.950			
CP3	0.946			
CP4	0.888			
Mimetic pressures	-	0.952	0.965	0.873
MP1	0.918			
MP2	0.932			
MP3	0.942			
MP4	0.946			
Normative pressures	-	0.924	0.952	0.869
NP1	0.916			
NP2	0.944			
NP3	0.936			
Sustainable construction	-	0.972	0.975	0.723
SCPEcS1	0.910			
SCPEcS2	0.872			
SCPEcS3	0.914			
SCPEcS4	0.861			
SCPSoS1	0.859			
SCPSoS2	0.799			
SCPSoS3	0.772			
SCPSoS4	0.887			
SCPSoS5	0.840			
SCPEvS1	0.820			
SCPEvS2	0.814			
SCPEvS3	0.864			
EvS4	0.861			
EvS5	0.828			
EvS6	0.841			

Table 4: Fornell-Larcker criterion

	CP	**MP**	**NP**	**SCP**
CP	0.922			
MP	0.875	0.935		
NP	0.920	0.903	0.932	
SCP	0.911	0.870	0.889	0.850

Source: Field survey, (2022)

Assessment of the structural model

The structural model assessment aids in determining how the data collected supports the hypothesis established. Structural model assessment is done using the coefficient of determination (R^2), path coefficients and significant values. The R-square value represents the predictive accuracy of the model. As shown in ***Table 5*** an R-square value of 0.850 was attained which depicts a substantial level of predictive accuracy (Hair et al., 2014). Thus, 85% of the endogenous latent variable is explained by exogenous latent variables. The path coefficients and significant values were computed using the bootstrapping process at a sample of 5,000 and a confidence level of 95% ($\alpha = 0.05$; two- tailed test). As shown in ***Table 5,*** H1 and H3 were supported whiles H2 was not supported. ***Figure 2*** shows the final model.

Table 5: R-square, Path coefficients and significant levels

Paths	**Path coefficients**	**t-statistics**	**p-values**	**Inference**
H1: CP→SCP	0.553	3.512	0.000	Supported
H2: NP→SCP	0.149	1.126	0.260	Not supported
H3: MP→SCP	0.251	2.074	0.038	Supported
R-square = 0.850				

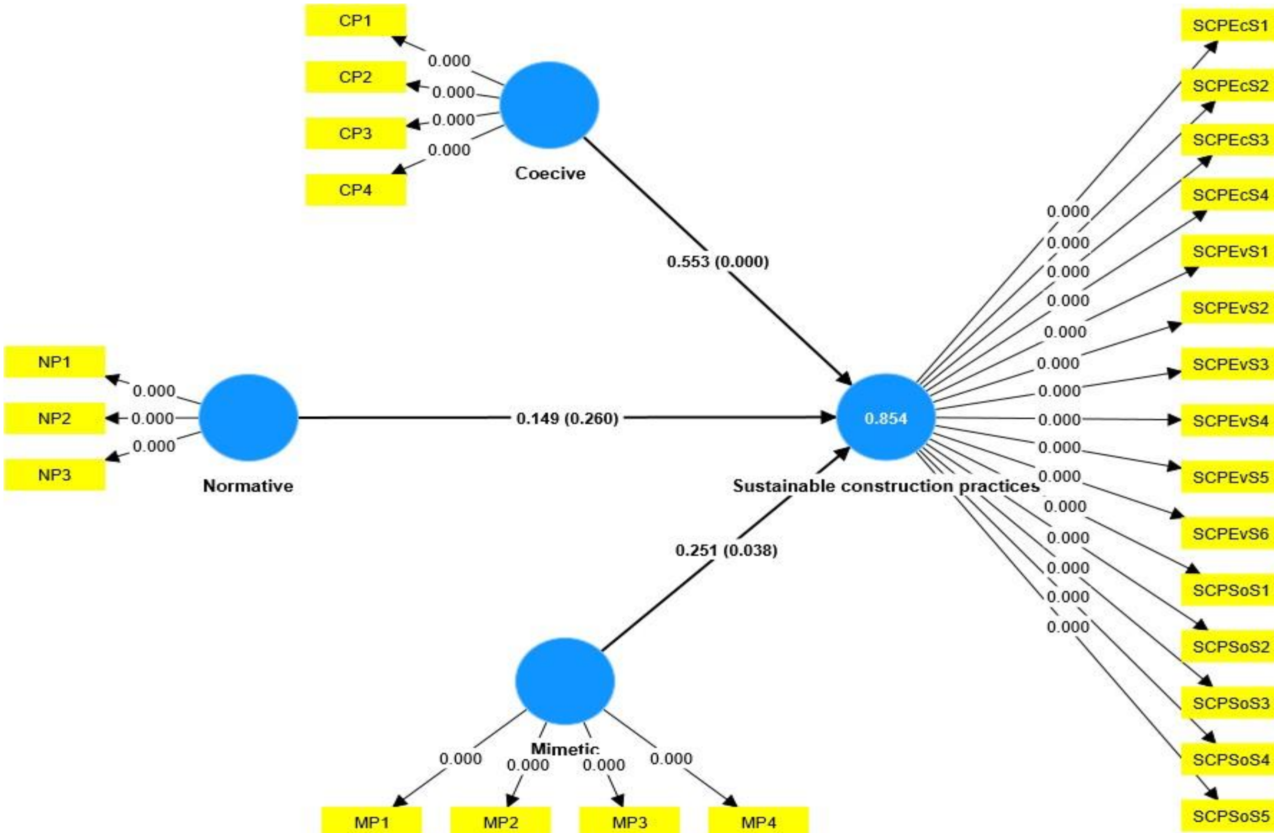

Figure 2: Final model
Source: Field survey, (2022)

Discussion of Results

The results showed that construction professionals were indifferent to the adoption of sustainable construction practices in Ghana. This was evident in extant literature as van Tulder and van der Zwart, (2006) indicated that, most companies develop reactive strategies towards sustainability and regularly use their sustainability strategy/policy as window dressing or greenwashing. Within three years of the adoption of sustainable practices, companies tend to engage in “SDG washing”, i.e., the use of the SDGs as an excuse for malpractice or as a cover-up for modest efforts, emerged (Eccles and Karbassi, 2018; Nieuwenkamp, 2017). This depicts professionals’ indifferent approach to sustainable practices adoption.

Additionally, the study showed that coercive and mimetic pressures positively and significantly affect the adoption of sustainable construction practices while the normative pressures effect was statistically insignificant. Esfahbodi et al. (2017), indicated that most firms’ adoption of sustainable practices is forced by government regulations. Additionally, Dai et al (2021) showed how mimetic pressures affect sustainable development. These were in line with extant literature; however, the normative pressures effect was statistically insignificant. Studies from Dai et al. (2021); Kauppi and Hannibal (2017) and Zeng et al. (2017) have shown how normative pressures positively affect the adoption of sustainable practices in other sectors, however, this was not the case for this study.

The significance of coercive pressures may be attributed to the fact that the government is the largest client in the Ghanaian construction industry. Hence, they have the power to affect the practices of any construction firm including coercing them to adopt sustainable practices. Mimetic pressures were significant as the construction industry is hugely competitive, and firms tend to study their competitors to develop strategies that make them more competitive. Normative pressures occur in situations where organizations seek to be perceived as legitimate (DiMaggio and Powell, 1993; Pishdad et al., 2012). Construction firms, just like any other firm, are concerned about survival which hinges on their ability to win projects. The selection of a construction firm for a project is mostly price-based (Sonmez et al., 2002; PPA Ghana, 2016; Acheamfour et al., 2023). Consequently, perceived legitimacy is based on pricing rather than sustainable practices.

Conclusion

Due to the criticality of the construction industry towards the achievement of SDGs, the sector needs to adopt sustainable practices. However, in most developing countries developing countries, the adoption of sustainable practices is still in its infancy. Hence, the study proposed institutional theory as an approach to influence construction firms in improving their sustainability efforts. The outcome of the study showed how construction professionals were indifferent to the adoption of sustainable construction practices in Ghana. Consequently, exploring the components of institutional theory showed that, coercive and mimetic pressures are crucial to the adoption of sustainable construction practices while normative pressures effect were statistically insignificant. This implies that the adoption of sustainable construction practices in Ghana can be significantly enhanced through the intensification of government policies on sustainable development This will push construction firms to adopt the practices and based on the mimetic aspect of institutional theory, there will be a ripple effect on other competitor firms.

This study has contributed to knowledge by highlighting the peculiarities of the construction industry in terms of institutional theory and the adoption of sustainable practices. Practically, the study has shown the criticality of the government and other regulatory bodies in facilitating the adoption of sustainable practices in the construction industry. Thus, government regulations can aid in creating a more proactive approach to dealing with sustainability issues within the Ghanaian construction industry. This study has shown the effect of institutional pressures towards the adoption of sustainable construction practices in Ghana. However, based on the contingency theory, other contingent factors can further boost the effect of institutional pressures. Hence, further studies can explore the moderating role of dynamic capabilities in the relationship between institutional pressures and the adoption of sustainable construction practices.

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Determinants of Environmental, Health and Safety (EHS) in the Construction Industry

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Abstract

Despite the societal and economic significance, the construction industry is notably recognised as a global contributor to occupational injuries. Environmental, health and safety (EHS) has become a fundamental and strategic element for business operations of industries. Yet, the construction industry continually faces challenges regarding EHS practices. Managing and implementing effective EHS strategies enables organisations to achieve their business objectives and increase productivity. While the field of occupational health and safety (OHS) has gained significant traction in the industry, there has been a lack of focus on effectively managing the environmental, safety, and health implications on the construction workforce and its activities. This study aims to determine the EHS components in the construction industry. A comprehensive literature review was conducted using Scopus and Google Scholar databases. The study findings identified components of each aspect. Environmental factors include waste management, noise, air emissions and ambient air quality, water management, energy conservation, and land management. Major health factors identified include physical, psychological, biological, chemical, ergonomics and psychosocial factors. In contrast, major safety components identified include safety climate, safety perceptions, safety behaviours, management strategies and physically unsafe conditions. The study outcome will enhance the study of critical factors influencing EHS on construction sites in future research.

Keywords: Environmental, health and safety (EHS), Factors, Construction industry

Introduction

Notwithstanding its considerable social and economic importance for a country's economy, the construction industry has regrettably attained the unenviable status of one of the leading causes of work-related injuries and illnesses, accounting for at least 30% of such incidents worldwide (Asah-

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Kissiedu et al., 2020). Industry associations, researchers, construction clients, and other major stakeholders have expressed great concern and significant efforts to improve the construction industry's health and safety performance (Khoza and Haupt, 2021), but it continues to face challenges in terms of environmental, health, and safety (EHS) risks and other risk factors (Soltanzadeh et al., 2022). In recent years, occupational health and safety concerns have become more important as a measure of success in building projects, alongside time, cost, and quality considerations (Ngacho and Das, 2016; Alzahrani and Emsley, 2013; Mahmoudi et al., 2014). The health and safety performance of an organisation has a significant impact on numerous other facets, including employee morale, project costs, and productivity (Goggin and Rankin, 2010; Mohamed 1999). Many construction safety issues are directly related to environmental concerns (Kibert and Coble, 1995). Despite significant attempts to tackle EHS issues in construction, the sector continues to be marked by accidents, injuries, deaths, and adverse environmental effects (Asah-Kissiedu et al., 2020).

Sustainability has emerged as a critical component of contemporary development (Hassan, 2012). EHS is crucial for promoting sustainable development in contemporary cultures, particularly in work environments prone to frequent accidents and risks (Akpeli, 2019). It ensures that workplaces are free from injuries and incidents for all workers, visitors, and contractors, while also improving the well-being of these individuals and local communities. A scarcity of Environmental Health and Safety (EHS) practices results in a lack of sustainability in the construction industry. In many developed and developing nations, building a proper platform for risk management and minimising events has become a national priority due to the extreme damage caused by construction projects (Seker and Zavadskas, 2017; Yang et al., 2019). Thibaud et al. (2018) categorise the construction industry as a high-risk EHS sector because of its constantly changing work environment involving process, labour, and equipment management. This industry is often marked by insufficient or unreliable data, significant safety risks, and complex and diverse processes. Certainly, there is an urgent need to improve EHS management in the construction industry (Asah-Kissiedu et al., 2020).

Although much attention has been given to occupational health and safety in the construction sector, EHS and its impact is still unpopular within the industry (Hassan, 2012; Saranga and Rajini, 2013). Nonetheless, identifying EHS components and their effect on organisational operations and workers helps to take preventive measure and minimise the negative effects. This is particularly crucial for the construction sector, where a significant number of EHS concerns are prevalent. Although necessary, research focusing on the EHS factors in the construction sector is scarce. As a result, the objective of this paper is to identify EHS components in the construction industry through literature review. The next section presents a brief review on the concept and existing literature on EHS. Subsequently, the research method and findings are presented which are followed by the discussions and conclusion.

Concept of EHS

In the early 20th century in industrialised nations, occupational health and safety primarily focused on protecting workers from health and safety threats. Engineering control and protection devices were prioritised. Nonetheless, as community concerns regarding the elimination of hazardous chemical emissions and exposure grew, so did public participation in environmental management and consciousness. Therefore, as individuals recognised the connection between occupational health and safety, working conditions, and environmental challenges, special emphasis was placed on Environmental Health and Safety (EHS) management in the workplace (Stellmen, 1998).

Today, Environmental health and safety (EHS) is a crucial and strategic component of business operations across all industries (Rampuri, 2020). Environmental Health and Safety (EHS) is a discipline focused on the practical implementation of measures to preserve the environment and ensure safety in the workplace. It refers to the actions organisations need to take to ensure that their operations do not harm anyone (Thibaud et al., 2018). EHS focuses on safeguarding the well-being of employees in their specific work environment (Shamsuddin et al., 2015). Ensuring a secure work environment is crucial for environmental safety. EHS collaboratively enhance the health and safety of occupants while managing environmental concerns. Companies worldwide use the word interchangeably with occupational health and safety (OHS) (Sharma and Mishra, 2021). The EHS dimension of industries is closely linked to business (Rampuri, 2020). The morale of stakeholders, productivity among employees, and organisational performance are directly affected by it (Saranga and Rajini, 2013).

The World Health Organisation (2013) defines environmental health as the physical, chemical, and biological components of human health and illnesses influenced by environmental causes. It pertains to the theory and application of evaluating and managing elements in the environment that may impact human health. Companies that consider environmental protection, occupational health and safety at work as important as providing quality products usually have managers and departments responsible for these issues. They are called environmental, health and safety (EHS) departments, also SHE or HSE departments (Manivannan et al., 2014). The EHS department is responsible for the development, implementation, management, and monitoring of EHS management system, policies and programs (George, 2008).

Literature Review

Globally, the performance of occupational health and safety (OHS) as well as environmental management is deemed poor. This is evident in Health and Safety Executive (2021) and ILO (2018) which indicate a disproportionality in accident rate in comparison with the workforce and other industries. Other previous studies such as Shen and Tam (2002), Asah-Kissiedu et al. (2021) and Opoku (2019) have also stated the contribution of construction activities to environmental pollution in terms of air, water, noise, traffic, landscape, energy, waste, etc. Hence Uher (1999) posited that construction activities, including off-site, onsite, and operational activities, exert a substantial influence on the environment. The construction industry is continually faced with challenges in terms of environmental health and safety risk factors other risk factors (Soltanzadeh et al., 2022). Therefore, Rowlinson and Jia (2015), and Kim et al. (2019) mentioned the various risk factors in construction to include personal risks, environmental risk (unsafe conditions), occupational risks, unsafe acts, and managerial/ organisational factors. In a case study, Peckitt and Stephen (2005) also suggested that the limitations in EHS management of construction projects usually caused by several factors such as Crown immunity, focus on cost and time, traditional procurement practices, and political influence to deliver project on time. Previous studies also report on the EHS practices implemented on construction sites; green construction; lean construction, sustainable construction, safety training, accident reporting, risk assessment, proper use of PPEs and clothing, provision and execution of EHS management plans, inspections, audits, permit to work, toolbox talks, etc. (Hassan, 2012; Windapo and Jegede, 2013; Umeokafor, 2015; Vyas and Jha, 2016; Zang et al., 2022; Samsudin et al., 2022). Due to the severity of losses and damages caused by construction projects, most nations have made the establishment of a suitable risk management process a national priority to reduce accidents (Sousa et al., 2014). In EHS management, Peckitt and Coppin (2005) indicated that the design process for construction can be enhanced by placing greater emphasis on EHS risk assessment, sharing best practises, standardisation, and waste reduction. Moreover, Kibert and Coble (1995) suggested the integration of construction safety and environmental regulations such that some EPA and OSHA functions will enhance efficiency while minimising conflicting guidance from agencies as well as improving the quality of workers' safety and environmental protection. The integration of these functions would need management systems (MS) in various firms for effective implementation (Koehn and Datta, 2003). Hence the systematic approach developed to handle EHS issues for projects is documented in EHSMS (Vandermolen and Cella, 1999; Remmen et al., 2005) which follow specific standards, ISO 14001 and OHSAS 18001 (Pheng and

Kwang, 2005; Zeng et al.,2010; Manivannan et al., 2014). Asah-Kissiedu et al. (2021) asserted the need for organisational capability for effective EHSMS implementation in construction firms in terms of strategy, process, people, resources and information. Using the Modified Waterfall Model with IT experts, Leyesa et al. (2022) developed a decision support system in EHS to aid the implementation of effective integrated management system regarding the easier storage, retrieval, and update of pertinent documents whereas Gangolells et al. (2013) developed a model which focused on the sub-systems for on-site environmental impacts and health and safety risks to enhance MS in construction firms.

Research Methodology

A comprehensive review of literature related to EHS in the construction industry and construction project was conducted. This was initiated by a search for publication where Scopus and Google scholar were the main databases. The keywords were "Environmental", AND "Health" AND "Safety", "EHS OR SHE OR HSE" risks" AND "Construction industry" OR "construction projects" OR "sites". New keywords were used since EHS is usually used interchangeably with OHS. The review was used to identify the various components that are covered under each aspect of EHS. This also involved the identification of the potential EHS risks and their causal factors in construction. The identification of the risks is required to ensure the inclusion of all components. Therefore, environmental components, health components, and safety components were identified with the literature sources as indicated in Table 1.

Findings

The findings of the study revealed that all the aspects of EHS (i.e. environment, health and safety) have components needed to resolve or respond to the potential risks attached to the components. Specific to the construction industry and its operations, environmental components include waste management, noise control, air emissions and ambient air quality energy conservation, water management, and land management. There were six (6) health components and five (5) major safety components identified from literature.

Table 5: EHS Components and Potential Risks

<table>
<tr><th colspan="2">EHS Components</th><th>Potential EHS Risk</th><th>Causal factors</th><th>Author</th></tr>
<tr><td rowspan="5">Environmental components</td><td>Waste management</td><td>Production of solid,</td><td>Demolition, deconstruction activities</td><td rowspan="5">Hassan (2012); Medineckiene et al. (2010) Marzouk et al. (2017); Yusof et al. (2017); Ametepey and Ansah (2014); Manivannan et al. (2014); Soltanzadeh et al. (2022); Ijigah et al. (2013)</td></tr>
<tr><td>Noise control</td><td>Noise pollution</td><td>Noise from vehicle, equipment, plants, workers</td></tr>
<tr><td>Air emissions and ambient air quality</td><td>Air pollution</td><td rowspan="2">Emission from vehicles and plants, dust emissions through transportation of Use of fossil</td></tr>
<tr><td>Energy conservation</td><td>Energy consumption</td></tr>
<tr><td>water management</td><td>Water consumption</td><td>Use of water for construction activities</td></tr>
</table>

	Land management	Damage to land	Use of land, use of natural resources	
Health components	Physical	Musculoskeletal disorders, Fatigue, heat stress	Manual lifting and material handling, repetitive motions, frequent heavy exertions, Workers health, exposure to high temperature	Acharya et al. (2018), Sobeih et al. (2006); Soltanzadeh et al. (2022)
	Psychological	Mental health disorders, harmful substance use,	Job stress, bullying, anxiety, depression	Jia et al. (2016); Acharya et al. (2018); Sun et al. (2022)
	Biological	Exposure to biological hazards	Exposed to bacteria, fungi, viruses, parasites	Jayasekara et al. (2022); Lee et al. (2010);
	Chemical	Skin Problems (Irritation, Contact with Chemicals)	Transportation and hazardous materials such as paints, glues, fuels, solvents, asbestos and dust	Purwayudhaningsari et al. (2023), Hassan (2012); Khan and Gazder (2016);
	Ergonomics	Wrong posture while working, contact stress of muscles and tendon, extreme temperature condition, force and repetition in specific movement	Human-related factors, task-related factors, equipment/tools-related factors	Parida and Ray (2015); Lop et al. (2019); Torghabeh et al. (2013), Acharya et al. (2018); Sun et al. (2022)
	Psychosocial factors	Musculoskeletal disorders, high injury rate	High demands, low control over task, lack of support, job dissatisfaction, perceived aggression	Jia et al. (2016); Acharya et al. (2018); Sobeih et al. (2006); Sun et al. (2022)
Safety components	Safety climate	Lack of communication, safety awareness and conscious of job-related safety and health issues, consciousness of wearing PPEs, enforcement of safety regulations	Low safety conscientiousness of workers	Seker and Zavadskas (2017); Mosly (2019); Han et al. (2021), Gangolells et al. (2013); Segbenya and Yeboah (2022)

	Safety perceptions	Lack of safety culture	Differences in cultural values, background, language	Korkmaz and Park (2018); Andersen et al. (2015)
	Safety behaviours	Wrong working posture and positioning, Refusal to wear PPEs provided	Employees actions/ behaviour	Seker and Zavadskas (2017); Sharma and Mishra (2021); Segbenya and Yeboah (2022)
	Management strategies	Lack of PPEs, safety trainings and regular safety meetings	Lack of safety management	Costa et al. (2021); Seker and Zavadskas (2017); Ghahramani (2016); Sharma and Mishra (2021)
	Physical unsafe conditions	Poor site management	safety equipment of management, lack of education, exposure to high level vibration, record keeping	Seker and Zavadskas (2017), Costa et al. (2021); Sharma and Mishra (2021)

Source: Authors' construct

Discussions of Components of EHS in Construction Industry

Organisations have experienced many benefits of incorporating these environmental and health and safety measures into the workplace.

Environmental components

The environmental component of EHS focuses on establishing a systematic approach to adhering to environmental requirements. Concerns have been increasing over the effects of construction activities on human and environmental health (Ametepey and Ansah, 2014). Construction operations produce a substantial volume of waste and consume enormous amounts of energy, resulting in considerable adverse environmental effects. Pollutant emissions mostly stem from construction and refurbishment activities (Medineckiene et al., 2010). Implementing a well-established waste management strategy results in waste reduction, less use of raw resources, and lower prices. Proactively addressing environmental concerns under the various environmental components helps firms minimise liabilities.

Health Components

Improving health should prioritise creating safe, high-quality, and environmentally friendly procedures and practices to minimise the chance of injury to employees, stakeholders and any other third party. With the nature of construction job which is also considered labour-intensive, the likelihood of encountering risks that affects the workers is high. Issues related to ergonomics, psychosocial challenges, poor physical and mental conditions are usually plagued with construction. Therefore, the health components within EHS must address these challenges or risks to enhance productivity.

Safety Components

In terms of Safety perspective of EHS, it involves creating organized efforts and procedures for identifying workplace hazards and reducing accidents and exposure to harmful situations and substances. It is to ensure an increase in safety performance. According to Manivannan et al. (2014), safety measures are components of a facility that aim to either eliminate hazards or reduce the severity of their consequences or limit their effects. This includes procedures, systems, and devices. Safety measures act as barriers that prevent dangers from leading to significant accidents and causing harm to people, property, and the environment. The construction industry is plagued with several safety risks factors which must be addressed. In order to have a safe construction site with high safety performance levels, safety climate must be the utmost priority of any organization's management team (Mosly, 2019). Safety climate is a practical diagnostic tool, as it can facilitate the recognition problems that might be seen vital to improving safety (Meliá et al., 2008). It also increases the safety awareness of employees and reduces their unsafe actions. To achieve a positive safety culture, it is important that safety culture perceptions among different levels in the organization are aligned (Fung et al., 2005). With the level of diversity among construction workforce (ethnicity, skill, background, race, etc.), there is high risk of variations in the safety perceptions which when addressed will improve safety performance. Top management commitment to safety has been identified as a key strategy which has positive impact on safety performance (Ghahramani, 2016; Seker and Zavadskas, 2017; Mosly, 2019; Sharma and Mishra, 2021).

Conclusion

EHS is crucial for promoting sustainable development in contemporary cultures especially where accidents and dangers occur frequently like the construction industry. It also has a direct impact on morale of stakeholders, employee productivity as well as on organisational performance. In order to administer an EHS properly, there is the need for identification of various components of all aspects of the EHS. Hence, this study aimed to determine the components of EHS specific to the construction industry. The study based on the review of existing literature which revealed 17 major components which include 6 environmental components, 6 health components and 5 safety major components. The findings also highlighted the potential EHS risks and their causal factor. Future can focus on the critical factors influencing EHS on construction sites as well as the challenges to the implementation of EHS. With technological advancement, a further study in the application IT to enhance EHS would be an area of interest.

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A Review of Approaches for Building Energy Performance Certification Research

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Abstract

Energy performance certification (EPC) of buildings has become a research topic of high interest given the global challenges regarding sustainable development in the present century. This study aimed at conducting a systematic literature review of currently employed data collection and analysis methods for EPC research. To achieve this aim, scholarly articles published from 2002 to 2022 were obtained from the Scopus electronic database. Keywords including "energy rating", "energy performance certification", "energy labelling" and "methods" were combined with the Boolean operators "AND"/ "OR" and searched. Subsequently, a filtration process with exclusion criteria was adopted to select a representative sample of relevant publications for the study. These articles were then analysed to gain insights into the various methods employed by previous researchers conducting studies on the EPC of buildings. From the analysis of data collection methods, case study was the predominant technique accounting for 32.84% of publications reviewed. Other noteworthy methods were surveys (17.91%) and literature reviews (16.42%). It was further evinced that the frequently employed data analysis techniques were descriptive statistics, simulation, and multivariate data analysis techniques such as regressions. The leading computer software identified for the simulations were Design Builder, Energy Plus, TAS, and TRNSYS. The key contribution of this research is that it has unearthed the common methodological practices in EPC studies, highlighting their limitations and revealing what methods would be suitable for research towards a proposed EPC scheme for existing office buildings in Ghana, West Africa.

Keywords: Energy performance certification, Literature review, Research methods, Sustainability

Introduction

Most buildings exist for a considerable amount of time and leave indelible footprints on the environment from the time of construction throughout their lifecycles. As such, there is a grave concern for energy reduction despite the ever-increasing need to improve indoor comfort for users (Veselýn & Zeiler, 2014). Consequently, the global quest for sustainability has driven the implementation of several building

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performance certification schemes with one criterion – energy performance – serving as a key indicator of sustainable building how sustainable a building is (Gobbi et al., 2016). A certificate is usually issued to show the performance of several indices including the energy consumption within a building. According to Pérez-Lombard et al. (2009), the concept of building energy certification was borne out of the need for a system to reduce energy use and carbon dioxide (CO_2) emissions. The energy performance evaluation helps in the classification of buildings according to energy usage and can be used as a means to diagnose building energy problems.

Presently, the problems of increased energy demand in buildings due to complexity and high occupancy (Adam et al., 2016; Borgstein et al., 2016) have prompted extensive inquiries into the energy performance certification of buildings. Accordingly, varying approaches have been used in gathering, analysing, and synthesising EPC data worldwide. Prior investigations revealed that researchers depend on more than one data collection strategy in studies relating to the assessment of energy efficiency in buildings (Addy et al., 2014; Borgstein et al., 2016). Additionally, seven main groups of data analysis techniques have been utilized by previous researchers of building energy efficiency (Cristino et al., 2018). Given the global calls for sustainable development in current times, there is no doubt that building energy performance research will continue to be of great interest to researchers.

This review is therefore undertaken with a focus on ascertaining what methodological techniques have been employed for data collection and data analysis in studies related to building energy performance certification within the last two decades. It is aimed at noting similarities and variances of the methods while also examining their limitations. This review would unearth gaps in the literature and inform future research as part of a larger study aimed at implementing a building energy certification scheme for existing office buildings in Ghana, within the sub-Saharan Africa (SSA) region. The scope of this review focuses on methods for evaluating energy performance in buildings. It does not cover explicit discussion on the impact of the methods on the outcomes of studies.

Literature Review

Previous research by Pérez-Lombard et al. (2009) traced the origins and development of EPC schemes through an appraisal of literary sources. This unveiled key concepts including benchmarking tools, energy ratings, and energy labelling as critical to the energy performance certification process. Further reviews on benchmarking and evaluation methods were undertaken by Nikolaou et al. (2011) and Borgstein et al. (2016) to consolidate findings on methodologies for energy certification of buildings. Literature has also been reviewed to summarize the different methods and techniques that have been used to collect and analyze EPC data (c.f. Addy et al., 2014; Martinez-Molina et al., 2016; Cristino et al., 2018). It has been unveiled that the methods adopted could have an impact on the conclusions drawn from the EPC data gathered (Li et al., 2019; Semple & Jenkins, 2019).

This current research proposes an examination of the techniques employed for data gathering and analysis in building energy performance certification research. Such a holistic appraisal would highlight the most extensively used methods, indicating their benefits and limitations. This would enable researchers to be more enlightened on what approaches could successfully help in data acquisition and analysis as well as reveal which methods would be best suited for subsequent evaluation of the energy performance of existing office buildings in Ghana.

Research Method

The method adopted for this research was a systematic literature review. Several researchers including Pérez-Lombard et al. (2009), Nikolaou et al. (2011), Li & Yao (2012), Addy et al. (2014), Borgstein et al. (2016), Cristino et al. (2018), Li et al. (2019), and Semple & Jenkins (2019) have previously relied on

review of literature to gain insights into the methods for various aspects of building energy research. A systematic literature review was used in this paper to present the academic discourse on methods employed in energy performance certification research, subsequently revealing best practices for future studies.
The methodological approach was divided into three phases namely identification of academic publications, screening and choice of target papers, and examination of the selected articles (illustrated in Figure 1).

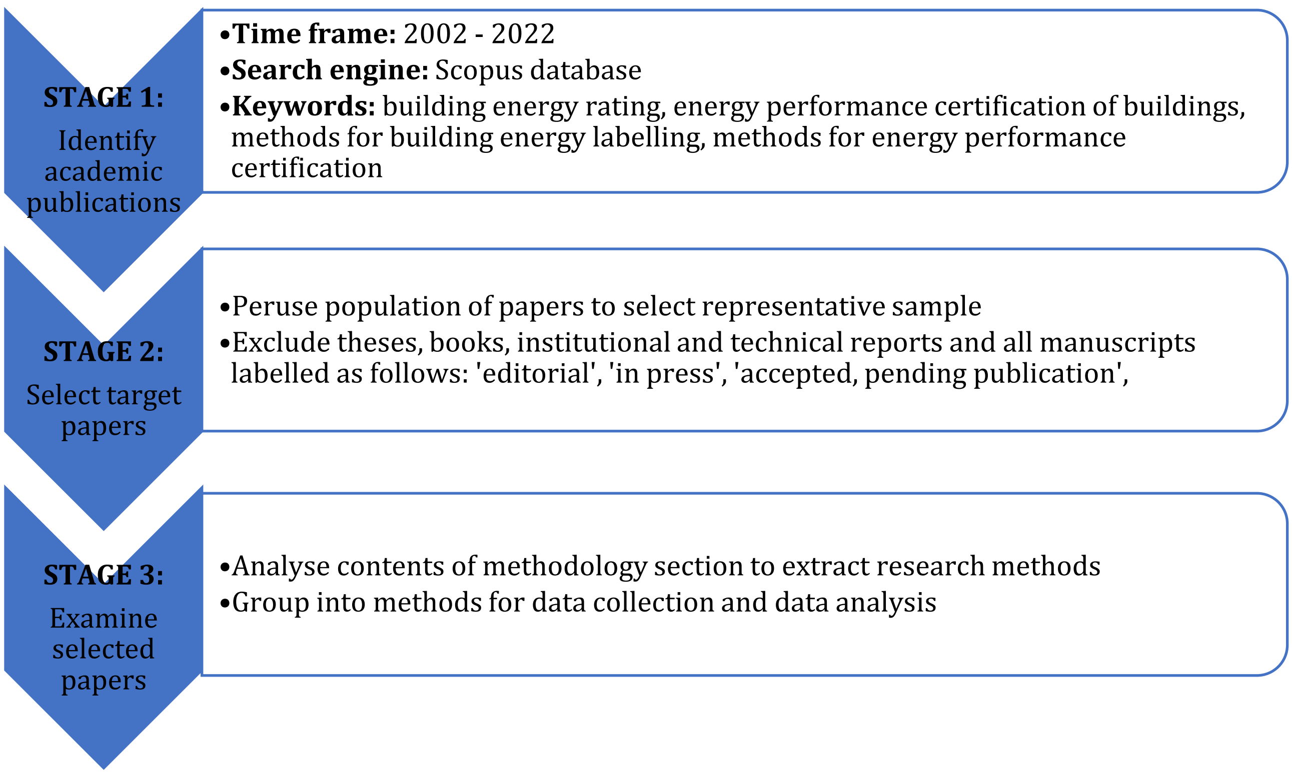

Figure 1: Stages in data collection
Source: Authors' construct (2023)

Identifying Academic Publications

To identify academic publications, a search was carried out in the Scopus database, which is one of the multidisciplinary databases of academic journals. From a scoping review of the literature, certain terminologies were identified which were subsequently used to search the titles, abstracts, and keywords of publications in a string as indicated below:
TITLE-ABS-KEY (("energy performance certificat*" OR "energy efficiency label*" OR "EPC scheme*" OR "energy rating*") AND ("building*") AND ("method*" OR "approach*"))
The initial search, carried out in April 2023, yielded 279 documents published from 2002 to 2022. The rationale for selecting this period was to capture trends in methods for EPC research within the two decades following the European Building Performance Directive (EPBD) of 2002.

Selecting Target Papers

Relying on the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) framework, an inclusion and exclusion procedure was used to source the final material included in the review. This is explained in order of occurrence as follows:

The search was narrowed to papers done between 2002 and 2022. All papers in the English language in the fields of Engineering, Energy, Environmental Science, Arts and Humanities, Social Sciences, and Material Science were considered to have met the search requirements and therefore, identified as part of the initial population. The search resulted in the inclusion of 220 documents while four documents in Spanish and one in Korean were excluded. The selected fields of study were considered as the most relevant areas to source publications on building energy performance and energy efficiency studies as discovered by Cristino et al. (2018). The publication status was limited to published articles. Hence, papers categorised under "editorial", "article in press", and "accepted manuscript" were excluded.

Furthermore, the source type of documents was limited to journal articles and conference papers. Hence, books, theses, book chapters, conference reviews, reports, notes, and all undefined documents were excluded from the search. This reduced the body of literature to 150. Afterwards, manual screening of the titles and abstracts was performed and a final 98 publications comprising 78 journal articles and 20 conference papers were settled on. These were considered as a representative sample for further analyses in this study.

It must be emphasised that a sample of papers was selected since it would not be feasible to examine a complete population of publications on EPC research.

Examining Selected Papers

The methodology section of each selected paper was read to identify the main data collection and analysis techniques respectively. The authors, year of publication, country of origin, and methodologies adopted for each paper were extracted and inputted in Microsoft Office Excel 2013 for visualisation in the form of tables and graphics. The results were presented as descriptive statistics.

Results and Discussion

The examination of the publications on the methods adopted to probe varied aspects of building EPC revealed that many authors had previously employed different techniques. These are discussed subsequently.

Context

Scientific journals

The articles reviewed in this study came from two main sources – journals and conference proceedings. The 78 journal articles considered in the review were sourced from 34 journals as illustrated in Table 1.

Table 1: Journal sources of reviewed articles

S/N	Journal Name	Number of Articles	Percentage of Total (%)
1	Energy & Buildings	23	29.49
2	Energy Policy	10	12.82
3	Energies	4	5.13
4	Renewable & Sustainable Energy Reviews	3	3.85
5	Advances in Building Energy Research	2	2.56
6	Applied Energy	2	2.56
7	Building Research Information	2	2.56
8	Energy Conversion and Management	2	2.56
9	Facilities	2	2.56
10	Journal of Science and Technology	2	2.56
11	Open Journal of Energy Efficiency	2	2.56
12	Sustainability	2	2.56
13	Buildings	1	1.28
14	Ecological Economics	1	1.28
15	Energy	1	1.28
16	Energy Economics	1	1.28
17	Energy Efficiency	1	1.28
18	Energy for Sustainable Development	1	1.28
19	Energy Informatics	1	1.28
20	Energy Reports	1	1.28
21	Energy Sources Part B	1	1.28
22	Frontiers in Engineering and Built Environment	1	1.28
23	Habitat International	1	1.28
24	International Journal of Engineering and Computer Science	1	1.28
25	International Journal of Engineering and Technology	1	1.28
26	International Journal of Energy Sector Management	1	1.28
27	International Journal of Research	1	1.28
28	International Journal of Sustainable Energy	1	1.28
29	Journal of Building Appraisal	1	1.28
30	Journal of European Real Estate	1	1.28
31	Journal of Performance of Constructed Facilities	1	1.28
32	Journal of Real Estate Finance and Economics	1	1.28
33	Structural Survey	1	1.28
34	Sustainable Development	1	1.28
	Total	78	100.00

It was unveiled that Energy & Buildings was the most productive journal having the most publications (23 papers) followed by Energy Policy (10 papers), Energies (4 papers), and Renewable & Sustainable Energy Reviews (3 papers). This wide array of journals portrays the varied interests of researchers and the prevalent scope of publishers. Previous findings such as by Addy et al. (2014) and Cristino et al. (2018) also identified Energy & Buildings as a leading journal with publications related to energy efficiency assessment and energy performance certification of buildings.

Number of publications by country

The three top-most productive continents in the period under review were Europe (57 publications), Asia (28 publications), and Africa (10 publications). This outcome is not surprising as Europe has previously been tagged as a leader in energy performance certification studies (Janda, 2008). However, China was the most productive country with 10 papers.

Data Collection Methods

Different methods can be used when collecting data in energy performance certification studies. They include reviews, surveys, metering and modelling. Illustrated in Figure 2 are the several data collection techniques as identified in this review.

It must be emphasised that due to some papers adopting more than one data collection method, the total shown in Figure 2 (N = 134) exceeds the 98 publications perused. The individual methods are subsequently discussed.

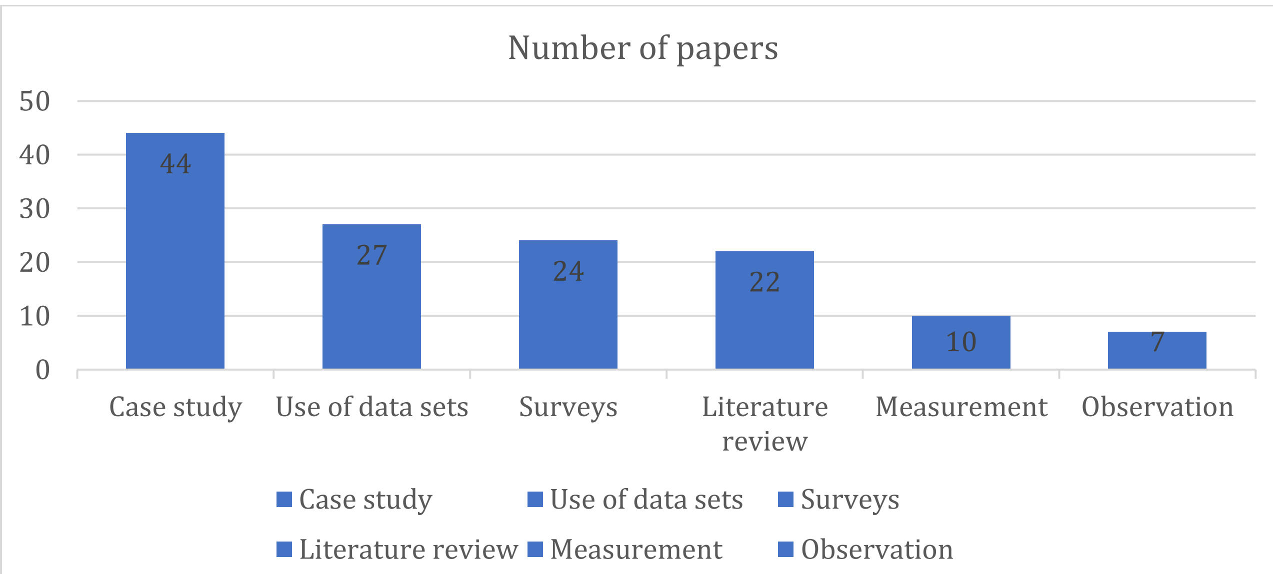

Figure 2: Data collection methods adopted for EPC research work

Source: Authors' construct (2023)

Case Study

The leading primary data collection strategy adopted was case study, used in 44 of the publications reviewed. This particular approach offers the researcher the opportunity for an in-depth and real-life study of an entity and has the advantage of being a rich source of information (Yin, 2013; Gaille, 2018). Thus, most research on EPC had studied particularly selected cases ranging from one building (cf. Baharetha et al. (2021) in Saudi Arabia) to 30,000 buildings (cf. Nikolaou et al. (2009) in Greece). Corroborating the findings by Addy et al. (2014), there was not a single publication which had relied only on the case study strategy to gather data. Instead, it was discovered that all papers using this approach had combined with other methods such as interviews, observation, parametric measurements, and questionnaire surveys to enrich the data gathered from the studied buildings.

Neuman (2014) asserts that the use of a combination of methods enhances the validity of the data gathered.

Some authors utilised the case study in an exploratory manner, coming out with new knowledge after studying selected buildings. Other researchers engaged in constructive research where information from the case studies was used to solve some problems. In some of the publications reviewed, the researchers tested some hypotheses with empirical evidence. Examples of such works are by Čongradac et al. (2012) and Gyimah & Addo-Yobo (2014) who employed dynamic simulation of case study buildings as a means of validating a developed model. In using the case study approach, a researcher is free to explore and access a varied range of information about the selected case building(s). A major disadvantage of using this method is that the results cannot be generalised since the findings may only apply to the studied case building or at most, some buildings with similar features.

Review of Datasets

Upon examination of the selected papers, 27 were discovered to have relied on existing datasets from countries that had implemented EPC schemes as main data sources. This included accessing data from national and regional repositories to retrieve the vital information conveyed about the energy performance of buildings. Researchers including Cohen et al. (2006), Fuerst and McAllister (2011a), Hyland et al. (2013), Brøgger and Wittchen (2016), Olaussen et al. (2017), and Raushan et al. (2022) have applied this method. Using existing datasets saves both time and money. However, similar to literature reviews, this secondary data may have been previously analysed by the one who originally collected it as well as several others.

Literature Review

Although in all the 98 publications analysed there had been a review of pertinent literature before the use of other methods to gather data, in 21 papers, a literature review was the exclusive research strategy. Examples of such works are by Pérez-Lombard et al. (2009), Nikolaou et al. (2011), Veselýn & Zeiler (2014), Martínez-Molina et al. (2016), Harputlugil (2018), Li et al. (2019), dos Reis and Dias (2020), Bortolini et al. (2022) and Olasolo-Alonso et al. (2022).

The literature review method has the advantage of revealing gaps in closely related previous studies to show how much has already been researched in a particular field, thereby helping scholars to investigate topics in detail. Secondly, reviewing existing literature on a subject is a means of establishing the importance of new research and serves as a basis for comparing results in related fields of research through the synthesis of information and drawing of conclusions (Webster and Watson, 2002; Aveyard, 2007; Creswell, 2009). However, it has been argued that when used as a standalone research strategy, reviews do not offer a variety of options for data analyses, thus researchers may end up not critically appraising the prior studies but only describing a compilation of works. Additionally, the reliance on secondary data employed in this methodology results in publications that lack originality as compared to empirical studies which present primary data representing original knowledge. Yet when done objectively without bias, reviews offer answers to a variety of questions leading to the creation of fresh knowledge to enrich a particular field of study.

Surveys

In 24 of the publications reviewed, surveys had been used to gather data. Surveys included questionnaire surveys (used in 18 papers), interviews (Xu et al., 2012; Cozza et al., 2020), building energy audits (Nikolaou et al., 2009; Adam et al., 2016; Al'Qdah et al., 2020), focus group discussions

(Johansson et al., 2016) and thermographic surveys (Šadauskienė et al., 2014; 2016). Surveys are considered the preferred data collection method in studies where human perceptions are needed as it allowed for the participation of a wider range of people including experts in the field.

Researchers who used questionnaires reached their respondents through web-based questionnaires (e.g. Parkinson et al., 2013; Charalambides et al. 2018), via email (e.g. Xu et al. 2012), or by distributing hard copy (paper) questionnaires (e.g. Burke et al., 2005; Hernandez et al., 2008; Kalogirou et al., 2010). Questionnaires are known to have the advantage of revealing first-hand, the experiences and perceptions of users of the spaces. This method explores subjective views about occupant preferences and issues affecting energy consumption in buildings. Nevertheless, this method can be limited when in some instances, respondents may answer superficially and not give correct information especially when they may have forgotten the event they are asked about.

Measurements

This data collection method refers to the use of instruments to empirically determine building characteristics and indoor environmental parameters. Of the papers reviewed, 10 had measured certain parameters of selected case studies including physical dimensions of floor area, sizes of windows, and heights of buildings. Another type of measurement involved the use of sensors to ascertain indoor parameters like temperature, lighting, and relative humidity levels. In EPC studies, it is also common for researchers to install meters or sensors to measure the actual energy consumption of buildings.

The International Energy Agency (IEA, 2020) described the metering methodology as one of the main approaches for end-use data collection. Using this method of data collection ensures accuracy and authors including Hamid et al. (2017), Moujahed et al. (2022) and Seo & Yun (2022) were among those who had done so.

Observation

Data from case study buildings had been obtained via observation in 7 papers such as by Herrando et al. (2016) and Hamid et al. (2017). This qualitative research technique involves systematically selecting, watching, and recording behaviours and characteristics of people, objects, or phenomena. In covert observations, the subjects are not aware of being observed to provide more reliable data from an unpretentious setting. However, it has been argued that since there are no instruments to measure the precision and accuracy of the data, generalisations from observations were deemed not to be reliable. Additionally, the personal bias of the observer could render the results subjective instead of objective.

Data Analysis Techniques

Data analysis plays a crucial role in evaluating energy efficiency measures and identifying patterns and trends in building energy performance research. Analysing the data involves several methods which can provide valuable insights into energy consumption, energy efficiency, and potential areas for improvement. Among the techniques identified in this review are descriptive statistics, regression analysis, simulation modelling, and inferential statistics, buttressing the findings by Cristino et al. (2018).

Similar to the data collection methods, it was evinced that researchers adopted multiple data analysis techniques. Consequently, the total under consideration (N = 150), as depicted in Table 2, surpasses the 98 papers reviewed. These frequently used techniques for data analysis are displayed in Table 2 and discussed afterward.

Table 2: Data analysis techniques adopted for EPC research work

S/N	Data analysis technique	No. of publications	Sources/Authors
1	Descriptive Statistics	39	Bortolini et al. (2022); Ni et al. (2022); Olasolo-Alonso et al. (2022); Alyami & Omer (2021); Baharetha et al. (2021); McCord et al. (2021); Ahern & Norton (2020); Al'Qdah et al. (2020); Droutsa et al. (2020); Jonkutė et al. (2020); Yu et al. (2019); von Platten et al. (2019); Semple & Jenkins (2019); Pasichnyi et al. (2019); Li et al. (2019); Akbarova (2018); Charalambides et al. (2018); Burroughs (2017); Olaussen et al. (2017); Zaid et al. (2017); Abela et al. (2016); Herrando et al. (2016); Johansson et al. (2016); Martínez-Molina et al. (2016); Šadauskienė et al. (2016); Somuncu & Menguc (2016); Kontokosta (2015); Ma et al. (2015); O'Leary et al. (2015); Šadauskienė et al. (2014); Wagner (2014); Martin (2013); Li & Yao (2012); Fuerst & McAllister (2011a; b); Kalogirou et al. (2010); Poel et al. (2007)
2	Content Analysis	28	Bortolini et al. (2022); Moujahed et al. (2022); Olasolo-Alonso et al. (2022); Seo &Yun (2022); Erebor et al.(2021); Cozza et al. (2020); dos Reis & Dias (2020); Li et al. (2019); Pasichnyi et al. (2019); Semple & Jenkins (2019); Adam et al. (2016); Borgstein et al. (2016); Brøgger & Wittchen (2016); Johansson et al. (2016); Ayarkwa et al. (2015); Lee et al. (2015); Yan et al. (2015); Goldstein & Eley (2014); Wagner (2014); Yang et al. (2014); Hertzsch et al. (2012); Li & Yao (2012); Yang et al. (2012); Nikolaou et al. (2011); Perez-Lombard et al. (2009); Campbell (2007)
3	Simulation	23	Moujahed et al. (2022); Ni et al. (2022); Seo & Yun (2022); Alyami & Omer (2021); Baharetha et al. (2021); Clausen et al. (2021); Koranteng et al. (2021); Gonzalez-Caceres & Hempel (2020); Nematchoua et al. (2020); Hamid et al. (2017); Herrando et al. (2016); Johansson et al. (2016); Simons et al. (2015); Martinaitis et al. (2015); Gyimah & Addo-Yobo (2014); Yang et al. (2012); Hertzsch et al. (2012); Koranteng (2010); Koranteng & Abaitey (2009); Nikolaou et al. (2009); Hernandez et al. (2008); Corrado et al. (2007); Burke et al. (2005)
4	Multivariate Data Analysis	22	Lui et al. (2022); Li et al. (2022); Cho et al. (2021); McCord et al. (2021); Jonkutė et al. (2020); Khazal & Sønstebø (2020); Bottero et al. (2019); Olaussen et al. (2019); von Platten et al. (2019); Olaussen

			et al. (2017); Johansson et al. (2016); Jia & Yan (2015); Addy et al. (2014); Cerin et al. (2014); Hyland et al. (2013); Parkinson et al. (2013); Xu & Chan (2013); Fuerst et al. (2012); Fuerst & McAllister (2011a; 2011b); Ballarini & Corrado (2009); Lee & Rajagopalan (2009); Carlo & Lamberts (2008)
5	Inferential Statistics	22	Moujahed et al. (2022); Ni et al. (2022);Raushan et al. (2022); Zhuravchak et al. (2022); Alyami & Omer (2021); Clausen et al. (2021); Koranteng et al. (2021); Al'Qdah et al. (2020); Droutsa et al. (2020); Li et al. (2019); Pasichnyi et al. (2019); Yu et al. (2019); Harputlugil (2018); Burroughs (2017); Hamid et al. (2017); Wong & Krüger (2017); Zaid et al. (2017); Lopes et al. (2016); Martinaitis et al. (2015); O'Leary et al. (2015); Pagliaro et al. (2015); Goldstein & Eley (2014); Parkinson et al. (2013); Xu et al. (2012); Yang et al. (2012); Panayioutou et al. (2010); Kalogirou et al. (2010); Ballarini & Corrado (2009); Burke et al. (2005)
6	Stochastic Processes	11	Li et al. (2022); Moujahed et al. (2022); Hamid et al. (2017); Kontokosta (2015); Tu (2015); Martin (2013); Xu & Chan (2013); Ahmad et al. (2012); Ballarini & Corrado (2009); Lee & Rajagopalan (2009); Burke et al. (2005)
7	Computational Intelligence	5	Liu et al. (2022); Popa et al. (2022); Seo and Yun (2022); Clausen et al. (2021); Xu et al. (2012)
	Total	150	

Descriptive Statistics

From the findings, it was discovered that in majority of the publications, the data had been summarised and described. These statistics provide a clear and concise representation of the data, allowing researchers to gain insights into the energy performance of buildings. Among the descriptive statistics used were frequency distributions, measures of central tendency, and measures of dispersion. This analysis technique helps researchers to summarise large amounts of data into meaningful and concise measures for easy interpretation and understanding. Additionally, the use of this technique facilitates comparison of energy performance across different buildings or time periods, thus helping to establish meaningful benchmarks and tracking energy consumption over time.

However, it is proposed that descriptive statistics should be complemented with other statistical techniques to accurately reflect the true energy performance of buildings since the data could be influenced by biases from the sample or measurement. Additionally, descriptive statistics provide a simplified summary of the data, which can sometimes overlook the complexities and do not provide insights into causal relationships or the reasons behind observed patterns.

Content Analysis

This method of data analysis provides valuable insights into the perceptions, attitudes, and behaviours related to energy performance of buildings. Content analysis allows researchers to identify patterns and themes within the data, providing deeper understanding of the underlying issues or opportunities for energy efficiency improvements.

Content analysis relies on human interpretation which introduces the potential for subjectivity and bias. Again, it typically focuses on analysing textual or qualitative data and consequently, limits the depth of analysis. The findings may not also be generalizable to larger contexts.

Simulation

Simulation plays a vital role in EPC research as it provides an opportunity for practical testing of phenomena. The analysis is done by employing a virtual counterpart of the real-time structure. By simulating different scenarios, researchers such as Clausen et al. (2021), Koranteng et al. (2021), and Seo and Yun (2022) evaluated the performance and efficiency of energy systems under different conditions to identify opportunities for improvement. Additionally, simulation is used to predict the behaviour of buildings and systems over time by incorporating factors such as weather data, occupancy patterns, equipment usage, and control strategies. This helps in assessing the energy performance of existing or proposed systems and evaluating the impact of energy efficiency measures or technologies. For example, Burke et al. (2005) used dynamic simulation to investigate the impact of variations in the input data on the energy performance rating of classrooms in Ireland.

This analysis technique allows for sensitivity analysis to understand the impacts of changing input parameters on energy performance outcomes. By varying key parameters within specified ranges, researchers can assess how sensitive the results are to different inputs in order to identify critical factors that significantly influence energy performance. Thus, Koranteng and Abaitey (2009) recommend that simulations be carried out in the early stages of the design of a building to identify alternative design considerations aimed at enhancing energy efficiency. Furthermore, simulation helps assess economic viability, feasibility, and return on investment of different options, supporting decision-making processes. Gyimah and Addo-Yobo (2014) adopted simulations to analyse the effects of EPC on building energy demand and the viability of EPC usage in the residential estate market in Ghana and concluded that it was a feasible venture.

To unveil the commonly used software programmes for simulation, the number of publications in which the authors had used them were considered. The leading simulation software was DesignBuilder (used in 7 papers), followed by EnergyPlus (used in 6 papers) and TAS (used in 4 papers). These software are general and not country-specific such as the CALENER-GT of Spain (used by Herrando et al., 2016). Other software for simulation include TRNSYS, Sefaira Architecture and IDA – ICE.

Multivariate Data Analysis

These techniques are commonly used to analyse and understand the relationships between multiple variables. They help researchers uncover hidden patterns, understand the interrelationships between variables, and gain insights into factors influencing energy performance in a comprehensive and systematic manner. Multivariate data analysis techniques include Principal Component Analysis, Cluster Analysis, Factor Analysis, Regression Analysis and Structural Equation Modelling.

Using this type of data analysis technique allows for the exploration and understanding of complex relationships between multiple variables, helping researchers to uncover the interdependencies and interactions among various factors affecting energy performance, such as weather conditions, building characteristics, occupant behaviour, and energy consumption. However, such comprehensive data may be limited, incomplete or subject to measurement errors; a situation which can affect the reliability and validity of the results obtained from the analysis.

Inferential Statistics

Inferential statistics play a crucial role in energy performance research by allowing researchers to make inferences, test hypotheses, analyse relationships and develop predictive models. They provide statistical evidence and insights that help inform decision-making, and energy efficiency planning. They include confidence intervals, regression analysis, ANOVA, etc. Inferences are drawn in studies where data are collected from case studies. Authors such as Koranteng et al. (2021), Moujahed et al. (2022), Ni et al. (2022), Raushan et al. (2022) and Zhuravchak et al. (2022) drew inferences after analysing case studies.

Stochastic Processes

Stochastic processes specifically focus on analysing and modelling random variables or processes. Classified under this analysis technique were papers that adopted the BEEST-EB framework, multi-criteria decision making (MCDM) methods including Analytical Hierarchy Process (AHP), Analytic Network Process (ANP) and other pairwise comparisons.

Computational Intelligence

The use of Artificial Intelligence (AI) has been incorporated into analysing energy performance of buildings. Thus, computer-based methods including fuzzy set theory, digital twin analysis, and machine learning were used by some authors to analyse data. Digital Twins (DT) incorporates information about an existing building including the building systems, operation schedules, occupancy and equipment density and schedules, among other things. Seo and Yun (2022) adopted the DT technique to assess the rate of energy savings from university classrooms in South Korea. Although the use of this technique offer very accurate simulations of real-life scenarios, it is an expensive to set up and run the DT.

Conclusion

In building energy performance research, it is essential to collect and analyse data to gain insights into energy consumption and identify areas for improvement. This systematic literature review has unveiled the commonly used data collection and analysis methods as extracted from 98 publications consisting of 78 journal articles and 20 conference papers. It was discovered that both qualitative and quantitative methods have been used to collect and analyse data in EPC research to provide holistic insights and results. These methods can be used separately or in combination to gain a comprehensive understanding of the energy performance of buildings. The use of current methods such as Digital Twins can help with exposing energy usage patterns, identifying inefficiencies, and developing effective strategies to enhance energy performance and sustainability in buildings. It is therefore recommended that the most appropriate methods to select for research on the energy performance certification of existing office buildings in Ghana include case study, surveys, observation, descriptive statistics, simulation, and multivariate data analysis techniques. It is envisaged that this mixed method approach would enrich the study. The chosen methods would be adapted to suit the objectives of the study, the available data and the specific context of the research to add on to the body of knowledge on energy performance certification studies globally.

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Impact of Sustainable Buildings on Housing Development in Ghana

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Abstract

Ghana, like many other developing countries, is facing significant population growth and urbanization, resulting in a high demand for housing, particularly in urban areas. However, the supply of affordable housing has not kept up with this demand, leading to a housing crisis characterized by overcrowding, informal settlements, and inadequate living conditions. This paper focuses on the impact of sustainable buildings on housing development in Ghana, specifically in high-end markets. It examines various factors influencing the construction of sustainable and affordable housing, such as high capital costs, increasing building materials expenses, power supply availability, and rental costs. The study suggests the development of a housing sustainability model and the implementation of stricter sustainability requirements in project design and construction. Additionally, it recommends the use of cost-effective building materials to reduce operating costs in affordable housing projects. The study employed a purposive sampling technique and administered questionnaires, achieving an 80% response rate. Data analysis was conducted using statistical tools such as SPSS and Microsoft Excel, uncovering that the key challenge in affordable housing is the high cost of capital, emphasizing the need for cost-reduction strategies. The study underscores the importance of integrating sustainability into affordable housing construction to meet the growing demand and establish a stable housing market

Keywords: Sustainable buildings, Affordable Housing, Sustainability, Housing development, Ghana.

Introduction

Achieving environmental, social, and economic sustainability are the main goals of sustainable development (Govindan et al., 2020). To reduce the negative environmental effects of construction activities, a great deal of awareness has been raised (Omer and Noguchi, 2020). Resources and the

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environment are under tremendous strain due to the building industry's massive demands (Adesina, 2020). Acid rains and global warming are the results of this, and they have led to unsustainable development (Tafazzoli and Sadoughi, 2021). Sustainable building has been embraced as one of the creative strategies to support sustainable development to reduce this deficit (Štreimikienė and Kačerauskas, 2020). According to Zhang and Tu, (2021), there are several advantages to sustainable building practices, such as improved health and well-being, environmental preservation, and energy efficiency. According to Weerasinghe (2021), there have been allegations that the beginning stages of design and construction incur higher costs than those of traditional buildings.

Affordable housing is a fundamental human right, but in Ghana, the supply of housing is insufficient to meet the growing demand (Adabre, 2021). This has led to severe and ongoing housing shortages, affecting both poor-income households and the economy. The rise in urbanization has led to overcrowding and unsafe dwellings, with many people living in cramped quarters without utilities (Sunikka-Blank et al., 2021). Sustainable development, which promotes community building and a secure future, is crucial to address the rising worldwide demand for housing (Messerli et al., 2021). Ghana's growing birthrate is causing a shortage of affordable housing, making it difficult for the government and private real estate developers to supply low-cost or medium-income households (Aduwo et al., 2022). Addressing the increase in demand and the decrease in housing supply is essential for Ghana to establish a stable society and ensure the safety of its citizens (Boateng, 2020). Previous literature focused on: modeling the impact of barriers on sustainable housing in developing countries (Adabre and Chan, 2021); Also, others focused on critical components of environmentally sustainable building design practices of office buildings in Ghana (Asman et al., 2019); More so, other researchers explored on towards a sustainability assessment model for affordable housing projects: The perspective of professionals in Ghana (Adabre and Chan, 2020); and lastly, impediments to the development of the green building market in sub-Saharan Africa: the case of Ghana (Addy et al., 2021) but none of the studies focused on exploring the impact of sustainable buildings on housing development in Ghana, hence the need for this study.

This study's main goal is to investigate how sustainable building practices affect Ghana's housing market. This study employed a quantitative research approach, the relative inferential index was used as an analytical tool for analyzing the data. Fifty questionnaires were distributed and a total of 45 responses were received representing an eighty-percent (80%) response rate. The study was undertaken in the Kumasi metropolis of Ghana which is one of the most populated among the sixteen regions of Ghana, so there is a possibility that the study may not apply to all the other regions in Ghana despite its good findings. The study emphasizes the importance of enhancing sustainability in affordable housing construction, aiming to create a comprehensive program for developers and governments. This strategy will help manage housing construction from start to completion, eliminating developers' fear of adopting sustainability, and addressing the current housing demand oversupply.

Literature Review

Sustainable Development

Sustainability is a condition or state that requires sufficient resources and energy to live or exist without becoming less (Rees, 2021). It involves the use of natural products and energy in a way that does not harm the environment or can continue for a long time (Oláh et al., 2020). The concept of sustainability was first defined by the Brundtland Report in 1987, which aimed to encourage development with a dual focus on reducing poverty and considering long-term ecological effects (Rout et al., 2020).

Sustainable development is the process of achieving sustainability, aiming to balance the needs of humans and their generations while avoiding environmental degradation (Hummels and Argyrou, 2021). The construction industry, which consumes a third of global resources, one-sixth of global freshwater withdrawals, 25% of wood harvested, and 40% of all raw materials, plays a significant role in encouraging sustainable development globally (Lal et al., 2021). The construction sector is responsible for about 50% of all energy usage and anthropogenic greenhouse gas emissions (Zhong et al., 2021).

The triple bottom line of sustainable development, consisting of the economy, society, and the environment, consists of three interdependent and mutually reinforcing pillars (Zaharia and Zaharia 2021). The construction industry's role in promoting sustainable development has led to the creation of various aspects of sustainability, such as sustainable architecture, sustainable building, sustainable design, sustainable real estate, and green building (Rane, 2023). The goal is to create a balance that is manageable and enjoyable for everyone, ensuring that the world population's consumption of resources and waste exceeds the earth's capacity to provide these resources and absorb waste (Wan et al., 2019).

Sustainable Buildings

Throughout a building's whole life cycle, a more environmentally conscious procedure and structure are combined to create a sustainable building (Najjar et al., 2019). Site selection, design, construction, operation, maintenance, refurbishment, and demolition are among the life cycle stages (Ivanica et al., 2022). The building industry is largely to blame for the world's current levels of energy consumption and greenhouse gas emissions (Wei et al., 2021). To attain sustainable development, modifications must be made to the notions of architecture, construction, and spatial planning (Bibri et al., 2020). The entire influence of a building on the environment and the health and well-being of its residents should be taken into consideration when designing a sustainable building (McArthur and Powell 2020). To lessen the effects of building construction on the environment, it is crucial to construct sustainable buildings (Munaro et al., 2020). Since most people in modern societies spend between 80% and 90% of their lives indoors, sustainable building designs must create spaces that support building occupants' health, physiological comfort, psychological welfare, and productivity (Šujanová et al., 2019).

Affordable Housing

The affordability of housing has been a significant policy issue since the 19th century, with property ownership being a significant aspect of Ghanaian society (Gyimah, 2020). Governments have pushed for national and regional enhancements in affordable housing policy decision-making to improve community living environments (Li and Spidalieri, 2021). Local governments have been commended for their efforts to improve living equity and fit the needs of more residents (Liang et al., 2022). Post-independence housing policies focused on direct housing construction, subsidized housing loans, subsidized construction finance, and housing market liberalization (Abhijat and Pathak, 2023). Affordability is measured by the ability of people to procure housing commensurate with their wages, which includes rent, utility costs, mortgages, insurance, utility costs, and taxes (Bauer, 2022). Research on affordable housing in Ghana often focuses on the public provision of affordable housing and the mediatory role of state institutions (Ansah et al., 2020). The direction of housing policy over the years has been characterized by uncertainty due to shifts in governance orientation, economic paradigms of global players, and strategic positioning of local actors (Yang, 2023). Existing studies focus on affordability and strategies for improving access to affordable housing, but there are competing notions of this concept (Stephen Ezennia and Hoskara, 2019). Arguments for implementing affordable housing often rest on the merits of residents with financial limitations in purchasing housing and the sustainability of the housing policy (Adabre and Chan, 2019).

Methodology

Research Approach

It is imperative to critically assess various research procedures when selecting a research design approach, particularly considering their implications for data collecting, result analysis, and study conclusion (Bashir Ganiyu, 2016). There are no hard and fast guidelines for choosing research methods, and there is no such thing as the "best research methods" (Yin, 1994), as the choice of research methods is influenced by the kinds of research aims and questions (Fellows and Liu, 2015). Thus, when choosing research methodologies, special consideration should be given to the type of data required to meet the objectives of the study (Akadiri, 2011). This study uses questionnaire surveys as a means of data collecting and applies a quantitative research technique.

Research Strategy

The researcher's direction for conducting research must be explained (Bryman, 1998; Baiden, 2006). Research strategy is the investigation of research objectives, according to Naoum (1998). Consequently, triangulation, qualitative, and quantitative research methodologies are the three primary categories, according to Baiden (2006).

The quantitative method of research was employed for the study. Relational questions about variables in the research can be addressed by quantitative research. "Quantitative researchers look for explanations and forecasts that can lead to other people and locations. Establishing, validating, or confirming correlations and creating generalizations that advance theory are the goals (Leedy and Ormrod, 2001). A problem statement is the first step in quantitative research, which also entails the formulation of a hypothesis, a study of the literature, and a quantitative data analysis. According to Creswell (2003), researchers using quantitative research "collect data on predetermined instruments that yield statistical data, and employ strategies of inquiry such as experimental and surveys."

Sampling Technique And Sample Size

Procedures for sampling provide information about how the demographic subset used for the data was chosen. The universe of units from which the sample is drawn is known as the research population (Bryman, 2004). The participants in this study will be instructors from Kwame Nkrumah University's construction technology and management department in Accra, as well as registered construction enterprises. The GIOC secretariat will provide the list of registered construction companies in Kumasi. Since Kumasi is the center of most construction activity, the survey will only include businesses based there (Ahadzie, 2007).

The population and the sample frame for this investigation are the same. Since the researcher already knows the respondents, purposeful sampling will be used in this study. According to Lewis and Sheppard (2006), Bernard (2002), and Tongco (2007), purposeful sampling is a type of non-probability sampling in which the researcher makes decisions about which individuals to include in the sample based on a variety of criteria, such as specialized knowledge of the research issue or capacity and willingness to participate in the research. The sample size for the study was fifty (50) and the response rate was forty (40), as a general rule, sample sizes between thirty and fifty are considered sufficient for the Central Limit Theorem to hold (Botchway et al., 2023).

Data Analysis and Discussion of Results

Problems of Affordable Housing

One of the purposes of this survey is to determine the problems of affordable housing. To achieve this purpose, the need to assess individuals in the construction industry on sustainability and affordability is essential. This assessment was based on the five-point Likert scale (1= not very significant, 2=not significant, 3=moderately significant, 4=significant, and 5=very significant). The respondents were asked to rate a list of problems of affordable housing. Survey data was analyzed using both mean score ranking and one sample T-test. The mean and standard deviation were some measures computed in the mean score ranking and one sample T-test was the inferential statistics used in Table 4.7 and Table 4.8 below. The mean score ranking was used to give an average value of the distribution and the one-sample t-test was used because of the population size.

Table 4.1 One Sample T Test Of The Problems Of Affordable Housing

Problems Of Affordable Housing	t	df	Sig.(2-tailed)	Mean Difference
Land acquisition	8.875	39	.000	1.32500
Income inequality	9.224	39	.000	1.20000
Increasing cost of building materials	10.380	39	.000	1.37500
High cost of capital	12.428	39	.000	1.47500
Inadequate financing schemes	8.327	39	.000	1.20000
Unskilled workmen	1.356	39	.183	.22500
High level of urbanization	4.529	39	.000	.80000
Poor policy programmes	4.451	39	.000	.80000

Source: Field survey, 2023

Table 4.2 Descriptive statistics of the problems of affordable housing

Problems Of Affordable Housing	N	Sum	Mean	Std. Deviation	Ranking
High cost of capital	40	179.00	4.4750	.75064	1st
Increasing cost of building materials	40	175.00	4.3750	.83781	2nd
Income inequality	40	173.00	4.3250	.94428	3rd
Land Acquisition	40	172.00	4.3000	.91147	4th
Inadequate financing schemes	40	168.00	4.2000	.82275	5th
Poor policy programmes	40	152.00	3.8000	1.13680	6th
High level of urbanization	40	149.00	3.7250	1.01242	7th
Unskilled workmen	40	129.00	3.2250	1.04973	8th

Source: Field survey, 2023

Statistical Analysis of the Problems of Affordable Housing

The mean score ranking and the sample T-test for the problems of affordable housing are presented in Table 4.1 and Table 4.2 above respectively. From Tables 4.1 and 4.2, it could be inferred that the majority of the respondents agreed that the high cost of capital is the main problem of affordable housing. The variable obtained the highest mean (4.4750) the least standard deviation of (.75064) the highest test of strength value (12.428) and a p-value (significance) of (.000), hence the variable was ranked first.

It can be deducted from Table 4.8 that most of the variables obtained a p-value of (.000). This means that most of the respondents agree that all the variables are statistically significant. From the statistics, the increasing cost of building materials was ranked second. This is expected as the increasing cost of building materials affects the cost of accommodation. Other variables with a very high test of strength values include; income inequality (9.224), land acquisition (8.875), inadequate financing schemes (8.327), high level of urbanization (4.529), and poor policy programs (4.451). Unskilled workmen were the least ranked among all the problems identified. It was ranked 8th with a mean of 3.2250 and the least test value of strength value (1.356).

How Sustainability Can Address Affordable Housing Problems in Ghana

How sustainability can address affordable housing problems is one of the objectives of this study. The five-point Likert scale was used for this assessment (1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree). The respondents were asked to rate a list of ways sustainability can address affordable housing problems. Survey data was analyzed using the relative importance index and one sample t-test. The mean and standard deviation were some of the measures computed. The relative importance index was used to identify most of the important criteria based on participants' replies and it is also an appropriate tool to prioritize indicators rated on Likert scales one sample t-test was used because of the population size. The arrangement for the table is so because Ahadzie (2007) opined that where two or more variables have the same mean, the one with the lowest standard deviation is assigned the highest significance ranking.

Table 4.3 One Sample T-Test to Address Affordable Housing

Strategies To Address Affordable Housing Problems	t	df	Sig. (2-tailed)	Mean Difference
Maximize resource Reuse	3.004	39	.005	.67500
Minimize resource consumption	1.039	39	.305	14.32500
Protection of the Natural Environment	6.526	39	.000	1.22500
Waste reduction	5.816	39	.000	1.12500
Promote Socio-Economic Sustainability	6.649	39	.000	1.07500
Decreased Developmental Issues	3.840	39	.000	.75000
Cost reduction	6.777	39	.000	1.22500

Source: Field survey, 2023

Table 4.4 Relative Importance Index To Address Affordable Housing

Strategies To Address Affordable Housing Problems	N	RII	Sum	Mean	Std. Deviation	Rank
Protection of the Natural Environment	40	0.845	169.00	4.2250	1.18727	1st
Cost reduction	40	0.845	169.00	4.2250	1.14326	2nd
Waste reduction	40	0.825	165.00	4.1250	1.22344	3rd
Promote Socio-Economic Sustainability	40	0.815	163.00	4.0750	1.02250	4th
Decreased Developmental issues	40	0.750	150.00	3.7500	1.23517	5th
Maximize resource Reuse	40	0.735	147.00	3.6750	1.42122	6th
Minimize resource Consumption	40	0.715	693.00	17.3250	87.20309	7th

Source: field survey, 2023

Statistical Analysis of How Sustainability Can Address Affordable Housing Problems in Ghana

The one-sample t-test and relative importance index of the various factors of how sustainability can address affordable housing problems are presented in Table 4.3 and 4.4 above respectively.

From Table 5.3, the majority of the respondents agree that protection of the natural environment and cost reduction are the main ways for sustainability to address affordable housing problems. The variable for protection of the natural environment obtained the highest mean value (4.2250) and a standard deviation (1.18727). The variable for cost reduction obtained the highest mean value (4.2250) and a standard deviation (1.14326). The least ranked had a mean value (3.6750) and standard deviation (1.42122). From Table 4.3, most of the variables obtained a p-value of (.000). This means most of the respondents agree that all the variables are statistically significant.

Conclusion and Recommendations

Introduction

The results of the study were summarized here, along with a conclusion, recommendations for future research, and managerial implications.

Summary of the Findings

A total number of 50 questionnaires were distributed, out of the 50 questionnaires 40 valid questionnaires were retrieved for the analysis, representing an 80% percent response rate.

Discussion of Variables (Problems of Affordable Housing)

To help achieve this particular objective, a five-point Likert scale was used to determine the problems of affordable housing hence, respondents were asked to rank those challenges appropriately. Thus, the rankings were labeled as 1 – Not very significant through to 5 – very significant. The results were then analyzed using a mean score ranking test and one sample T-test to find the mean scores and standard deviations of each of the challenges.

The high cost of capital was identified to be the main problem of affordable housing. One of the Ghanaian housing market's price or rental affordability in Accra, the housing affordability challenges are due to constraints such as the high cost of capital (Arku et al., 2012). The cost savings on energy consumption and other services are believed to offset part of the increased capital cost (Chang, Rivera, and Wanielista, 2011). Investors use the cost of capital as one of the financial metrics they consider in evaluating companies as potential investments. Hence the higher the cost of capital, the fewer investors.

Increasing the cost of building materials was also another problem of affordable housing. Du Plessis (2002) identifies the increasing cost of building materials as one of the challenges facing sustainable construction in both developed and developing countries. A study by Tam (2011) examined the cost-effectiveness of housing and it was found that about 26.11% and 22.68% of the construction cost was the increase in building material cost. The increase in the cost of building materials is connected to fluctuations in construction costs and the rise in maintenance costs. The high cost of building materials slows down the development of affordable housing since the cost of building materials affects the cost of accommodation and also the housing quality and schedule for the project.

Income inequality was ranked 3rd. The higher cost of housing in markets with higher wages also may be exacerbating income inequality because less-educated and lower-income households are particularly the ones likely unable to afford housing. Sullivan and Ward (2012) emphasize that because low-income communities lack energy-efficient homes, poorer households are subjected to greater utility expenditures about their earnings and ability to pay.

Land values in the major cities are extremely high, driving all new housing developments to these cities' peripherals where land is relatively cheaper. Land administration and registration often involve long and difficult bureaucratic processes and often result in high transaction costs. Inadequate financing schemes also affect affordable housing with unaffordable interest on mortgages to homeowners, especially low-income households.

Discussion of Variables (How Sustainability Can Address Affordable Housing Problems in Ghana)

This last stage of the objectives was to explore how sustainability can address affordable housing problems in Ghana. But to help obtain the true result, we also used a Likert scale scenario of five rankings through which respondents were asked to rank on knowledge-based principles. The rankings used were; 1 – Strongly disagree; 2 – Disagree; 3 – Neutral; 4 – Agree; and 5 – Strongly agree. The results were then analyzed using a relatively important index and one sample t-test to find the mean scores and standard deviations.

Protection of the environment was ranked first, and cost reduction was ranked second in the statistics. Cost reduction of housing makes it affordable all thus for both low-income and high-income workers. Waste reduction helps in the protection of the environment by preventing pollution and promoting socioeconomic sustainability is essential for protecting natural resources, creating harmony, and building an environment that guides the construction industry in making more sustainable and affordable buildings and settlements. Addressing the issue of affordability is a necessary condition for transformation toward sustainable housing, and yet, affordability is not enough because so-called affordable homes cannot be considered sustainable if they create negative impacts on the environment or social life. Developing Assessment tools and certification systems to analyze the degree of sustainability and affordability according to specific criteria that depend on the local needs within a country, can guide design and construction, even if the goal is not certification itself (Fastofski et al., 2017). Ross et al. (2010) argued that it may not be possible to apply all the principles of sustainability to housing for low- and middle-income households. Instead, it may be necessary to make trade-offs and reach compromises.

Conclusion

There are several advantages to sustainable building practices, such as improved health and well-being, environmental preservation, and energy efficiency. There have been allegations that the beginning stages of design and construction incur higher costs than those of traditional buildings. The core aim of this research was to explore the impact of sustainable buildings on housing development in Ghana. Moreover, to achieve the stipulated aim of this study, three standardized objectives were conveyed. Findings show that high capital costs, increasing building materials costs, power supply availability, and rental costs significantly influence sustainable and affordable housing. The study suggests the development of a housing sustainability model and increased statutory requirements for sustainable performance in project design and construction. It also recommends enforcing the use of building materials that reduce operating costs for affordable housing construction.

Further Research

The scope of the study was focused on the professionals in Kumasi, Ashanti region of Ghana, since there are sixteen regions in Ghana, the study should be expanded to the other fifteen regions to get very good data to represent the population. A mixed method of research could also be adopted in other to get the view of the respondents during the interview sections.

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Appraising the Use of Sorghum Stalk as Soffit Formwork for a Suspended Concrete Slab Construction in Semi-Arid and Tropic Regions

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Abstract

The sorghum stalk can be used as sustainable building material. It has high tensile strength of up to 280 Mpa at the middle region, high LEED rating on environmental friendliness, low embodied energy, this will eliminate the underutilization due to traditional usage, stalk is generally left to decompose, or burnt, despite high annual production of sorghum. It can be produced in all semi-arid and tropic areas of the world notably Sub- Saharan African regions. Africa produce 20 million out of 60 million metric tons world annual sorghum production. There is need to make use of sorghum stalk as traditional building material in formwork construction. This research appraises the use of sorghum stalk as soffit in suspended slab as possible alternative to timber planks or plywood in construction. The research adopted quantitative research approach involving experimental and comparative analysis. This research shows the advantages of sorghum stalk to include; availability, affordability, reusability and biodegradability, renewable with little environmental impact among others. The sorghum stalk should be adopted for use as soffit in suspended slab formwork in building construction. This research would contribute to the body of knowledge in the area of sustainable building materials. It is recommended that there should be improvement on the method of usage.

Keywords: Sorghum Stalk, Soffit, Formwork, Sustainable materials, Suspended Concrete Slab, Embodied energy.

Introduction

Environmental protection and sustainability are one of the policy drivers of any country in the world today, the question of sustaining of our environment from the menace of increasing energy

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demand by industries has been an issue of growing concern especially in Africa. (Usman *et al*. 2021). The world bank in 2015 project more than half of the population growth between now and 2050 occur Africa, (UN,2015) realizing that the population momentum will ultimately place enormous demand on all sectors, more affordable and sustainable form of construction is needed; like utilizing agricultural waste to meet the demand of housing, to minimize the cost of housing and reduction in the depletion of natural resources, without compromising the quality of construction. The diminishing of wood resources and restrictions due to forest conservation, imposed on felling trees has focus the global attention on the need to explore a substitute material that should be renewable with less environmental impact and also available (Kumar, et al 2017).

The timber consumption will increase rapidly, putting our forests in danger of deforestation due to higher demand, building materials requiring sophisticated processing, like concrete has gained wide acceptability and has subsequently become a major and widely used building material (Duggal 2012). The biggest challenges with the concrete, is the most expensive building material and thus creating an imbalance between economic constraints and sustainability considerations with performance as the focal point. According to BRE 2009, Sustainable materials are the ones that ; does not deplete natural resources and has no adverse impact on the environment when used; these criteria are very unrealistic but it serve as a major yardstick for measuring the sustainability of building material, it further gives the parameter for reducing environmental impact by using materials with lower embodied energy, reducing the mileage, use of biodegradable material and designing and constructing for the ease of reuse and recycling. The evaluation of the sustainability of emerging alternative building materials to replace and supplement aggregates, cement and timber in the production of concrete structure, therefore become necessary, in order to guide their appropriate development, selection and utilization as more sustainable building materials than the conventional materials. Research in to sustainable building solutions especially for low- and middle-income countries, has grown in recent years greater use of natural materials both minerals and bio-based, offers opportunities for more affordable, available and sustainable materials and products.

Sustainable buildings are only possible when they are built with sustainable materials. Jain (2008) to reduce the embodied energy or salvaged from reclaim materials. Sustainability, availability and affordability are the three main factors that are always considered for any material. like other sustainable materials such as bamboo, rice husk, palm kernel shell, etc which are studied and now incorporated as building material, though many researchers have studied the fibers, structures properties of sorghum stalk, but due to lack of confidence on trial and information; low expectations; cost concerns; unsupportive regulations; and limited technologies for waste recovery (Shooshtarian et al., 2020). To date, there has been little research into potential uses sorghum stalk. In an attempt to fill this gap, this paper considers the use of sorghum stalk as construction material in the production of concrete slab as soffit formwork, for low-cost construction in low- and middle-income countries.

Sorghum is one of the top five cereal crops cultivated worldwide especially in Africa with Nigeria as the second largest annual producer of sorghum in the world and Egypt fourth with 9,318,000mt and 866,948 mt respectively, (Fou 2010) sorghum is monocotyledon plant which belongs to grass family, its stalk can reach up-to 3.5m in height usually upright, consisting of nodes each with leaf, and cross section consist of pith and rind in the solid stem. The agro residue of sorghum which consist of stalk and leaves is about 74% by weight of the crop are either open field burned to release Co2 into atmosphere or highly under-utilized despite having optimum characteristic regarding cost, availability, affordability, renewable natural resource, environmental friendliness, Co2 neutrality, low density, in addition to their acceptable strength, sorghum stalk had not been studied well for high value applications especially in the area of construction, this research studied the sorghum stalk for higher value application in the production of concrete as soffit formwork for suspended slab construction. Formwork is a mold used to shape the concrete the economic cost of formwork ranges from 35% to 60% of the total cost of concrete structure (Jorn, 1999). considering the impact of formwork on total cost, in design of structure the economy and safety of forming most be considered, not just the economy of finished product. The use of sorghum stalk Soffit formwork for suspended slab has been in use for many years in northern part of Nigeria where the sorghum is cultivated but no literature that will help in the evaluation and the improvement of the practice for global acceptance ad standardization as building material for that purpose, therefore creating more value-chain for sorghum production, to make it available in the literature, for further research, and to understand the modus operendi of the process and improvement on the process. LEED rating system Bahaudin et al. (2014), agreed that LEED is becoming the standard by which many green buildings are measured, therefore this research adopt LEED criterion in rating the materials and resources.

Literature Review

Sorghum

Sorghum is monocotolydon plant, which belongs to grass family (Winch 2006). It is normally semi-arid and tropic areas of the world notably Sub-Saharan African regions and can reach up to 3.5 m high and the stalk are usually upright, consisting of nodes, each with leaf. In the radial direction the stalks consist of pith and rind. Similar to sugarcane and maize sorghum has solid stem. Sorghum stalk; is the by- product of sorghum plant which consist of rind and pith. The rind is very soft fibrous tissue, thus promising higher strength and mechanical properties than the pith, where the fibre bundle is few in numbers, and scattered within the pith tissue. The higher mechanical properties of the rind suggest their application as composite reinforcements, the pith can further be utilized for low strength applications, such as low-density particles boards. (Wang 2002). Baheer Bakeer et al 2013, observed that the pith consists of vascular bundles surrounded by weak tissue of large thin- walled parenchyma cells, whereas the rind is found to be composed of compacted fibre bundles. And also noted that the rind has higher density of fibre bundles compared to the pith; the higher fibre ratio provides for higher tensile strength of the rind.

Green Building Materials/Assessment Tools

Ahankoob (2013) noted that the remarkable growth in the advanced construction techniques characterised by excessive use of resources such as water, materials, energy and fossil fuels on a global scale, has intensified significantly the needs for having sustainable buildings. Sustainable buildings are only possible when they are built with green materials. Jain (2008) described Green Building Materials (GBM) as those building materials obtained from natural renewable sources that have been managed and harvested in a sustainable way; or they are obtained locally to reduce the embodied energy or salvaged from reclaimed materials.

Green materials are environmentally responsible because they are usually assessed using green specifications that look at their Life Cycle Analysis (LCA) in terms of their embodied energy, durability, recycled contents, waste minimization, and their ability to be reused or recycled. Consequently, many countries have taken notable steps in identifying, assessing and utilizing GBMs. These steps have led to introducing sustainable assessment tools. In this regard, many countries have provided appropriate strategies to prevent the excessive consumption of materials' situation from getting worse. Building Research Establishment (BRE) in England took the pioneer steps in 1990 by establishing the Building Research Establishment Environmental Assessment Methodology (BREEAM). BREEAM is the world's longest established method of assessing, rating, and certifying the sustainability of buildings and building materials. This was followed in 1996 by the United States Green Building Council's Leadership in Energy and

Environmental Design (LEED) (Ahankoob, 2013). LEED is a third-party certification programme and approved as a benchmark in the world. This programme provides a clear direction for various phases in a project including design, construction and operation of buildings. According to Ahankoob (2013), assessment tools in the past were primarily used to measure specific concepts of green methodology. The focus area was selected to address key aspects of inefficiencies in buildings. Most tools focused on three main areas: energy, material and water use in the building. In recent years, new sustainable practices were applied such as: day lighting analysis, native plants, material re-use, recycle and densification. A closed comparison of the various councils revealed that each council employ at least five (5) of the following criteria for assessment: Energy Efficiency, Water Efficiency, Indoor Environment Quality, Site Planning and Management, Innovation, Materials and Resources, Environmental Protection, Transport, Land Use and Ecological Environment. However, both studies by Ahankoob, (2013) and Bahaudin *et al.* (2014) agreed that LEED is becoming the standard by which many green buildings are measured. LEED quantifies a building's performance in the following major categories as shown in Table 2.1.

Table 2.1: LEED Scoring and Rating Award for construction materials

S/N	Criteria	Scoring
1.	Energy and Atmosphere	17
2.	Water Efficiency	5
3.	Sustainable Sites and Transportation	14
4.	Indoor Environment Quality	15
5.	Materials and Resources	13
6.	Innovation and Design	5
	TOTAL	**69**

Source: Bahaudin, *et al.* (2014).

According to Bahaudin *et al.* (2014), LEED takes a much broader "triple bottom line" approach considering people, planet and profit, not just energy use. The triple bottom line factors in the economic, environmental and social issues are present throughout the entire building process from concept, design, development and future operation. It has however been concluded that, the only criterion that has relevance to the preoperational stage of a building is Materials and Resources where emphasis is on recycled, reused sustainable materials and green products during the construction phase.

Embodied Energy: - all energies that are associated with production of a particular material, system or components, or the total energy required for the extraction, processing, manufacture and delivery of building material to the building site.

Energy consumption produces CO2, which contributes greenhouse gas emission, so EE is considered as an indicator of the overall environmental impact of building material and system. EE analysis is interested in what energy goes to supporting the consumers and so all the energy depreciations is assigned to the final demand of consumers. Up to date there is no standard consensus on the methodologies, on how to find EE of any material, there is wide range in EE values for any given materials. every building is a complex combination of many processed materials, each of which contributes to the building's EE renovations and maintenance also add to the EE over a building's life-span. Choices of materials and construction methods can significantly change the amount of energy in building, assessment of embodied energy is very difficult task.

Assessing embodied energy; the embodied energy contained in the structure is difficult to assess. This energy use is often hidden. It also depends on where boundaries are drawn in the assessment process. For example, whether to include:
The energy used to transport the materials and workers to the building site.

- Just the materials for the construction of the building shell or all materials used to complete the building such as bathroom and kitchen fittings, driveways and outdoor paving.
- The upstream energy input in making the materials (such as factory/office lighting, the energy used in making and maintaining the machines that make the materials).
- The embodied energy of urban infrastructure (roads, drains, water and energy supply). Gross Energy Requirement (GER) is a measure of the true embodied energy of a material, which would ideally include all of the above and more.

In practice this is usually impractical to measure. Process Energy Requirement (PER) is a measure of the energy directly related to the manufacture of the material. This is simpler to quantify. Consequently, most figures quoted for embodied energy are based on the PER. This would include the energy used in transporting the raw materials to the factory but not energy used to transport the final product to the building site. In general, PER accounts for 50-80 per cent of GER. Even within this narrower definition, arriving at a single figure for a material is impractical as it depends on:

- Efficiency of the individual manufacturing process.
- The fuels used in manufacture of the materials.
- The distances materials are transported.
- The amount of recycled product used, etc.

Each of these factors varies according to product, process, manufacturer and application. They also vary depending on how the embodied energy has been assessed. Estimates of embodied energy can vary by a factor of up to ten. As a result, figures quoted for embodied energy are broad guidelines only and should not be taken as correct. What is important is to consider the relative relationships and try to use materials that have the lower embodied energy.

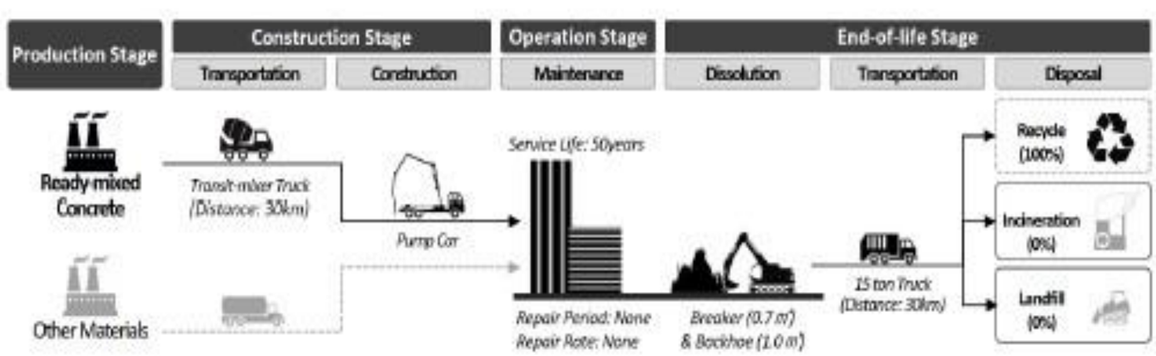

Figure 1: Example of scenario-based embodied environmental impact (EEI) evaluation
Source: Roh et. al. (2018)

Production stage:

In the production stage, the EIs arising from the production of building materials are assessed. In this study, the EIs of the production stage were assessed using the average inputs per unit area of the six major building materials (ready-mixed concrete, reinforcement steel, glass, concrete bricks, insulation, and gypsum) derived from previous research in accordance with the cut-off criteria of LCA.

Construction stage:

The construction stage is divided into the transportation process of building materials and the construction process of buildings. In the transportation process, building materials are transported from their production sites to the construction site. In this study, freight vehicles for each of the major building materials were selected as shown in Table 4 on the basis of the standard estimation system for construction works (KEITI, 2018).

In addition, the transport distance was assumed to be 30 km for all of the major building materials.

Classification	Ready-Mixed Concrete	Rebar	Others
Freight vehicle	Transit-mixer truck	20 ton truck	8 ton truck

Table 4: Freight vehicles (Roh et. al., 2018)

The construction stage represents the EIs caused by the use of equipment during construction, and it was assessed using the LCI DB for the unit of construction work for each building material.

Maintenance stage:

In the maintenance stage, the EIs arising from the production and transport of building materials that are periodically replaced in order to recover status of aging buildings during their service life are assessed. In this study, the service life of buildings was set to 50 years, in accordance with the upper limit of the standard service life of the Enforcement Regulations of the Corporate Tax Act of Korea (KEITI, 2018). In addition, the EIs of the maintenance stage were assessed using the repair period and rate for each building material suggested by the standards for the formulation of the long-term repair plan in the Enforcement Regulations of the Multi-Family Housing Management Act of Korea.

In other words, it was assumed that ready-mixed concrete, reinforcement steel, concrete bricks, glass, and insulation, among the selected six major building materials, were not replaced during the service life of the buildings and that 100% of the gypsum boards were replaced every 20 years.

End-of-life stage:

The end-of-life stage is divided into the demolition process, the transportation process of waste building materials, the incineration proc0ess, and the landfill process.

In the dissolution process, the EIs of the equipment and machinery used for building demolition are assessed through fuel efficiency (diesel consumption per unit of work) information of the demolition machines after the number of machines is calculated on the basis of the amount of waste material generated in the demolition process. In this study, it was assumed that both crushers (0.7 m3) and backhoes (1.0 m3) were used as demolition equipment (Roh &Tae, 2016) and that the amount of waste material generated in the demolition process was the same as the input quantities of the six major building materials in the production stage.

In the transportation process, the EIs arising from transporting the waste materials generated in the demolition process to recycling centers, incineration plants, or landfills are assessed. In this case, it was assumed that the waste building materials were transported using 15ton trucks in accordance with the standard estimation system for construction works (Harkouss, 2018) and that the distances from the demolition site to recycling centers, incineration plants, and landfills were 30 km.

In the end-of-life process, the EIs arising from incinerating or landfilling waste materials are assessed. In this study, the cut-off method imposed on recycling companies was applied to the EIs of the waste material recycling process, and only the EIs of the incineration and landfilling of non-recycled waste materials were assessed. For this, the construction waste processing data from waste statistics (KEITI, 2017) published by the Korean Environmental Industry and Technology Institute were investigated, and the recycling, incineration, and landfill rates of each major building material were applied as shown in Table 5.

Table 5: Processing ratios of waste building materials (Roh et. al., 2018)

Classification	Recycle Ratio (%)	Incineration Ratio (%)	Landfill Ratio (%)
Waste concrete	100.0	0.0	0.0
Waste rebar	100.0	0.0	0.0
Waste concrete brick	100.0	0.0	0.0
Waste glass	79.0	0.0	21.0
Waste insulation	46.7	53.3	0.0
Waste gypsum board	62.7	0.2	37.1

Water Absorption Capacity = $\frac{W2-W1}{W2} * 100$ ---(3.1)

Where:

W_1= Weight of the concrete sample after oven dry

W_2= Weight of the saturated surface dry concrete sample

Materials and Methods

The study adopted quantitative research approach involving experimental and comparative analysis. The material for the study is sorghum stalk which was obtained from sorghum farm in Giris, Kebbi State Nigeria, leaves are removed all parameters are measured. Water absorbency was determined following submersion of the stalk into water for 24h. Specimen mass was recorded before (m^1) and after (m^2) immersion. The latter value was measured in a saturated dry surface condition, which was achieved by removing excess water. Water absorption capacity (w) was measured as follows; the mass and average area of the stalk were also measured to obtain the density of the stalk using the mass/volume, embodied energy of the stalk and green features assessment of sorghum stalk were also conducted, remaining was prepared in form of sorghum stalk raft measuring 2.0m x 1.2m by traditional sorghum stalk raft wovers in traditionally accepted method of preparation ready to be used as soffit formwork. The research also demonstrates the processing of the raft, placement, arrangement as soffit as well as finished product. Building materials green feature assessment criteria of LEED was adopted in assessing the green features of both conventional materials and derived material cover entire life cycle of building material: from manufacturing process through building operations to post building management.

Table 3.1: LEED LCA of Sorghum Stalk

GREEN LIFE CYCLE ASSESMENT OF SORGHUM STALK					
Manufacturing		**Building Process (MP)Operations**		**Waste Management/Post Operations (BO)**	
Waste reduction	√	Energy efficiency	√	Biodegradable	√
Pollution prevention	√	Water treatment & conservation	√	Recyclable	√
Recycled		Non toxic	√	Reusable	√
Embodied energy reduction	√	Renewable energy source	√		
Natural materials	√	Longer life	√		

√ = applicable

Source: Field study 2023.

From table 3.1 the life cycle assessment LCA of sorghum stalk as building material under LEED criteria, four out of five green requirements under manufacturing process are satisfied, all requirements in the building operation process are satisfied and all requirement under post operation process are satisfied. Total of 12 out 13 (92%) requirements are meet. This will classify sorghum stalk as building material as platinum LEED category of building materials.

Table 3.2: LEED LCA of Timber

GREEN LIFE CYCLE ASSESMENT OF TIMBER					
Manufacturing		**Building Process (MP)Operations**		**Waste Management/ Post**	
Waste reduction		Energy efficiency	√	Biodegradable	√
Pollution prevention		Water treatment & conservation		Recyclable	√
Recycled		Non toxic	√	Reusable	√
Embodied energy reduction	√	Renewable energy source	√		
Natural materials	√	Longer life	√		

√ = applicable

Source: Field study 2023.

Table 3.2 the life cycle assessment LCA of Timber as building material under LEED criteria, only two out of five green requirements under manufacturing process are satisfied, four out five requirements in the building operation process are satisfied and all requirement under post operation process are satisfied. Total of 9 out 13 (69%) requirements are meet. This classifies timber as less sustainable building material than sorghum stalk.

Table 3.3: Embodied Energy Calculation for Sorghum Stalk

	Item	**Energy per hour**	**Energy per day kj**	**Total energy in kj**
1.	Harvesting	5 kj/h	5x8	40
2.	Loading and offloading	5kj/h	5x 4	20
3.	Transportation	671kj/km	671 x 10	6710
4.	Processing	5kj/h	5x8	20
5.	Miscellaneous	Assumed		20
	Total energy	10 rafts		6830
	Out-put	2.0mx1.2m		24m^2
	Embodied energy	6830/ 24	285	**285 kj/m^2**

** average distance of 10km is considered for transportation.
Source: Field study 2023.

Table 3.3 shows the computation of embodied energy of sorghum stalk the energy contributors in preparation of sorghum stalk raft are identified, out put of labor per our using medium level job is 5kj/ h, 8 working hours per day is also considered. Energy in transportation is medium capacity vehicle using 671 kj/km is considered. All the energies are added to give an output of 24m^2 embodied energy is given by total energy used all over total out-put which give 285kj/m^2

Table 3.4: Physical characteristic of sorghum stalk

	Sorghum stalk	Timber
1. Density	8 kg/m^2	26 kg/m^2
2. Water absorption	156%	43%

Source: Field study 2023.

Table 3.4 shows some of the physical features measured by this research indicating sorghum stalk has density of 8 kg/m^2. The result implies that if sorghum stalk is used as soffit in place of timber there would be reduction in self-weight, it further shows sorghum stalk has higher water absorption than timber it is relatively lighter than the timber, but it has higher water absorption, use of polyethene sheets on sorghum stalk raft prevent direct contact with cement grout, so as the water absorption.

Table 3.4 Sustainable features of Sorghum Stalk and Timber

		Sorghum Stalk	Timber
1 2 3 4	Embodied energy Biodegradability Replenish Reusable	0.284mj/ m^2 6 months 4-6 month 2-3 times	250mj/ m^2 24 months 10-15 years 4-6 times

Source; field study 2023.

Table 3.4 shows some of the sustainable features of sorghum stalk and timber, sorghum stalk has very low embodied energy of less than 1mj/m^2, low time of biodegradability of 6 month, takes far more less time to regrow with the life span of 6 month and it can be reuse up to 3 times in construction. It also shows high embodied energy by timber, longer time to decompose and timber can reuse more times up to 6 in construction.

Table 3.5 Cost of Sorghum Stalk and Timber

		Sorghum Stalk	Timber
1 2	Workmanship Cost per m^2	60 m^2 /h #750	20 m^2/ h # 4000

Source: Field study 2023.

Table 3.5 shows the workmanship implies reduction in of workmanship and cost of materials per square meter shows reduction of cost if sorghum stalk is used by more than 400%.

Method

Raft of preparation

Sorghum stalk is prepared in form of raft by traditional method, by sandwiching one horizontal stalk in the two vertical using traditional hemp rope to make rectangular raft 1.2m x 2.0m by traditional woovers.

Figure 1. Sorghum raft placed as soffit in suspended slab construction.

Figure 2. Underside of sorghum stalk soffit.

Figure 4. Laying of polythene sheets on soffit.

Figure 5. Arrangement of reinforcements on soffit formwork.

Discussion

From table 3.1 life cycle assessment of sorghum stalk shows that it has satisfy all but one LEED criteria of green building materials from manufacturing, building operation and waste management, scoring 92%, which is classify as platinum rating on environmental friendliness with little or no environmental impact, even timber though it is consider as sustainable material, its life cycle assessment satisfy 9 out of 13 criteria for sustainability making 69% of the requirements as in table 3.2, this shows if sorghum stalk is use as soffit formwork more green material is incorporated because the more we use sustainable materials in construction the more we produce sustainable building which will help our environment to be greener.

This research also calculates embodied energy of sorghum stalk using current environmental impact assessment method by relating energy used in the production of sorghum stalk raft ready for use as soffit formwork the average distance of 10km is assumed which is the only fuel use in the production process to use energy of 671 kj/km, and average man out-put of 5 kj/h and 8 hours working day is considered, making 40kj/ day total energy used is 6830kj, this input will produce 10 rafts per day making total of 24m^2 per day, making the embodied energy for sorghum stalk as 0.284mj/ m^2 as in table 3.3.

Table 3.4 some physical features of measured by this research shows sorghum stalk has density of 8kg/m^2 which implies reduction in self-weight if sorghum stalk is used as soffit in place of timber planks with density of 26kg/m^2 the result of water absorption shows sorghum stalk absorb more water 156% than timber planks 43%, use of polyethene sheet on sorghum stalk rafts to prevent direct contact with cement grout so as the water absorption.

Table 3.5 shows sustainable features of sorghum stalk and timber this research considers 4 sustainable features for comparative analysis i.e. embodied energy, biodegradability, replenish and reuse. The table shows there is huge difference in embodied energy between sorghum stalk 0.284mj/m^2 and timber 250mj/m^2 this shows sorghum stalk has less environmental impact if use as soffit as it requires less energy for processing, transportation and workmanship. The issue of waste management of biodegradability sorghum stalk can decompose within 6 months to add soil nutrients whereas timber take 24 months to decompose due to high density this will add to waste management problems and sometimes agricultural processes. Another sustainability aspect this research consider is replenish; sorghum stalk is annual crop with the total life span of 6 months from planting to harvesting, the stalk is agro residue which even not use for construction purpose it will be left in the field to decompose, making it very available in the arid and semi- arid regions, timber is from perennial trees which will take more than ten years to grow to full timber tree, cutting down the trees for timber is one of the environmental challenges we are facing globally. The research also compare reusability of the materials timber is more reusable 4-6 times than sorghum stalk 2- 4 times.

Table 3.6 depicts economy in the use of sorghum stalk cost of materials is #750 per meter square whereas cost of timber is #4000 per meter square, this shows huge cost saving in the materials. Cost of workmanship shows use of sorghum stalk is 3 times faster than timber which also translate to reduction in cost.

Findings

Findings from this research shows that sorghum stalk is one of the most sustainable building materials; which satisfy the features availability, affordability, reusability, biodegradability with less environmental impact.

The research found sorghum stalk to satisfy 92% criteria of the green building materials life cycle assessment by LEED. The research also calculates embodied energy of sorghum stalk raft to be 0.284mj/m^2. Cost of concrete production will be reduced due to the reduction in the cost of material and workmanship if sorghum stalk is used as soffit formwork in suspended slab production.

Conclusion

In this research, sorghum stalk was tested to obtained the density and water absorption, embodied energy and other environmental impact assessment were also conducted to concludes the use of sorghum stalk can enhance the quality of the house in Africa and re utilization of agro-waste in construction reducing the environmental impact of using building materials with high embodied energy, saving our forests by substituting timber with sorghum stalk, reducing use of timber in construction. use of sorghum stalk also reduces the cost of construction. This research helps to appraise the use of agricultural waste; sorghum stalk as construction materials with least possible cost and environmental impact. The limited time and the resources for the study did not help in applying more tests on the research material.

The sorghum stalk should be adopted for use as soffit in suspended slab formwork in building construction in a manner explain in this research. This research will contribute to the body of knowledge in the area of sustainable building materials. Further research to investigate other properties of sorghum stalk should be conducted in order to improve on the materials methods and process of using sorghum stalk as construction materials.

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TRACK 5: SUSTAINABLE INNOVATIONS IN URBAN CONFIGURATION AND MOBILITY IN AFRICA

An Evaluation of Coastal Management Solutions for Climate Adaptation in Ghana: The Case of Azizakpe

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Abstract

Inhabited islands are identified to promote the tourism potential and growth of local economies. In Ghana, there are several inhabited islands which are located both inland and along the coast. However, due to climate change, the coastal islands are steadily disappearing because of severe flooding and erosion. Azizakpe is a community on one of Ghana's coastal islands. Parts of the island are being gradually wiped off as a result of sea level rise that is exacerbated by changes in global climate systems. Over the years, several coastal management strategies for adaptation have been implemented in Azizakpe. However, the outcomes of these interventions remain highly uncertain. Drawing on the case of Azizakpe, this study critically assessed the resilience of coastal management strategies in Ghana. It applied relevant climate resilience framework to understand how existing coastal management strategies have helped to build resilience in vulnerable island communities. In this study, it was realised that about 58% of the implemented strategies were community driven projects, while 8% were government driven. These strategies were haphazardly implemented and had no research backing. As such the strategies have not provided enough resilience against floods and erosion. It is argued in this study that coastal management strategies should not be applied as a quick fix, but there should be a thorough analysis of vulnerabilities in relation to the local context to ensure a strong output legitimacy.

Keywords: Climate resilience, Adaptation Strategies, Island communities, Floods, Erosion

Introduction

The increasing infiltration of heat-trapping gases into the earth's atmosphere has been a global phenomenon (Denchak, 2019). This has been so due to the intensity of some human activities, like burning of fossil fuels, that generate substantial amounts of heat pollution. The atmosphere's warmth shows how much water it is able to hold and the amount of the ice or glaciers that are melted (Denchak, 2019). Thus, sea levels have been on the rise due to heavy rainfalls through convection and the melting of glaciers.

The continues rise in sea levels is causing floods in many parts of the world and resulting in the erosion of land inhabited by man. Sea levels have been predicted to rise even more by the next three decades, such that they will push chronic floods to be higher than land that is currently

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inhabited by over 300 million people (Climate Central, 2019). The sea levels have as well been predicted to rise by 2 to 7 feet by the end of the twenty-first century (Climate Central, 2019).

There have been many adaptation strategies applied around the world which have been aimed at curbing the issues of floods and erosion at the environment and building scales. At the environment scale, such strategies include; hard structural solutions like seawalls, seabee walls, rock walls, storm surge barriers, diversion channels, oyster reefs, and car tyres. The soft structural solutions include sand dunes with vegetation, mangrove swamps, and flood plains. At the building scale, three main solutions were identified (HNFMSC, 2006). They include; water avoidance technologies (landscaping, drainage and retention features, free-standing structures or barriers, the elevation of buildings on pillars or stilts, extended foundation walls or raised earth structures and floatation), water exclusion technologies (door and window guards, air brick covers, smart air bricks, non-return valves, pumps, cladding systems, plastic skirts, flood resistant doors and coated walls) and water entry technologies (HNFMSC, 2006). Put together, these adaptation strategies aim to ensure that disruptions have less impact on people and their communities in case those disruptions strike again. This is referred as resilience.

Sub Saharan Africa has been identified as the most vulnerable region to the negative impacts of climate change (Sono et al, 2021). Hence, a number of adaptation strategies align the coastal areas of this region. Ghana has not been exempted from this ordeal. Adaptation strategies like sea walls, rip rap walls, sand bags, car tyres, groynes, revetments and nature-based solutions have been implemented along the coasts of Ghana to reduce the impact on vulnerable communities and their livelihoods. A daunting question however, is, how resilient the adaptation projects in Ghana are to floods and erosion? This question is important because of the continues impact of flood and erosion on most of these communities that have had some of these adaptation projects implemented.

Although Sub Saharan Africa has been identified as the most vulnerable region (Sono et al, 2021), the climate resilience of the region has not been extensively studied. (Sono et al, 2021). So far, about 72% of research in Africa has focused on climate adaptation with less attention to mitigation processes (Baninla 2022) and resilience (Sono et al, 2021). The failure of most of the coastal management solutions for adaptation, especially on the Keta Sea Defense Project, in Ghana informs the World Banks report on the need for long term and holistic strategies and plans informed by scientific and empirical evidence in order to create resilient solutions (World Bank Group, n.d.). It therefore becomes relevant to explore how resilient the already employed adaptation strategies are.

Literature Review

Climate Adaptation and Resilience

Climate Change is a diverse and complex issue with numerous discussions on definitions of some terminologies related to it, including, climate resilience, mitigation and adaptation. According to the Emissions Gap Report for 2020, although the COVID 19 pandemic caused a reduction in carbon emissions, the world temperature will still rise by 3˚C beyond the Paris Agreement goal of limiting it to 2˚C by 2030 (UNEP, 2020). The Intergovernmental Panel on Climate Change's (IPCC) 2021 report also suggests that global temperatures will continue to rise to at least 2050 even if general emissions are reduced. This is because most of the changes are already in progress (UNDP, 2024). This beckons the need for adaptation and resilience (UNDP, 2024).

Climate change adaptation refers to adjusting to and coping with current and future changes in climate (Global Climate Change, 2024). While this process helps to avoid or moderate the impact to some regions, for some other regions, it helps them exploit the opportunities that the changes bring. The IPCC defines resilience as "the capacity of social, economic, and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure, while also maintaining the capacity for adaptation, learning, and transformation" (IPCC 2014). It is the "ability of individuals, communities, organizations or countries exposed to disasters, crises and underlying vulnerabilities to anticipate, prepare for, reduce the impact of, cope with and recover from the effects of shocks and stresses without compromising their long-term prospects." (IFRC, 2014).

Generally, resilience is built through the iterative process of identifying the shocks, identifying relevant solutions, designing diverse solutions, implementing the solutions and evaluating and monitoring the implemented solutions. The haphazard selection of solutions does not help build resilience. It is therefore imperative that to build resilience, shocks are evaluated and understood based on the geological setting and context, and then, possible alternatives analyzed and sustainable resilient solutions proposed (McCreedy, 2018). A number of factors inhibit the application of some adaptation strategies in the West African region, including Ghana. These factors include the activities and influence of the local communities, lack of education, the timeliness and proactiveness of interventions, sustainability issues, limited funding mechanisms, and political pressures (World Bank Group, n.d.). These factors, although highly relevant, seem to be of little importance to stakeholders in proposing adaptation strategies for resilience building in Ghana, and therefore the need to analyse the implemented strategies.

The State of Island Communities

Islands, like other waterfront communities, face issues regarding erosion and inundation. As part of the total land surface area of the world, which is 148.9 million km^2 (Scheyvens and Momsen, 2008), are a number of large and small islands states and communities. The most vulnerable are small islands. They have been identified to have small economies causing them to have economic vulnerabilities (Scheyvens and Momsen, 2008). These economic vulnerabilities are due to the isolated nature of islands from major markets, causing them to face difficulties in engaging in the trade of their few primary product exports. The limitedness of their resources, including human resources, lands them in having small domestic markets (Briguglio et al, 1996; Milne, 1997), and causes them to depend heavily on external aid. Impeding their economic development are issues with regards to inadequate transportation networks, difficulty in accessing remote areas, inadequate local start-up capitals for businesses and the inadequate appropriate work skills among the locals (Harrison, 2003).

In addition to their economic and social challenges are environmental challenges including the threat of rising sea levels and phenomena such as cyclones, hurricanes and seismic activities which usually lead to tsunamis (Briguglio et al., 1996). The expected rise of sea levels puts small island communities at a huge risk of losing their lands (Martry-Koller et al, 2021).

There are over 21 islands in Ghana. The most vulnerable of these islands is the Azizakpe community, located on the Volta River, in the Ada East District. Since 2016, aerial views of the community from Google Earth show that major parts of the community are being wiped off due to its close proximity to the estuary. The issues of floods and erosion, coupled with the low availability of amenities and infrastructure has caused the emigration of most of the inhabitants and the abandonment of most buildings,

A number of adaptation strategies have been implemented in the community. As such, the community will be used for the study. This paper aims to address two objectives. Firstly, to create the understanding of how climate resilience can be achieved through a thorough appraisal of a climate resilient framework- The Climate Resilience Framework (Tyler and Moench, 2012; Moench, 2014). This framework will be applied to this study because it is a comprehensive framework that guides on building climate resilience. Secondly, this study will analyse the adaptation strategies in Azizakpe based on the frameworks.

Methodology

The materials used in this paper include news articles, policy documents, academic articles, maps, site observations, interviews and focused group discussions. The Climate Resilience Framework (Tyler and Moench, 2012; Moench, 2014) has been well documented in literature. Therefore, much data was derived from secondary sources like academic articles. There is hardly any documentation of the Azizakpe community. Hence, primary sources of data were applied to obtain information through interviews, focused group discussions, field observation and photographs.

In conducting the interviews and focused group discussions, simple random sampling, convenience and purposive sampling techniques were applied. Purposive sampling was used in identifying and selecting stakeholders and institutions for this study. The community was informed about the group discussions. Those interested in participating in the focused group discussions did participate; convenience sampling. 28 houses, out of a total of 56 houses in the community, were randomly sampled to be assessed and for interviews as well. In total, 122 people were interviewed through the focused group discussions, and 6 institutions were also interviewed. The institutions included the chief of the community, the assemblyman and the following departments in the Ada East District Assembly: The National Disaster Management Organization (NADMO), the Community Development and Social Welfare Department, the Physical Planning Department and the Development Planning Department. These interviews were to aid understand the problem in details and the adaptation solutions that have been implemented to curb the problem.

Thematic and qualitative content analysis were used to analyze the data obtained from the interviews. This helped convert the qualitative data to quantitative data such that statistical applications such as central tendencies, frequency and percentages could be applied. Additionally, data obtained from the focused group discussions were analyzed using the Constant Comparison Analysis, which ensured data was grouped in themes that are in line with the objectives of this study. The most or less mentioned themes by the focused groups helped draw conclusions on the subject matter. Themes that emerged from the analysis of the data were discussed according to the objectives.

This paper is organized as follows: Firstly, we assess the climate resilience frameworks and adapt its concepts and ideas. Afterwards the paper delves into a brief history of Azizakpe and an overview of the community's historical development. The effects of the issues are then considered. This will be addressed at the community scale and the building scale. The coping strategies they may have applied is then looked into to access their resilience. Conclusions are then drawn on how effective these strategies are with necessary recommendations.

Results

The Climate Change Resilience Framework (CCRF)

Asia's rapidly growing population, as well as the limited practical experience in planning and implementing adaptation measures, influenced the Rockefeller Foundation to fund climate change adaptation planning and implementation measures in 2008, in 10 medium-sized cities in India, Indonesia, Thailand and Vietnam over a 5-year period which later extended to 7 years (Tyler and Moench, 2012). The programme was named Asian Cities Climate Change Resilience Network (ACCCRN). In each of the ten cities, Rockefeller partnered with local and national organizations in each country to help build capacity and undertake local planning and implementation of adaptive measures (Tyler and Moench, 2012). The Institute for Social and Environmental Transition in collaboration with the local and national partners (Moench, 2014) provided technical support that helped develop a methodology for planning for climate resilience in the ten cities. They developed a framework which identifies the diverse array of actors, institutions and often very localized systems as essential components to factor when understanding vulnerabilities and building resilience in order to reduce system rigidity and the likelihood of complete failure (Moench, 2014). The framework provides guidance on how climate resilience could be practiced. It is structured as both an analytical framework and as an iterative planning process (Moench, 2014). As a result, it encourages insights across systems, agents and boundaries with regards to situations and also encourages adaptive responses to situations and builds understanding through shared learning (Tyler and Moench, 2012; Moench, 2014).

Generally, there are three elements of urban resilience which include agents, systems and institutions. The systems are physical elements that agents (individuals or organizations) use and manage. Institutions govern the agents and the use of the systems and structure behavior. When stresses occur, systems, agents and institutions react to them differently, but because of their interconnection, the resilience of each element towards those stresses causes total resilience since all factors are efficiently considered.

Systems

The availability of critical systems and infrastructure help cities to function (Little, 2002). Systems can be grouped into core systems and broader adaptive capacity systems. These systems help deliver essential services to cities and some systems rely on other systems to also deliver services. For example, food production and trade will require services like transportation and communication to help with distribution processes. Also, some cities rely on systems like trade and investments to help connect to other cities. Some cities also depend on the systems of other cities in order to thrive. Due to how important these systems are, and their interconnectedness, as well as how they connect cities, a disruption in one system could affect many other systems and cause activities in a city to come to a halt (Tyler and Moench, 2012). The floods in Bangkok from October to November 2011, for example, flooded local manufacturing facilities that produced computer and auto-mobile components. This affected the global supply chains of these components. It also led to the temporary closure of these factories and caused the lay-off of workers in many cities even outside Thailand (Chachavalpongpun, 2011).

Incorporating flexible and diverse systems in our cities whose failure do not cause the failure of other systems and the disruption of activities is what is referred to as resilient systems. For systems to be resilient, they should possess the following characteristics; flexibility and diversity, redundancy and modularity and safe failure (Tyler and Moench, 2012; Moench, 2014).

a. Flexibility and Diversity

Flexible and diversified systems are able to provide essential services under varied conditions and could be applied in different ways as well. They are also adaptable to change and hence could be modified when there is a need for an upgrade. For diversity of systems, its key assets and functions are distributed to different locations so that one disturbance does not affect them all at once. The systems should also have varied ways of meeting a need.

b. Redundancy and Modularity

Redundant and modular systems make available more systems than required to serve contingency situations, like surge in demand of those systems or the likelihood of failure of one of those systems. They apply buffer stock principles.

c. Safe Failure

The safe failure of a system is the ability of the system to absorb sudden shocks such that its failure is not highly catastrophic to cause a sudden breakdown of the system. It also helps ensure that the breakdown of one system does not cause the breakdown of all other systems that are interrelated or dependent on that system.

Agents

Agents are individuals, organizations, government entities, businesses, community advocates or households whose lifestyles are structured by their location or the structure of their society, their preferences, their opportunities and their constraints. They are capable of making purposive decisions, deliberating on issues, making independent analysis, engaging in voluntary interactions and making strategic choices when issues spring up. The capacity of individuals and organizations is vital to building resilience (Leichenko, 2011). They have identifiable but varied interests and opinions. Through strategy, experience and learning, they develop enough capacity to change behaviour when situations occur. However, circumstances make agents' ability to change difficult. Hence, it is important to understand and recognize the opportunities and constraints agents face as well as the incentives they can respond to in order to help them change and adapt to new behaviours in response to situations.

Agents are responsible for the creation, management, operation and use of systems; however, each agent is involved in varied ways pertaining to the above activities. While some are involved in the creation of some systems, others just consume the systems. Capacities of agents to help build resilience depends on their financial status, their physical assets or possessions, their natural or environmental assets, their social assets like families, friends and clans, their human assets like health and skills and their educational or knowledgeable assets. Agents depend on these assets when situations arise and depend on them as resources to enhance their wellbeing and ensure their safety. The assets influence the levels of agents' vulnerabilities and their ability to respond to situations (Pelling, 2003). The availability of these assets does not prevent the occurrences of hazards or other situations. They are however useful to help agents adapt to critical situations and build resilience.

Agents collectively organize and plan for preventive risk reduction strategies either autonomously through community groups or through the support of local governments. This helps them prepare towards risks and effectively respond to them when they. In order to build agent resilience, the following characteristics have to be developed (Tyler and Moench, 2012; Moench, 2014):

a. Responsiveness

Agents are responsive when they have the capacity to identify problems, plan, prepare for the problem and respond quickly after the problem has occurred.

b. Resourcefulness

Agents are resourceful when they are able to mobilize various assets and resources to help prepare or respond to problems. Organizations usually have enough financial assets to help tackle issues. The ability to access supporting systems also determines the resourcefulness of agents.

c. Capacity to Learn

This refers to the ability of agents to learn new skills, identify and learn from past experiences in order to avoid repeating failures, and the ability to innovate in order to improve performance. Becoming aware of hazards and the ability to access enough information about these hazards and how to respond to them all help build capacity for resilience building.

Institutions

"The concept of institutions in social sciences refers to the social rules or conventions that structure human behavior and exchange in social and economic interactions" (Tyler and Moench, 2012). Institutions help order and direct human behavior for easy predictions (Campbell 1998). They direct the interactions between agents and systems in responding to climatic issues.

Institutions have the ability to either engage or constrain agents in decision making processes. This helps determine whose interests are of importance. They provide either formal or informal structures that organize agents through communication, recruitment, transport and remittances. With that, they shape the ability of agents to gain access to systems such as food, transportation and other essential services. For agents that are highly marginalized and constrained from accessing essential services they become much more vulnerable to climate impacts than those with services (Moser and Satterthwaite, 2010)

They also help regulate systems or infrastructure by applying standards and codes which in turn determine if those standards and codes help meet the needs of users. They also help develop the pricing structure of services or systems which helps determine which infrastructure may benefit in the society.

Institutions are responsible for ensuring the communication of vital information on how to make use of resources and systems when issues occur. They also help foster learning and change in order to build agent capacity. The ability of agents to learn and find innovative ways of solving issues helps produce viable legislated codes and standards that are beneficial to solving issues. The necessary characteristics for building institutional resilience include (Tyler and Moench, 2012; Moench, 2014);

a. Rights and Entitlements in relation to Accessing Systems

The rights and entitlements of all towards the usage of resources or systems should not be constrained in ways that reduces resilience opportunities for the marginalized.

b. Decision-Making Processes

Transparency, accountability and responsiveness is required and tagged as good governance during decision making processes towards development or system management. This helps the marginalized or those most impacted by hazards to make to make legitimate inputs during decision making.

c. Information Flows

All agents, including households, businesses and organizations should have ready access to credible and meaningful information about risks so that they are able to prepare towards them and build resilience. This will reduce the impact of the shocks on them, and help them bounce back easily after shocks due to their preparedness.

d. Application of New Knowledge.

Institutions that support the generation of new knowledge, and ensures that the knowledge is distributed and applied when shocks occur, enhance resilience.

The Link Between Systems, Agents and Institutions

Systems, agents and institutions are treated as separate elements for in depth analysis. However, they are integrated as a framework for total climate resilience due to their interdependencies and linkages, the strongest of those linkages being that of institutions to agents and systems. Figure 2.1 shows the process by which the framework can be applied to resilience building.

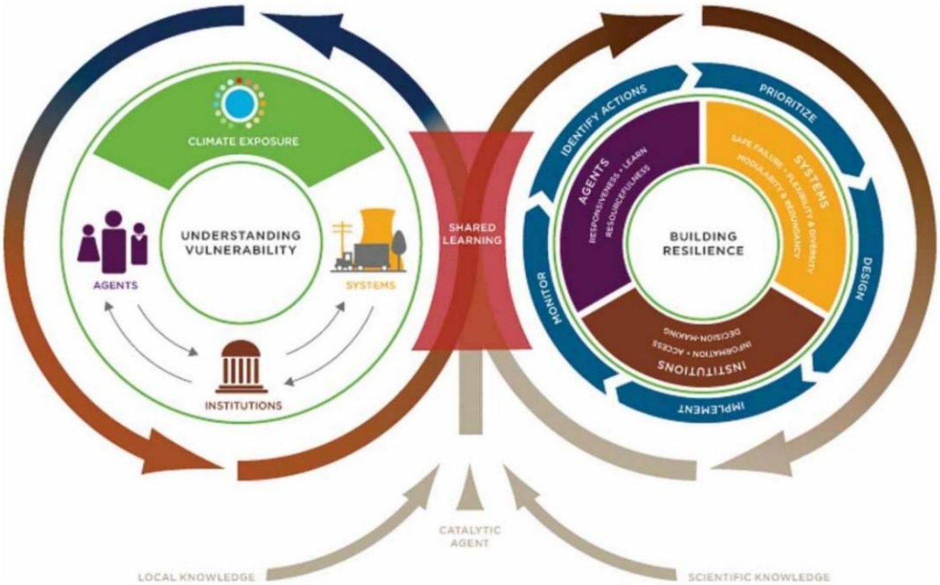

Figure 1: The Climate Change Resilience Framework
Source: Tyler and Moench (2012)

The diagram shows two iterative tasks. The first structures the Climate Resilience Framework as an analytical framework that first assesses or understands the vulnerabilities with regard to systems, agents, institutions and the climate exposure.. The second iteration is structured as an iterative planning process that encourages shared learning in order to build understanding and eventually build resilience. It focuses on the steps that can be taken to build resilience. The process for building resilience begins with an analysis, followed by the identification of context specific actions, prioritization, design, implementation and then monitoring. Since it is an iterative process, the analysis could begin again.

Profile of Azizakpe

The study area for this research was Azizakpe, a fishing community in the Ada East District of Ghana. Azizakpe means dwarf-stones. It is an island on the Volta River that sits at the estuary of the Lower Volta. It occupies an area of 301, 420sqm and stretches 1, 135m by length and 351m by width. It also has a perimeter of 3, 222m.

A member of the Terkpebiawe clan received Azizakpe as a gift from a member of the Kudragbe clan for saving his life. The first settlers, the Tekpebiawe people, were chased out by dwarfs who stoned them. The dwarfs lived in the thick mangrove forest of the island but no longer reside on the island. The fishing community accommodates about 476 people which is lesser than the population of the community after the 2010 population census, 690 people, and the projected population for 2018, 939 people. The number of houses identified on the site was 56 with an average household size of 5 people. Azizakpe is boarded by the Volta estuary, Kewunor, Azizanya, Alorkpem and Treasure Island.

Table 1: 2000 and 2010 Population Size, and Projected Population Size

YEAR	2000	2010	2011	2011	2012	2013	2014	2015	2016	2017	2018
POPULATION	516	690	714	739	765	791	819	847	877	908	939

Source: Ada East District Assembly

The Problem

As can be identified in Figure 2, the original position of the estuary used to be farther away from the site. The Akosombo Dam's construction and the issues of poor sanitation in the region led to the ingress of hyacinth weeds in the river and the spread of bilharzia in the river since 1968 (Nyekodzi et al, 2016; Sokolow, 2015). The Volta River Authority (VRA) who is in charge of the Akosombo Dam took on the project to help reduce the bilharzia infection in the river. They did this by dredging a part of the mainland (a sand bar) that separated the river and the sea and protected the island communities in the river (Nyekodzi et al, 2016; VRA, 2022). This project began in 1990, lasted for twenty-six (26) years and ended on 24th July, 2016. (Nyekodzi et al, 2016; VRA, 2022; GhanaDot.com, 2016).

Although the dredging has helped reduce the bilharzia infection in the river through the direct ingress of huge volumes of the salty sea water, it has also made way for the erosion of island communities in the river. Azizakpe, which is closer to the estuary than the other island communities, has been impacted most. As can be seen in Figure 2, the estuary has widened as compared to what it used to be in the year 1985. The shape and size of Azizakpe has been significantly impacted as well.

Fig 2: The 1985 and 2020 Map Showing the Initial State of the Estuary and its Widened state now.

Source: Google Earth

The Effects

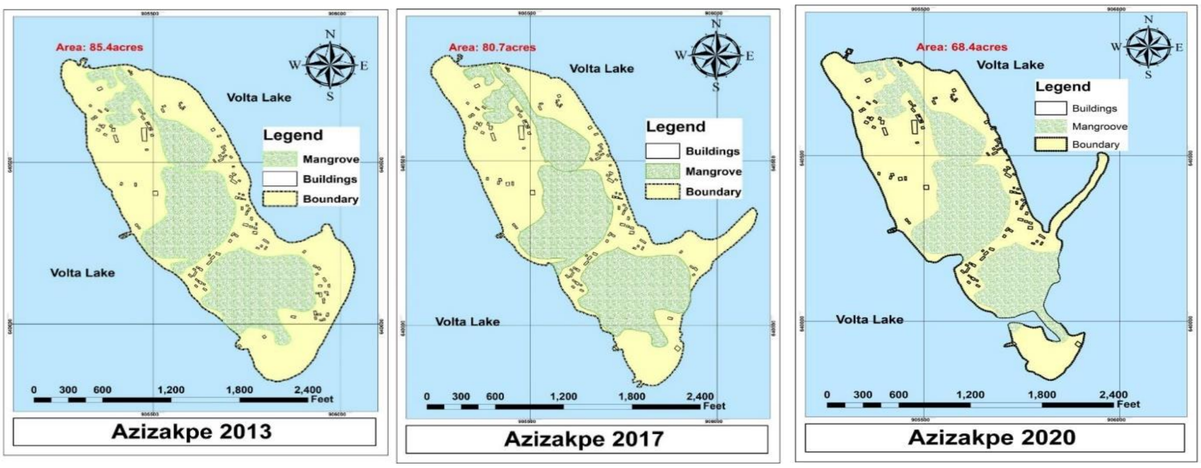

Fig. 3 The Levels of Erosion after 2013
Source: GIS

Over 20 acres of Azizakpe's land has been lost to erosion. This has negatively affected the agents(stakeholders), the systems and the institutions of the community both at the environmental scale and the economic scale. Most inhabitants have emigrated to safer areas in the community or to other communities. It has also caused the distraction of many plants and animals. Farming activities have come to a halt, and the dependence on the river water and boreholes for all forms of activities has also reduced because they are now salty. This has increased the cost of living of the people since food and drinking water are imported into the island.

As a fishing community, Azizakpe also engages in other occupational activities such as coconut oil production, crab hunting, boat making, fishing, weaving, broom making and animal rearing. However, the floods and erosion have caused the fall of a number of coconut trees and the low production of coconuts in the community; causing economic hardships for those who depend on them to make coconut oil, brooms or weaved products for income.

Coping Strategies

Table 2: Implemented Projects by various Stakeholders

	Government	**Private sponsors**	**NGOs**	**Community Driven Interventions**
Community Scale	Rock Sills at estuary	Car tyres wall filled with concrete	Mangrove restoration projects	Rock chippings perpendicularly arranged to river
		Sand bags and tubes filled with sand		Wooden bridges
		Chemical storage tanks		Arranged remnants of buildings and coconut trees along river
				Jute sacs filled with sand
Building Scale				High plinths
				Creating sand-filled planters
				Raising buildings on stilt
Total (%)	**8.3**	**25**	**8.3**	**66.7**

Source: Author's Construct

State of Strategies

a. Community Scale: There were a number of coping strategies identified at the community scale to help reduce the impact on the community. Although some of these strategies have not been effective enough, some have been very helpful in preventing massive erosion from taking place. Small pieces of rock have been arranged perpendicular to the river on the western part of the site. The idea around this was to help sand fill up behind the rocks when the tides were high instead of drawing sand away. This strategy has been effective at the main estuary where larger rock sills were arranged for sea defense but not at Azizakpe due to the rock sizes.

Car tyres filled with concrete have also been arranged at the western part of the site. The idea behind this strategy was also to help stabilize the soil from being carried away by floods due to the sandy nature of the soil. This strategy has been quite effective. Its however sinking in since the base sand finds way to slowly wash away.

Sand bags and tubes have been arranged all around the southern part of the site to help reduce erosion. Eroded sand was dredged into the bags and placed at the beaches of the site. When the high waves draw water behind the bags, they are not able to draw sand away in large quantities while they recede, making the strategy fairly effective.

Fig. 4 Sand Tubes for Erosion Control (Source: Author's Photograph)

Fig. 5 The Mangrove Restoration Project (Source: Author's Photograph)

One bridge has been constructed behind the school and anther created with a fallen coconut tree at the north-west of the site. These bridges help navigate these areas since they flood up most when the tides are high. Remnants of broken-down buildings and coconut trees are left along the shores to help reduce the impact of the erosion. This strategy has not been effective.

Fig. 6 The Jute Sacs for Erosion Protection Failed (Source: Author's Photograph)

Fig. 7: Car Tyres Filled with Concrete (Source: Author's Photograph)

The mangrove swamp is another resilient strategy that existed, was destroyed, has been restored and is still being destroyed by the inhabitants. The restoration project was undertaken by the Ada East District Assembly, the Forestry Commission and the Ada Tourism Stakeholders Association. The inhabitants however cut these mangroves for firewood or their building structures even at the erosion prone areas. They do not replant these mangroves usually because mangroves can grow all by themselves. This has made the mangrove swamp at the south-west of the community ineffective in preventing erosion since most of the plants have been cut off.
Two strategies have already failed. These projects include the use of jute sacs filled with sand and the use of chemical storage tanks filled with sand as defense. The waves usually drew them away.

b. Building Scale: A few buildings have also implemented a few strategies to make them resilient against the floods. Some of these solutions include having high plinths, creating sand-filled planters, surrounding coconut leaves buildings with block work to prevent flood water ingress, laying concrete filled pipes around their buildings and raising buildings on stilt.

Fig. 8: 600mm High Plinth (Source: Author's Photograph)

Fig. 9: Concrete-filled 4inch Pipes Around Building (Source: Author's Photograph)

Fig. 10: Sand-filled Planters (Source: Author's Photograph)

Fig. 11: Sandcrete Blocks around Coconut Leaves Buildings (Source: Author's Photograph)

Assessing the Resilience of Systems

Table 3: Characteristics of Projects

	Government	**Flexible and Diverse**	**Redundant**	**Modular**	**Safe Failure**
Community Scale	Rock Sills at estuary	√	×	√	√
	Car tyres wall filled with concrete	√	×	√	√
	Sand bags and tubes filled with sand	×	√	√	√
	Chemical storage tanks	×	×	×	×
	Mangrove restoration projects	√	√	√	√
	Rock chippings perpendicularly arranged to river	×	×	×	×
	Wooden bridges	×	×	×	√
	Arranged remnants of buildings and coconut trees along river	√	√	×	√
	Jute sacs filled with sand	×	×	×	×
Building Scale	High plinths	√	×	×	√
	Creating sand-filled planters	√	×	×	√
	Raising buildings on stilt	√	×	×	√

Source: Author's Construct

a. Flexibility and Diversity

Varied solutions have been implemented within the community to address the impact of floods and erosion. While the solutions were applied in different ways , they are also upgradable. The solutions are also diverse since they are implemented at different portions of the community allowing for independent system failures. Independently, the solutions are however not flexible enough since they are not able to adapt to different conditions apart from solely ensuring that the floods or erosion do not cause great impact.

b. Redundancy and Modularity

Although the solutions are diverse, only the sand bag or tubes and the mangrove forest are redundant. This is because most of the solutions were community-driven and lacked scientific research or expertise backing their implementation. Hence, the community's willingness to find the best solutions against the flooding and erosion led to implementing diverse solutions that were not repetitive. The varied solutions are as well not systematically connected, and hence not modular.They were haphazardly distributed in the community, based on where the impact was felt most.

c. Safe Failure

A number of the applied strategies have failed, including the use of jute sacs filled with sand and the use of chemical storage tanks filled with sand as defence. The diversity and interdependence of the applied strategies ensure that the failure of one system does not impact all the other systems. Some of the other strategies are also able to absorb sudden shocks and are slowly deteriorating because the implemented strategies are not holistic enough.

Assessing the Resilience of Agents

a. Responsiveness

Due to the cyclical nature of the diurnal and semi-diurnal floods, the inhabitants are able to identify, plan and prepare towards them. Although the methods of preparation are not extensively advanced, they are still able to protect a number of valuables.

b. Resourcefulness

Due to the economic challenges of the community, they are unable to fully mobilise enough assets and resources to help prepare and respond to problems. They are however able to use natural and already existing resources like mangrove plants, coconut trees, sand and broken buildings to help cope with the issues. Hence, their coping strategies are not very effective and durable. Although government, private sponsors, and NGOs have been resourceful in supporting the community, they are unable to fully access relevant supporting systems who could help them build resilience. These supporting systems include technical expertise, social service systems and full government support.

c. Capacity to Learn

Learning from past experiences, the inhabitants are able to adapt to the climate issues. The community is able to identify and prepare for the cyclical nature of the floods and erosion. As such, the effects on their valuables is low. There are however no institutions set up to identify and assess the sudden occurrence of floods and erosion and their likely intensity. Hence, the inhabitants are unable to access prior information about such events, and prepare towards them. A few vacation homes in the community are elevated on stilts to avoid water entry into their interior spaces. The inhabitants have however been slow in adopting this style of building due to financial issues, inadequate construction expertise and inadequate knowledge of its effectiveness. Most of the community driven projects have however been ineffective because of lack of expertise.

Assessing the Resilience of Institutions

a. Rights and Entitlements in relation to Accessing Systems

The focus of the district assembly within which Azizakpe falls has been to generate and mobilise income for the district. Hence, building resilience for the communities experiencing floods and erosion hasn't been on top of their priorities. This has reduced the opportunities for building resilience for Azizakpe and other communities that get affected by floods and erosion. The Assembly however supports the communities with relief items to support the communities after they have been affected.

b. Decision-Making Processes

According to the inhabitants, they are hardly included in decision-making processes. This reduces the appreciation of most projects done within the community. The low involvement of the community through sensitization and collaboration has caused the continuous depletion of the mangrove plants which can curb the impacts of floods and erosion in the community.

c. Information Flows

As mentioned earlier, there are no institutions set up to identify and assess the sudden occurrence of floods and erosion and their likely intensity. Hence, the inhabitants are unable to access prior information about such events, and prepare towards them. As such the impact of shocks on the community affects them greatly such that they are unable to bounce back easily.

d. Application of New Knowledge.

Currently, there are hardly any institutions that support the generation of new knowledge or solutions that could be applied in the community to build resilience against the floods and erosion. However government institutions like the National Disaster Management Organisation (NADMO)help ensure that knowledge is distributed and applied when shocks occur so that inhabitants are aware of how to tackle the impacts.

Discussion

Small island communities in developing countries find it difficult to achieve climate resilience due to the limited adaptive capacity of the agents or stakeholders. According to Nasir et al. (2020), adaptive capacity is the ability for agents to adapt to and learn from disturbances after they have occurred, such that strategies will be formulated to prevent the intense impact of future shocks. It also involves the ability of agents to mobilise resources for adaptation. Considering the state of Azizakpe, all stakeholders have been identified to have very low adaptive capacity. While there has been much effort by individuals, NGO's and the community to help curtail the impact, their efforts have generated less results due to low capacity, which is mainly financial and technical related. As such, they have been unable to provide adaptive strategies that have been very effective, and factored the entire community as a whole. The adaptive strategies can be referred to as piecemeal.

It is generally expected that government takes charge of development and welfare projects. This includes projects that create climate resilience against climate crisis especially in highly vulnerable areas. However, African governments, including the Ghana government, have contributed negligibly to reducing the impact of the situation (UNEP, 2024). This is because of lack of resources and the need to settle their most pressing needs. The continent is characterised by socio-economic priorities such as food security, creation of jobs for the youth and economic expansion (UNEP, 2024). Thus, the focus on creating climate resilience has been low.

Through the interviews conducted, it was identified that most of the solutions were haphazardly implemented, scattered, inconsistent and not fully implemented at all vital areas. This was because of limited resources that were needed to implement each of the solutions. For example, the sand bags and tubes were only implemented at the south and partially on the east. This was because of the cost of the tubes itself and the cost of filling it with sand.

The ignorance on the benefits of mangrove plants in the community was another issue that was identified. The community cut the plants anywhere without replanting although they have been informed of its benefit in reducing the impact of floods and erosion.

Interviews were conducted to identify the proposals stakeholders may have in building resilience for their community. From the interviews conducted for stakeholders, they considered sea defence as a better solution against floods and erosion. They cited examples of how the rip rap walls at the estuary and a man's residence have helped reduce the action of erosion in those areas. Hard structural solutions however interfere with natural shoreline processes. They interrupt the movement of water and sediments and as a result may actually increase erosion in attempting to control it (McCreedy, 2018). The impacts of floods and erosion are low in areas where natural barriers like mangroves, coral reefs or coastal vegetation are present.

Living shorelines or nature-based solutions have proven however to be more sustainable and affordable. They incorporate vegetation and other living or natural elements like oyster reefs or rock sills for added stability (McCreedy, 2018). They are more environmentally sensitive. They maintain continuity of natural land-water interface and reduce erosion while providing habitat value and enhancing coastal resilience (McCreedy, 2018). It is therefore a good option for developing countries who cannot afford sea walls for coastal protection, and depend economically on water bodies (World Bank Group). For example, restoring mangroves has proven to be more cost effective as a defense than building and maintaining seawalls (EPIC, 2016). The net economic value or profit derived from using mangrove forests for coastal protection is $390,609 per year in the Krabi River Estuary (EPIC, 2016). Seawalls, unlike mangroves and other nature-based solutions, accelerate erosion elsewhere when waves are deflected down shore. The net economic value derived from mangroves for carbon sequestration is $22,466 per year, in the Krabi River Estuary (EPIC, 2016).

Since Azizakpe already has mangrove plants, more of these plants could be grown at vital areas to help build resilience against floods ad erosion. The district assembly also believes that the mangroves in the community need to be protected since they were ideal for coastal protection. There however needs to be strict regulations to ensure that the plants are not harvested in areas that will make it ineffective against floods and erosion. Rock sills could also be used to strengthen the resilience of the mangrove plants.

At the building scale of the environment, all stakeholders proposed that buildings should be designed such that the flooded water and river snakes do not make way to the homes to destroy their properties as well. They also proposed the need to make buildings resilient against cracks as a great way of keeping them resilient, especially based on the building materials applied. Floatinmmg or amphibious buildings have proven to be resilient strategies against floods and erosion. They are able to withstand high wind loads since they are not permanently raised to the top like buildings on stilts. They also prevent flooding of buildings since they rise and fall when water levels rise or recede on land.

Conclusion

Drawing on the case of Azizakpe, this paper sought to explore how resilient the employed adaptation strategies in developing countries are. The adaptation strategies employed in Azizakpe were identified, analysed and discussed. It was identified that most of the solutions were haphazardly implemented and lacked technical expertise backed by research. It was also identified that individuals, the community and NGOs have placed much effort in building resilience especially because of inadequate attention of government to the issues the community, and many other vulnerable coastal communities are facing. From the research, it has been identified that for climate resilience to be achieved, there needs to be collaborative effort between the state government, private sector and grass-root support. There is a however need for education to manage these processes. Critically, we point out the need to for all stakeholders to put together resources, especially their financial, technical and research expertise so that well informed, and practical climate resilient and adaptable strategies are applied to reduce this menace.

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The Interactive Influence of Institutional and Behavioural Factors on Green City Development

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Abstract

With an unequivocal objective that cities should provide their residents with high-quality places, the prospect of rapid growth in the world's population has spurred a need to develop new cities or enhance the sustainability and resilience of existing cities to effectively adapt to future changes. Despite these efforts, studies indicate that there exists an empirical gap to elucidate the interactive influences institutional and behavioural factors (IBFs) have on green city development (GCD). Consequently, this study assessed the influence of IBFs on GCD. A comprehensive review of relevant literature revealed that both institutional factors and behavioural factors influence GCD. The study was premised on a pragmatist philosophical stance and deductive reasoning which guided the epistemological positioning of this research. The study utilised a quantitative research method to gather data from experts in the field of green city development, and professionals with expertise in urban sustainability issues by administering a specifically designed questionnaire. The collected primary data were analysed with a one-sample t-test. Subsequently, the study hypothesis was subjected to validation through linear regression analysis. IBFs were found to have critical influences on GCD viz. influencing design schemes of green projects or development, the depletion of non-renewable resources and the financial feasibility of green projects or developments. This study adds to the emerging discourse on green city improvements in Ghana. Furthermore, to the best of the authors' knowledge, this is the first study that investigates the influence of institutional and behavioural factors on the development of green cities.

Keywords – green city; influence; urban; institutional factors; behavioural factors, Ghana.

Introduction

The UN DESA (United Nations Department of Economic and Social Affairs) reported in 2021 that, the global population of 7.8 billion in 2020 is exhibiting a swift increase and is anticipated to

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persist in its growth trajectory in the forthcoming decades, reaching nearly 11 billion by the end of the 21st century (UN DESA, 2021). The prospect of a swift surge in global population has engendered a necessity to develop new cities centres or retrofit extant ones to not only achieve sustainability but also be resilient against emergent transformations, with a primary intent of endowing cities with high-quality living environments for their inhabitants (Iwan and Poon, 2018). According to the Organisation for Economic Co-operation and Development (OECD) and the European Commission (2020), these urban areas not only accommodate approximately 50% of the global populace, but they also serve as crucial hubs for economic operations and advancement.

In contemporary times, sustainable development has garnered significant attention due to the urgent environmental and social challenges confronting the global community, propelled by ongoing innovations that consistently augment the well-being of individuals (Silvestre and Ţîrcă, 2019). Thus, green cities have emerged as a key concept in sustainable urban development, aimed at enhancing environmental sustainability, quality of life, and resilience in cities (Debrah et al., 2020). The term "green" has been frequently associated with the concept of sustainability and its related concerns, which prioritise efficient resources and energy utilisation (Brilhante and Klass, 2018). According to Hoornweg and Freire (2013), the establishment of environmentally friendly urban settings necessitates the bridging of knowledge and research gaps, the enhancement of stakeholder participation, and the promotion of behavioural or psychological transformation at all levels, including national, local, corporate, and individual. Hence, it is imperative to bear in mind that the development of green cities vies for precious land resources, incurs carbon and energy footprints, and may entail protracted compensation periods for the attainment of net benefits, which are ensured through a deliberate strategy, rather than the mere presence of green cities (Tan and Jim, 2017).

The concept of a green city can elicit diverse interpretations among individuals, encompassing a spectrum of human responses to the composition and presence of natural elements within and surrounding urban areas (Tan and Jim, 2017). This concept is not new (Lewis, 2015) as it has been previously couched in the term "sustainable development" which seeks to incorporate environmental, social, and economic considerations into development procedures (Ogunmakinde et al., 2022). Breuste (2023) defines a green city as a city that prioritises the protection, sustenance, and extension of all forms of nature that constitute green infrastructure, for the betterment of its inhabitants. According to Simon (2016), a green city is a carefully designed new settlement that not only improves the natural environment in its vicinity but also provides affordable housing and employment opportunities that are easily accessible to the local populace in pleasant and safe communities.

A few studies have highlighted the benefits of green cities in Ghana, including reduced carbon emissions, improved air and water quality, enhanced biodiversity, and healthier living conditions (Owusu-Manu et al., 2021; Debrah and Owusu-Manu, 2022 Debrah et al., 2022; Debrah et al. 2023). However, the development of green cities faces several barriers, especially in developing countries like Ghana. Key barriers identified in the literature include lack of awareness, environmental degradation, insufficient policy implementation, excessive waste generation, financial constraints, and unplanned urbanization (Debrah et al., 2020). At the root of these barriers are institutional and behavioural factors that inhibit the transition to greener and more sustainable models of urban development. According to Lindfield and Steinberg (2012), the emphasis on the advancement of environmentally sustainable urban areas should be redirected towards institutional and local capacity building, which will promote a shift in behaviour and prioritise green development initiatives, while not disregarding the physical elements of the city.

On the institutional side, studies point to weak policy and regulatory frameworks, lack of political commitment, funding limitations, and poor coordination among agencies as key obstacles to green city development (Debrah et al., 2022; Debrah and Owusu-Manu, 2022). There exists also a lack of standards, guidelines, and assessment tools tailored to the local Ghanaian context. On the behavioural side, there is low awareness among the public and key stakeholders about the concept, benefits, and practices of green cities (Debrah et al., 2022). Poor attitudes and perceptions inhibit the adoption of more sustainable behaviours and lifestyles needed to enable green cities. Overall, existing studies establish a range of barriers but do not provide an in-depth analysis of how these institutional and behavioural factors interact to shape green city development outcomes in the Ghanaian context. Addressing this knowledge gap is vital to inform evidence-based policy and practical interventions.

The barriers to green city development in Ghana are underpinned by unsupportive institutional arrangements and prevailing social attitudes and behaviours. This hampers evidence-based decision-making on requisite reforms and interventions needed to promote green cities as a pathway to urban sustainability. While highlighting various barriers, current studies do not provide an in-depth analysis of the institutional and behavioural factors shaping green city development. There is a lack of empirical evidence on the specific institutional weaknesses (policy, legal, regulatory, coordination etc.) hindering green city development locally; the prevailing social perceptions, attitudes, and behaviours inhibiting the adoption of green city concepts and solutions and how the institutional and behavioural dimensions interact to impede progress towards green cities. Therefore, this study seeks to address these empirical gaps focused on the Ghanaian context to provide vital insights to inform policy reforms, practical interventions, awareness creation, and stakeholder engagements critical for enabling green cities.

Green City Development (GCD)

Campbell (1996) posited that during the 1990s, the concept of sustainability was characterised by the amalgamation of social value, economic development, and environmental preservation in the context of urban development. The emergence of the concept of sustainable development led to the creation of other related concepts, such as green urbanism (Bhargava et al., 2020; Lehmann, 2011), sustainable cities (Bednarska-Olejniczak et al., 2019; Al-Nasrawi et al., 2015), and green cities (Breuste, 2023). These concepts remain relevant today and are central to discussions on the impact of city designs, urban forms, energy consumption, natural resource utilisation and other related factors (Brilhante and Klass, 2018). According to Pearson et al. (2014), the notion of urban sustainability encompasses more than just sustainability objectives or ambitions; it primarily focuses on the resilience of the process of urbanisation.

During the Mayor's Forum of the World Cities Summit - New York in 2015, Jan Eliasson, the former UN Deputy Secretary-General, expressed his belief that "cities are where the battle for sustainable development will be won or lost if we fail." Eliasson's assertion suggests that urban areas must be constructed in a manner that enables them to withstand the persistent disturbances caused by both natural phenomena and human actions, with particular emphasis on the ecological aspects of cities. Hence, the advent of sustainable urban development. According to a report by the Global Green Growth Institute (GGGI) in 2016, the development of green cities can be attributed to various international commitments such as the Sustainable Development Goals (SDGs), Intended Nationally Determined Contributions (INDCs), and the 2015 Paris Agreement. Furthermore, it highlights the objective of attaining "climate resilience and environmental sustainability," "social inclusion and poverty reduction," and "economic growth" as the fundamental motivators of green city development.

The green city concept represents a contemporary approach to addressing the challenges posed by the dispersed urban development model and enhancing the liveability of cities. This approach has emerged as a result of extensive research and endeavours aimed at mitigating the issues associated with urban sprawl (Brilhante and Klass, 2018). The concept of a green city is founded on the principle of sustainable development, as explicated by El Ghorab and Shalaby (2016) as a cognitive process and a lifestyle choice that employs rationality and intuition as a foundation, regarding sustainability as a philosophy or an ethical stance that enables individuals to contemplate the far-reaching implications of their actions and to adopt a comprehensive perspective that transcends conventional disciplines and boundaries.

The literature about the development of green cities encompasses a diverse range of terminology, which although often used interchangeably, should not necessarily be regarded as synonymous. These terms include "green city", "sustainable city", and "smart city". According to Polzonetti and Sagratella (2018), the differences in meaning between the aforementioned terminologies are explicated as follows:

(a) "A green city is a city that aims at developing infrastructures, spaces, facilities, and urban activities with a low or even no environmental impact."

(b) "A sustainable city is a city that aims at developing a socio-economical urban context able to balance economic development with respect for the environment and social equity."

(c) "A smart city is a city focusing on the use of technologies to improve life quality in urban areas."

Researchers contemplate the term "green city" and its correlation with other terms such as "sustainable," "eco-," "low carbon," and "smart city" (Kankaala et al., 2018). The aforementioned thoughts are closely associated with the concept of sustainable development, as posited by Leźnicki and Lewandowska (2016). Certain urban areas that have undergone or are undergoing the process of eco-modernization, known as "transformation towards eco-city" can be classified as green cities (Hu et al., 2016). Moreover, extant literature about green cities is associated with socioeconomic factors (Szyja, 2019). Several studies have examined the significance of these cities for diverse groups of stakeholders and their impact on the development of city branding (Fok and Law, 2018).

The concept of green city development pertains to the deliberate design and construction of communities that are conducive to the well-being of both humans and the environment. This is achieved through the implementation of sustainable practices that aim to reduce resource consumption while promoting the creation of more sustainable areas, societies, and behaviours. The interdisciplinary nature of eco-city design necessitates the involvement of various professionals such as urban planners, architects, environmentalists, engineers, transport physicists, psychologists, financial experts, sociologists, and other experts in the development of green cities (Tanner et al. 2014; Childers et al. 2015).

Green city discourse in Ghana

Ghana has been experiencing steady urbanization over the past decades, with the urban population reaching over 50% in 2021 (Ghana Statistical Service (GSS), 2021). Major cities like Accra, Kumasi and Takoradi have undergone rapid expansion without adequate planning, resulting in sustainability challenges. For instance, Ghana was found to have the second most polluted air in Africa in 2019 (IQAir AirVisual, 2020). Ghanaian cities also grapple with problems like flooding, plastic pollution, inadequate sanitation, and encroachment on green spaces (Srivastava and Paslowska, 2020).

While the green city concept has taken root globally, particularly in developed economies, there is limited research on green cities in Ghana specifically. Recent studies have sought to address this gap by examining green city development, barriers (Debrah et al., 2022), drivers (Debrah et al., 2023), indicators (Owusu-Manu et al., 2021), key sustainability content of green city (Debrah et al., 2022) and a potential green city framework (Debrah and Owusu-Manu, 2022). Debrah et al. (2022) reviewed the literature on green cities and conducted an expert survey to identify key barriers hindering green city development in Ghana, including lack of awareness of green city benefits, environmental degradation, and insufficient policy implementation. In another study focused on Kumasi city, Owusu-Manu et al. (2021) identified eight key indicators for measuring green city development. In a follow-up paper, Debrah and Owusu-Manu (2022) proposed a green city assessment framework tailored to the Ghanaian context, using Kumasi city as a case study. Their proposed Green City Framework comprised eight key performance indicators: air quality, water, sanitation, land use, health and safety, transportation, energy, and buildings. On the other hand, Debrah et al. (2023) using an exploratory factor analysis and fuzzy synthetic evaluation proposed four main drivers: health and wellbeing, green attraction and social inclusion, green governance and management, and green environment and materials.

Overall, the presented studies provide early investigations on green cities in Ghana. While they put forward frameworks, indicators, barriers and drivers, there is still limited understanding of national policy directions, actual development and implementation, monitoring mechanisms, and the role of stakeholders. Significant knowledge gaps also exist concerning how green city concepts and learnings from other countries may be adapted contextually to Ghanaian cities. Nevertheless, the studies represent a starting point and highlight the need as well as potential pathways for sustainable urban transitions in Ghana.

Contextualising the Influence of IBFs on GCD

The research conducted by Wang and Chan (2019) revealed that the primary determinant of earning capacity, stability and profitability of government finances is the initial ownership of land or property. The study also indicated that cities developed on public land tend to exhibit greater support for urban green initiatives. As per Walsh's (2017) findings, the possession of public property offers benefits in terms of robust policing capabilities, which are an inherent aspect of sovereignty enabling cities to partake in city planning by regulating land use. The findings of Wang and Chan's (2019) research suggest that while private land ownership at the outset is effective in ensuring financial stability, it falls short in terms of land use control, land availability, and fiscal capacity to provide urban spaces. The aforementioned assertion is consistent with the findings of a study carried out in the Netherlands by Buitelaar and Segeren (2011). The study posited that the morphology of development is influenced by the initial allocation of property rights. Specifically, the inability to acquire property rights is linked to the modification of site boundaries and the retention of pre-existing land use. Additionally, the cost of acquiring land rights has a bearing on the financial viability and design of a development project.

According to Wang and Chan (2019), the determination of the type of instrument that can be implemented is contingent upon the condition of the initial land ownership. According to Zhou and Wang (2011), the possession of land resources by local governments, whether through inherent ownership or acquisition, leads to the prioritisation of fundamental planning and regulatory mechanisms such as zoning ordinances, comprehensive plans, and subdivision regulations for the management of urban developments. This approach is customary in developed nations like the United States and continues to be extensively employed in developing countries like China. The escalating competition in the urban land market and the growing prevalence of private or collective land ownership have made it progressively challenging for cities to acquire land for green development. Consequently, incentive-based approaches have emerged as a viable alternative (Wang and Chan, 2019).

Incorporation of green initiatives in (re)development projects by developers necessitates the provision of incentives such as purchase for development rights, transfer of development rights, subsidies, conservation easements, etc. to prevent land development and promote extensive public access (Lichtenberg et al., 2007). The findings of Wang and Chan's (2019) research suggest that a higher level of institutional capacity is necessary for achieving the highest standards of the private-to-public ownership instrument that provides incentives to property owners for financial flexibility, as opposed to the more expensive private-to-public ownership instrument that involves purchasing properties for the development of green cities.

Zhang et al. (2017) assert that in China, local governments primarily rely on local government debts and land-related revenues that are secured by land assets to finance local public goods and promote the local economy. Research has indicated that examining the government's revenue and spending can be a viable approach to recognise and tackle the fundamental obstacles to urban green space provision, as well as to determine appropriate incentives to modify the conduct of local stakeholders (Buitelaar et al., 2011; Hotte et al., 2016). The allocation of funds in municipal budgets towards urban greening is a crucial aspect of public infrastructure and services. Typically, this is funded through the realisation of the land value and the capture of a portion of the resulting increase in value, as noted by Choumert (2010) and

Mathur (2013). Consequently, one may assert that a rise in land valuation is advantageous for funding the establishment of eco-friendly urban areas. The increase in urban trees in large cities in the United States can be attributed to urban development, as wealthy communities allocate a greater budget towards public forests (Zhu and Zhang, 2008). According to Wang and Chan (2019), governmental entities employ institutional mechanisms, such as regulatory frameworks and incentive-driven approaches, to safeguard urban environments from negative consequences, including land development market failures and urban sprawl.

The phenomenon of urban sprawl has significant environmental implications. Consequently, certain planners, design professionals, and municipalities have advocated for sustainable alternatives to traditional urban development patterns (Turner, 2017). According to Bruegmann (2015), the phenomenon of urban sprawl refers to the development of low-density settlements that prioritise automobile use and lack comprehensive public planning. Urban areas enable individuals to engage in work, artistic pursuits, leisure activities, and social interactions within a shared physical environment. However, it is worth noting that the concentration of both the population and economic activities within a limited area can result in environmental impacts and waste generation (Rubiera-Morollón and Garrido-Yserte, 2020). According to Chin et al. (2019), there is a correlation between environmental behaviour and environmental degradation, specifically air pollution. George et al. (2018) have observed that the management of natural resources is impacted by the conduct of individuals, corporations, and governments, which has a notable effect on the scarcity and sustainability of natural resources. This aligns with the concept that achieving sustainability necessitates a mindset that prioritises the safeguarding and protection of the planet's natural resources for future generations. Table I is a summary of the institutional and behavioural factors.

Table 1: Institutional and Behavioural Factors

SN	Institutional and Behavioural Factors
1.	Initial Assignment of Property Rights
2.	Instruments of Governments
3.	Institutional Capacity
4.	Environmental knowledge
5.	Environmental concern
6.	Income levels
7.	Transportation habits
8.	Awareness of green certifications
9.	Green premium
10.	Green promotion/advertisement
11.	Personality
12.	Perception of responsibility
13.	Social influence
14.	Behavioural intention
15.	Institutional Structure

Understanding the Key Green City Indicators

According to Heink and Kowarik's (2010) definition, an indicator within the fields of ecology and environmental planning, such as in the context of developing green cities, refers to a constituent or metric of environmentally significant phenomena that is employed to represent or assess environmental circumstances or modifications, or to establish environmental objectives. According to Pace et al. (2016), previous research has provided evidence for the assessment of urban sustainability through the utilisation of rankings, indicators, and indices, whether qualitative or quantitative. Brilhante and Klaas (2018) categorised the metrics utilised to evaluate the environmental sustainability of urban areas into distinct thematic domains, including socio-economic factors, CO2 and energy consumption, green spaces and land utilisation, transportation, waste management, water resources, sanitation, and air quality. Similarly, Pace et al. (2016) posit that the assessment of a city's level of environmental sustainability encompasses various indicators, including but not limited to energy, transportation, water, waste, and air quality.

The United Nations' Sustainable Development Goal 11 aims to promote the enhancement of urban areas and human settlements that are safeguarded, resilient, and sustainable. The evaluative measurement of the degree of sustainability of cities under SDG 11 is based on 13 classifications of indicators, which include CO2, air quality, energy, buildings, transport, water, waste, green areas, land use, acoustic environment, health and safety, education, equity, and participation, as stated by Pace et al. (2016). A recent study conducted by Owusu-Manu et al. (2020) identified eight key indicators for evaluating the progress of green city development in Ghana. These indicators include water (W), air quality (A), sanitation (S), health and safety (H), land use (L), transportation (T), building and construction (B) and energy (E). Owusu-Manu et al. (2020) demonstrate that the indicators commonly used to assess green city development or performance are subdivided into distinct variables. This study will prioritise the examination of the eight indicators proposed by Owusu-Manu et al. (2020), utilising quantitative metrics that are replicable in alternative geographic settings. This selection is advantageous for the current investigation as, within a geographical framework, both studies exhibit parity. Table 2 provides a concise overview of selected indicators that have been implemented to assess the sustainability of urban areas. Table 2 displays pertinent metrics for assessing the level of environmental sustainability of urban areas, encompassing land utilisation, sanitation, construction and infrastructure, energy consumption, water purity, air quality, transportation, and health and safety. The alignment of their significance corresponds with the indicators of green cities (IGC) as identified in the literature by Pace et al. (2016). Consequently, the aforementioned indicators are utilised in the current research investigation. Given that these indicators serve as measures of urban sustainability, it is acknowledged that the institutional and behavioural factors (IBFs) are positively correlated with the Indicators of Green Cities (IGC).

Table 2: Summary of Green City Indicators

GCD Indicator Category	Greenness Indicators
Land use	Green parks, urban green spaces, promoting mixed land use, preserving ecosystem and biodiversity, preserving cultural heritage
Sanitation	Minimal waste production generation, waste management plan, reducing flooding in cities, recycling and reusing, designing of green and efficient sanitary landfills
Building and Construction	Efficient design, green facades, green public procurement, affordable social housing, green linear corridors
Energy	Promoting energy efficient technologies in the city, energy saving policies, clean the efficient energy policies, reducing energy consumption, promoting renewable energy in the city
Quality of water	Efficient water storage system, treatment and reuse or disposal of sludge, improved sustainability of water treatment, preserving water sources, inhabitants served by water treatment plants
Air quality	Clean air policies, air emission rules, CO2 reduction target; ambient air quality, reduction of greenhouse gases
Transportation	Parking management, better mobility/less traffic in the city, quality transport system and bicycle lanes, formalized public transport, full integrative transport planning
Health and Safety	Health and well-being of the citizens, proper health system, resilience in the face of natural disasters, adaption of climate management, reduction of physical and chemical hazards

Theoretical framework-formulation of hypothesis

Illustrated in Figure I is the interactional relationship between Institutional and Behavioural Factors (IBFs) to the development of Green Cities (GCD). According to the findings of Wang and Chan (2019), institutional factors and arrangements play a crucial role in the decision-making process about land use and the provision of green cities. Behavioural factors also have a significant influence on the development of green cities. People's cultural beliefs and behaviours play a crucial role in achieving sustainability objectives in cities (Cazares et al., 2021). Consumer behaviour, such as the intention to continue using green products, is influenced by factors like green trust, concern for the environment, and perceived value (Nguyen and Phung, 2022). The green development behaviour of construction enterprises also contributes to resource recycling and environmental protection and is influenced by attitudes, subjective norms, and perceived behavioural control (Li et al., 2023). These factors interactively have a significant influence on the procedures followed for green city developments and ultimately determine the outcomes of such decisions. Thus, this present study posits a hypothesis (H) (Figure 1) that postulates a positive influence of Institutional and Behavioural Factors (IBFs) on Green City Development (GCD). Hence, the relationship between IBFs and GCD is one of direct proportionality.

H: IBFs have a positive influence on GCD

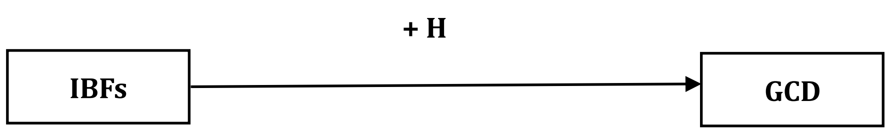

Figure 1: Interaction among IBFs and GCD.

Research Methodology

Pragmatism was the research philosophy that guided this study. This philosophical stance is common in contemporary sustainability and infrastructure literature (Owusu-Manu et al., 2021; Debrah et al., 2022; Edwards et al., 2022). This study adopts a quantitative methodological choice and a deductive approach as its overarching method and approach respectively. According to Creswell (2012), the utilisation of a quantitative method offers a systematic approach to collecting data from a vast population and subsequently summarising the findings. Borkan (2004) emphasized the importance of quantitative data-gathering approaches, which allow researchers to infer exclusively about the subject under study, and that statistical techniques may be the most effective in isolating or finding the correlates linked with changes through time. According to Burney and Saleem (2008), a deductive approach is characterised by the development of hypotheses and their subsequent testing throughout the research process. This approach is commonly utilised in quantitative research. A comprehensive review of related literature (Owusu-Manu et al., 2022; 2023) identified institutional and behavioural factors and their interactive influence on green city development. The statement aligns with the argument posited by Nakano and Muniz Jr. (2018) that a comprehensive review of existing literature is essential to substantiate the theoretical underpinnings of a research investigation.

The influences of IBFs on GCD, as identified in the literature, were transformed into a series of closed-ended questions. These questions were then utilised to construct a research questionnaire, which was subsequently administered to the study's participants for data collection purposes. The survey was distributed to individuals who possess expertise in urban development and are knowledgeable about sustainability concerns. These professionals hold positions of influence in the promotion of green city areas and sustainable urban development. Thus, construction professionals, sustainability researchers/academicians, energy experts, health and safety officers, environmental specialists, land surveyors, urban development planners, and district/municipal/metropolitan chief executives. These experts and professionals can further be categorised under the following: (i) educationists, (ii) construction and infrastructure professionals and (iii) governance.

The challenge of ascertaining the population size for a study on green city issues in Ghana has been attributed to the dearth of information on green city/sustainability specialists, as indicated by various scholarly works (Owusu-Manu et al., 2021; Debrah et al., 2023; Debrah and Owusu-Manu, 2022; Debrah et al., 2022). Consequently, the study utilised non-probability sampling methods, namely purposive and snowball sampling, to acquire a suitable sample size. Bernard (2017) posits that in research employing purposive sampling, there exists no upper limit to the number of participants required. When all necessary data for a study have been acquired, a sample is adequate (Debrah *et al.*, 2022). Snowball sampling generates a sample through referrals of study respondents from among their acquaintances (Kukah et al., 2022). Owusu-Manu et al. (2018) posit that snowball sampling is a viable method for accessing populations that are difficult to reach or concealed. This method operates under the premise that a connection exists between the initial sample and additional individuals within the same target population. Therefore, the snowball sampling technique was employed to identify participants who possess extensive and pertinent information about the study. The snowball sampling technique was utilised to obtain a sample size of 100 participants. The structured survey questionnaire was administered through self-administration using both an online survey and a drop-and-pick technique, as a result of COVID-19 restrictions (Kuoribo et al., 2022), with a response rate of 89%. This high response rate was achieved via optimal timing of follow-ups (via telephone and email) on the distributed questionnaires to respondents in the snowballing network. Participants of the study were requested to express their degree of agreement with the influences of IBFs on GCD that were identified from the literature by utilising an ordinal Likert scale ranging from 1 to 5, where 1 represents "strongly disagree," 2 represents "disagree," 3 represents "neutral," 4 represents "agree," and 5 represents "strongly agree."

Data Analysis and Results

The study's primary data were analysed using both descriptive statistics (means, standard errors, and standard deviations) and inferential statistics (relative importance index, one-sample t-test, and linear regression). The analysis was conducted using the 25th version of the Statistical Package for the Social Sciences (SPSS).

Demographic Findings

In terms of demographic profile, findings revealed participating construction professionals to be frequency (*f*) = 33, urban development planners (*f* = 16), environmental specialists (*f* = 14), health and safety officers (*f* = 10), land surveyors (*f* = 6), energy experts (*f* = 4); sustainability lecturers/researchers (*f* = 3), and metropolitan/municipal/district chief executives (*f* = 3). The varied range of competencies and expertise possessed by the participants involved in this study aligns with the results of Hammer et al. (2011) which determined that the assessment of eco-friendly urban development ought to encompass political, stakeholder, and technical viewpoints. Concerning education, a significant proportion of the participants exhibited a favourable educational profile, as evidenced by 94.3% of them possessing a Bachelor's and Master's degree. From a pragmatic perspective, the majority of professionals held tertiary degrees, indicating that they possessed adequate educational preparation to comprehend and analyse the variables (Kukah, 2017). The aforementioned statistics serve to substantiate the legitimacy of the participant's engagement in the development of green cities.

Descriptive statistics of one-sample t-test

Statistical analysis was performed using a one-sample t-test to determine the significance of a specific variable as perceived by the population. The test was conducted on the mean to determine the decisions made by the respondents. The researcher established the null hypothesis, denoted as H_0, which posits that the distribution under investigation is normal. Additionally, the alternative hypothesis, represented as H_1, was formulated to suggest that the distribution is not normal. The null hypothesis (H_0) posits that the p-value lacks statistical significance, while the alternative hypothesis (H_1) suggests that the mean value has statistical significance. The test was conducted using an alpha level of 0.05. A data set can be considered to have a normal distribution if the resulting p-values from the statistical test exceed the predetermined alpha level. According to Ahadzie (2007), it is crucial to report the mean of the test group, degree of freedom (df), p-value and t-value, when conducting a t-test. The study utilised a five-point Likert scale to measure the variables under investigation. A score of three (3) on the scale was interpreted as moderate, while a score of four (4) indicated a significant level of the variable. To achieve a balanced test value, a score of 3.5 was chosen.

The significance level was set at 95%, following conventional risk levels, as suggested by Ahadzie (2007). The statistical analysis using the t-test resulted in p-values of 0.000 for all influences except for three, specifically the influence of IBFs on GCD. As a result, the hypothesis was rejected for the remaining seven influences of IBFs on GCD. The study has identified the variables that are highly ranked for investigating the influences of IBFs on GCD, as presented in Table 3. The study found that IBFs have a significant influence on various aspects of project or development design schemes (t=9.216; sig.=0.000), depletion of non-renewable resources (t=7.065; sig. = 0.000), financial feasibility (t=7.482; sig.=0.000), availability of land for green developments (t=7.458; sig.=0.000), urban sprawl (t=6.699; sig.=0.000), stakeholder collaboration and confidence (t=6.449; sig.=0.000) and attribute of sovereignty through land use controls/regulations (t=6.300; sig.=0.000). However, the influence of institutional and behavioural factors on the successful development of green cities was not statistically significant, as evidenced by the t-values of 0.069, -0.371, and -0.628, and the corresponding significance values of 0.945, 0.712, and 0.532 for high rise of incentive-based strategies, waste generation and air pollution respectively.

Reliability test statistics

The Cronbach's alpha coefficient test was employed to assess the reliability of the scale and the internal consistency of the variables. The assessment of the research study necessitates the evaluation of the reliability of measuring equipment (Tavakol and Dennick, 2011). Furthermore, it was emphasised that a scale can be considered reliable when Cronbach's alpha test produces a coefficient of 0.700 or higher. The Cronbach's alpha coefficient of 0.745 obtained from the study indicates its reliability and its suitability for subsequent analysis.

Test of structural model and hypothesis

Linear regression was utilised to analyse the data to validate the formulated hypothesis. The mean values of the constituent components of IBFs and GCD were computed, and subsequently employed in performing regression analysis to establish the interrelationships between the components. The formula utilised for the computation of linear regression was as follows: The equation $Y = a + bX + \epsilon$ represents a linear regression model, where Y denotes the dependent variable or outcome, a represents the y-intercept or the value of Y when X is equal to zero, X represents the independent variable or explanatory variable, b represents the slope or coefficient ascribed to X during the regression, and ϵ represents the error. Based on the information presented above, the current study puts forward a hypothesis regarding the relationship outlined in Table 4.

Table 3: Tests of normality of the influence of IBFs on green city development

				Test Value = 3.5							
								95% Confidence Interval of the Difference			
	Mean	**Kurtosis**	**Skewness**	**t**	**df**	**p-value**	**Rank**	**Mean Difference**	**Lower**	**Upper**	**Null-Hypothesis**
Influence of design scheme of green projects or development	4.21	1.150	-.893	9.216	88	.000	**1st**	.713	.56	.87	Not Rejected
Depletion of non-renewable resources	4.16	3.714	-1.553	7.065	88	.000	**2nd**	.657	.47	.84	Not Rejected
Financial feasibility of green projects or developments	4.13	2.479	-1.202	7.482	88	.000	**3rd**	.635	.47	.80	Not Rejected
Land availability for green developments	4.04	-.149	-.271	7.458	88	.000	**4th**	.545	.40	.69	Not Rejected
Urban sprawl	4.04	-.366	-.386	6.699	88	.000	**5th**	.545	.38	.71	Not Rejected
Stakeholder collaboration and confidence	3.99	.627	-.556	6.449	88	.000	**6th**	.489	.34	.64	Not Rejected
The attribute of sovereignty through land use controls/regulations	3.97	.236	-.364	6.300	88	.000	**7th**	.466	.32	.61	Not Rejected
The high rise of incentive-based strategies	3.51	-.322	-.095	.069	88	.945	**8th**	.006	-.16	.17	Rejected
Waste generation	3.46	.309	-.620	-.371	88	.712	**9th**	-.039	-.25	.17	Rejected
Air pollution	3.44	.579	-.555	-.628	88	.532	**10th**	-.062	-.26	.13	Rejected

Table 4: Hypothesis Testing

Hypothesis	Statement	DV[a]	IV[a]
H	IBFs positively influence green city development	GCD	IBFs

Notes: DV[a] = Dependent Variable; IV[a] = Independent Variable;

Regression model development

A regression model is developed to validate the formulated hypothesis. Based on the regression model presented in Table 5, the R2 value indicates the degree of correlation between the predictor variable and the spontaneous influence of institutional and behavioural factors on the advancement of green cities. In the model, the correlation matrix (R) between IBFs and GCD was found to be 0.755, indicating a strong positive correlation between the two variables. The model demonstrated a strong correlation between institutional and behavioural factors and the development of green cities, as evidenced by an R2 value of 0.571, indicating a variance percentage of 57.1% which refers to the extent to which the explanatory variable accounts for the variability in the dependent variable's outcome. The model's Durbin-Watson value (1.821) fell within the range of 1 to 3, indicating the presence of autocorrelation among the variables. The statistical significance of the R2 of model 1 was demonstrated by a p-value of 0.000, which is less than the alpha level of 0.05. The ratio of the two mean squares, denoted by F, was found to be 115.611, with degrees of freedom of 1 and 87, represented by df1 and df2, respectively.

Table 5: Model summary of IBFs and GCD

					Change Statistics					
Model	R	R^2	Adjusted R^2	Std. error of the estimate	R^2 Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.755[a]	.571	.566	.36804	.571	115.611	1	87	.000	1.821

Notes: Predictors: (Constant), IBFs; Dependent Variable: GCD

Table 6: Coefficients of IBFs and GCD

Model		Unstandardized Coefficients					95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Standardized Coefficients Beta	t	Sig.	Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant	.481	.366		1.314	.192	-.246	1.209		
	IBFs	.983	.091	.755	10.752	.000	.801	1.165	1.000	1.000

Notes: Dependent Variable: GCD

ANOVA of regression model

According to the ANOVA Table 7, the utilisation of IBFs as an independent variable for predicting GCD exhibits a statistically significant outcome in comparison to utilising the mean as a predictor for GCD. This is evidenced by the corresponding significance p-value = 0.000 which is less than the predetermined alpha level of 0.05. If the ANOVA yielded non-significant results, it can be inferred that the predictor variable failed to predict the outcome variable.

Table 7: ANOVA of IBFs and GCD

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.660	1	15.660	115.611	.000[b]
	Residual	11.785	87	.135		
	Total	27.445	88			

Notes: Dependent Variable: GCD; Predictors: (Constant), IBFs

Coefficient of regression model

Table 6 provides the means to derive the unknown variables of the regression equation Y = a + bX + ϵ. The constant term, denoted by the y-intercept (a), has a value of 0.481. The first model's B-value was determined to be 0.983, while the standardised beta coefficient value was calculated to be 0.755. These results suggest a robust positive correlation between IBFs and GCD. Table 6 was assessed for collinearity and found to have a tolerance value greater than 0.1 and a Variance Inflation Factor (VIF) less than 10, indicating the absence of collinearity. This validates the noncollinearity assumption. The range of residual (ϵ) values observed was between -2.190 and 2.841, with a minimum and maximum value, respectively. The absence of outliers is denoted by {ϵ: - 3.29 ≥ ϵ ≤ 3.29} as a requisite of linear regression. Based on the analysis of Table 6, it can be inferred that a one-unit increase in the predictor variable (IBFs) is associated with a corresponding increase in the outcome variable (GCD) by the value of the unstandardized beta coefficient (B=0.983). The equation of regression utilised for the prediction of GCD based on IBFs is represented as Y = 0.481 + 0.755X. The 95% confidence interval for the slope estimate to predict GCD from IBFs, obtained through bootstrapping, ranges from 0.8 to 1.2. This implies that a unit increase in IBFs is associated with an increase in GCD ranging from 0.8 to 1.2 points.

Discussion of Findings

The study posited that IBFs would have a positive influence on GCD. The obtained results revealed that the regression coefficient (b) for IBFs was 0.983, with a statistically significant p-value of 0.000, which is less than the predetermined alpha level of 0.05. Furthermore, the R-squared value of 0.571 indicates that 57.1% of the variation in the development of green cities can be accounted for by IBFs. The results of the regression analysis indicate that hypothesis (H) presented in Table 4 is accepted, as there is a positive correlation between IBFs and the development of green cities.

According to Wang and Chan (2019), the initial land ownership condition plays a crucial role in determining the appropriate instrument to be employed in the development of green cities. According to Zhou and Wang's (2011) perspective, local governments' ownership of land resources, whether by inherent means or acquisition, leads to the prioritisation of fundamental planning and regulatory mechanisms such as zoning ordinances, comprehensive plans, and subdivision regulations to manage urban developments. This approach is a conventional practice in developed nations like the United States and remains prevalent in developing countries like China. The allocation of public space in a project can significantly influence its financial viability, quality, and design. This is exemplified by the practice of reducing public space to offset the financial burdens associated with expensive land acquisition costs (Buitelaar and Segeren, 2011). A comparative analysis by Wang and Chan (2019) of Middle Eastern, European, and Chinese cities indicated a significant correlation between a society's institutional characteristics and the development of its urban landscape.

According to Peattie (2010), there is a prevalent assumption that environmental knowledge serves as the primary motivator for green consumer behaviour. However, Debora Indriani et al. (2019) behavioural literature reveals a positive correlation between knowledge and behaviour. Esmaeilpour and Bahmiary (2017) posit that an individual's level of environmental concern regarding green consumerism may positively influence their inclination towards green products, leading to heightened environmental mindfulness and a greater propensity to purchase such products. Based on statistical evidence presented in this study and corroborated by existing literature, it can be concluded that institutional and behavioural factors have a positive influence on the development of green cities.

Implications, Contributions and Recommendations

To address the issues created by the dispersed model of sprawling and haphazard city development and to assist cities in rationalising urban living spaces for the broader health of the populace and environment, this study's findings have practical implications for city planners, construction professionals, responsible institutions and agencies, and policymakers interested in the development of green or sustainable cities. This study adds to the prevailing body of knowledge on developing sustainable cities and communities, which covers SDG 11 by illuminating the interactive influence of institutional and behavioural factors that influence green city development. A better understanding of these influences will guide policymakers to identify appropriate focus areas when developing urban planning policy strategies to make cities and human settlements resilient, safe, inclusive and sustainable.

Emergent findings demonstrate that the design scheme of green projects or development is the most significant green city development process influenced by institutional and behavioural characteristics. Consequently, city developers and residents are informed to adopt more sustainable practices in city designs and pro-environmental attitudes and lifestyles respectively to ensure city resources are not depleted but reused to ensure the survival of future generations. In the development of green cities, stakeholders are informed to adopt innovative financing mechanisms to secure funds to ensure the financial feasibility of green cities. Furthermore, city developers and urban land custodians must recognise the essence of monitoring and controlling urban land usage influenced by institutional and behavioural characteristics to avoid urban sprawl. This recognition assigns land sovereignty power to land custodians through the use of land controls and regulations. As a result of the capital-intensive nature of green developments, existing institutional structures tend to influence the degree of green development incentives to city developers to develop cost-efficient green infrastructures and spaces for city inhabitants.

This study recommends that institutional capacities are expanded to design, finance, develop and maintain green cities to scale up the efforts geared towards realising sustainable, resilient and eco-friendly cities. Additionally, the a need to trigger pro-environmental behaviours among infrastructural developers and city residents through tax reliefs, incentives and sometimes ownership and operational rights to green developments through public-private-partnership (PPP) agreements.

Conclusion

This study reported on the results of a quantitative survey on the influence of institutional and behavioural factors on developing green cities in emerging economies such as Ghana. The most significant influence of institutional and behavioural factors that were identified from the study on green city development was the influence of design schemes of green projects or development, depletion of non-renewable resources and financial feasibility of green projects or developments. Unquestionably, the concept of a green city is still in its infancy in Sub-Saharan African countries. However, this concept is significant to the development of emerging nations due to issues created by the dispersed model of sprawling and haphazard city development and to assist cities in rationalising urban living spaces for the broader health of the populace and environment. This study extends extant literature and the discussion in the direction of developing sustainable cities and communities by presenting a holistic and insightful discussion on the influence of institutional and behavioural factors on green city development in emerging countries with a focus on Ghana. It was indicative from the study findings that taking the right green governance steps considering institutional and behavioural factors has a positive influence on green city development.

A few limitations should be considered when interpreting this study's findings. First, although these limitations did not influence the findings' significance and reliability, the study's data was based on a small sample size. However, the sample composition was sufficiently varied in terms of city development and research knowledge that it was deemed adequate to provide valuable and reliable results given the immaturity of green city development in Ghana. Results from the survey may differ from those of other countries due to various social, cultural, legal and political considerations since Ghanaian professionals made up the study sample. Notwithstanding these limitations, the findings offer a comprehensive overview of the influences of institutional and behavioural factors that could be considered to facilitate the development of green cities in other nations comparable to Ghana in terms of their characteristics. Further research studies may be required due to this limitation.

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Socio-Economic Factors Influencing the Adoption of Sustainable Energy Technologies and Practices In Ghana

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Abstract

This study aimed to explore the socio-economic factors influencing the adoption of sustainable energy technologies and practices in Ghana. To identify the socio-economic factors influencing the adoption of sustainable energy technologies, a comprehensive literature review was conducted which provided context on linkages between energy and economic development, sustainability concepts, renewable energy technologies, and determinants of adoption established in prior empirical works. The study used the Diffusion of Innovation Theory and the Technology Acceptance Model as the theoretical underpinnings of the study. The study adopted quantitative research using the pragmatic research philosophy as the underlining philosophy for the study. Furthermore, the purposive and snowball sampling techniques were adopted with a sample of 338 respondents who completed questionnaires administered via online and in-person. The population consisted of energy policymakers, experts, financiers, researchers, and investors involved in the sector. Sample size was determined using Cochran's formula to be 385 participants. The data obtained from the respondents was then analyzed using Exploratory factor analysis (principal component extraction) to condense the variables into underlying dimensions. Two components; Component 1 *"Energy Consumption and Infrastructure Dynamics"* and Component 2 *"Policy, Market and Social Dimensions"* were jointly explained by 74.525% of variance based on eigenvalue and scree plot criteria. The findings provide empirical evidence to guide transition policy and strategy formulation in Ghana. Specifically, holistic frameworks spanning multiple spheres of public intervention, private activity, and social engagement are recommended based on the multi-stakeholder perspectives analyzed. The study expands existing theoretical paradigms and offers direction for future empirical inquiries in this domain.

Keywords: Energy, Sustainable Energy, Technologies, Socio-Economic Factors, Ghana.

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Introduction

Energy plays a crucial role in economic development (Inglesi-Lotz, 2016; Misry et al., 2018; Al-Khawaldeh and Al-Qudah, 2018). Hence, the transition from conventional energy sources towards a renewable and sustainable energy system is a subject of much discussion globally (Wang et al., 2018). Sgouridis and Csala (2014) posit that the transition towards sustainable energy systems is crucial for addressing environmental concerns and achieving long-term energy security. This transition involves the development and adoption of sustainable energy innovations (SEIs), which encompass new or modified processes, techniques, practices, systems, and products aimed at reducing environmental harm (Badi and Pryke, 2015). Additionally, the transition includes a shift from utilizing fossil fuels to exploiting renewable energy sources in energy generation and the evolution from centralized to decentralized energy systems (Mohammad et al., 2021). Furthermore, studies have also highlighted the significance of energy-efficient technologies in creating a more sustainable industrial structure and reducing CO_2 emissions (Cheng et al., 2021).

However, the acceptance and use of technology, such as sustainable energy technologies, are influenced by individual demographic differences, cultures, and additional significant influential factors that could motivate users' technology acceptance and actual use (Kwateng et al., 2018). Moreover, the combination of knowledge, personal skills, and company resources influences people in their innovation choices, including the adoption of sustainable energy technologies (Timpanaro et al., 2023). Furthermore, Antonakakis et al. (2017) assert that there is an ethical dilemma associated with energy consumption and its impact on economic growth, highlighting the complexities of promoting growth in a more efficient and environmentally sustainable manner. This ethical dimension adds a layer of complexity to the relationship between energy and economic development, emphasizing the need for sustainable energy policies to balance economic growth with environmental concerns. The ethical dimension of consumption, sustainable consumption, and "presumption" have been identified as part of the new trends in consumption, reflecting consumers' social responsibility in the process of energy consumption (Hoffmann-Burdzińska et al., 2022). These ethical consumer issues include protecting the natural environment through energy efficiency at home, supporting fair trade and worker's rights, and making ethical investments (Witkowski and Reddy, 2010).

Studies have found the adoption of sustainable energy technologies and practices to be crucial for addressing environmental concerns and achieving sustainable development goals (Dincer, 2000; Kylili et al., 2021; Al-Emran and Griffy-Brown, 2023). However, challenges such as accessibility, affordability, and efficiency need to be addressed (Singh and Ru, 2022). According to Djokoto et al. (2014), barriers to the adoption of sustainable energy technologies and practices in Ghana include a lack of green technology and techniques, reliability and quality of specification, leadership and responsibility, stakeholder involvement, and guide and benchmarking systems. Additionally, a study by Wang et al. (2020) among large organizations in California identified institutional barriers and policy implications as playing a significant role in the adoption of sustainable energy technologies. On the other hand, Elmustapha et al. (2018) conducted a study in Lebanon and found that the socio-cultural dimension also influences the adoption of solar energy technology.

Moreover, the literature suggests that there is an overemphasis on environmental factors in sustainability issues, with a need for greater attention to social and economic factors (Husted, 2005; Van den Bergh, 2008; Kopnina, 2016). Furthermore, Vafadarnikjoo et al. (2020) highlight that the social dimension of sustainability has been given much less consideration compared to the economic and environmental sustainability dimensions, noting that this negligence is very common in emerging economies.

While some studies suggest that sustainability might only be important for those for whom ecological consumption is significant (Hamari et al., 2015; Onel, 2020), others argue that environmental awareness is a major influencing factor in forming a positive attitude towards sustainability (Ashiq et al., 2019). However, Whang and Kim (2015) emphasize the importance of balanced application with economic and social issues for sustainable development, even if environmental factors are effective. On the other hand, Taibjee and Woodley (2020) point out that while sustainability is now a mainstream issue, perceived impracticalities attributed to more environmentally sustainable actions can act as a barrier to widespread adoption. Ivanov et al. (2022) argue that within the framework of sustainable development, environmental, social, and economic issues should be considered as a whole, with the goals of resource conservation and socio-economic development reinforcing each other. This knowledge gap (overemphasis of the environmental pillar in most sustainability studies and initiatives compared to social and economic issues) warrants this study.

According to Atta-Aidoo et al. (2022), the adoption of sustainable energy technologies and practices is influenced by a myriad of socio-economic factors, including behavioral, psychological, and demographic aspects. Additionally, scholars indicate that the role of economic growth, energy access, and environmental sustainability in the adoption of sustainable energy technologies is paramount (Adusah-Poku and Takeuchi, 2019; Nyasapoh et al., 2022; Gyimah et al., 2023). Despite the Ghanaian literature, there have been a number of studies focused on sustainable energy technologies and practices, viz., renewable energy technologies (Attachie and Amuzuvi, 2013; Asante et al., 2021; Yang et al., 2021). The majority of these studies focused on energy consumers, with little or no attention paid to energy policy makers, energy experts, sustainable energy financiers, sustainable or green energy researchers and academicians, and sustainable energy investors. This issue also creates a population research gap. Thus, this justifies the significance of this study, which included these population members and synthesized their opinions, knowledge, and experiences to draw a very fair conclusion on the socio-economic factors that influence the adoption of sustainable energy technologies and practices in Ghanaian society.

From the above realities, it is clear that in the adoption of sustainable energy technologies and practices, the focus should not exclusively be on the factors that address environmental adoption issues but also include social and economic factors. As such, this study sought to explore the socio-economic factors influencing the adoption of sustainable energy technologies and practices in Ghana.

Literature Review

Overview of the Energy Sector

The global energy sector is undergoing significant changes due to various factors such as the development of renewable energy, policy measures, and the impact of the COVID-19 pandemic (Bashir et al., 2022). These changes have led to uncertainty in energy price mechanisms, demand, and supply, affecting the industry on a global scale. The water footprint of electricity and heat production has also been highlighted as a critical aspect, with a need for a comprehensive global overview addressing different energy mixes used per country and operational and supply chain water use (Mekonnen et al., 2015). Furthermore, the impact of Industry 4.0 on modeling energy scenarios in developing economies has become a subject of interest, emphasizing the need for recommendations and analysis of the global energy sector (Tymoshenko et al., 2022).

The energy-GDP elasticity has been studied using per capita data for 132 countries, providing insights into sectoral energy use with respect to national gross domestic product (Burke and Csereklyei, 2016). Additionally, the decarbonization of the economy through the introduction of innovative technologies into the energy sector has been explored, focusing on the relationship between economic development, innovation, emissions, and the development of renewable energy in different countries (Voitko et al., 2021). Moreover, the impacts of 1.5 °C global warming have been assessed, providing a simulation protocol to understand the potential consequences of global warming on various sectors, including the energy sector (Frieler et al., 2017). The financial allocation in Malawi, which is out of step with global energy trends and obstructs meaningful progress in improving energy supply, serves as evidence that the challenges facing the energy sector are not exclusive to developed nations (Gamula et al., 2013).

Furthermore, the development of renewable energy in the GCC region has been discussed, highlighting the status and challenges in this area (Salim and Alsyouf, 2020). The importance of the energy sector in economic development has been emphasized, particularly in developing countries, where it forms the basis of sustainable growth (Gorodetskaya et al., 2021). The global energy sector is also intertwined with other sectors, such as the chemical industry, where decarbonization through electrification has been identified as a potential pathway, presenting both barriers and opportunities (Mallapragada et al., 2022). Additionally, the relationship between energy consumption and gross domestic product has been studied from a sectoral perspective, providing insights into the implications for future energy policy (Zhang et al., 2019). The global trends in renewable energy development have been characterized by the stable involvement of renewable energy resources in energy generation, reflecting the ongoing transition in the sector (Kurbatova and Perederii, 2020).

The energy sector in Africa is a multifaceted domain that encompasses various aspects such as energy consumption, renewable energy resources, policy frameworks, and industrial performance. Asongu et al. (2016) examined the relationship between energy consumption, CO_2 emissions, and economic growth in 24 African countries, highlighting the need for a comprehensive understanding of the interplay between energy, emissions, and economic development. Furthermore, Nwaiwu (2021) emphasized the nascent stage of digital technology adoption in the African energy sector and the existing gap between policy environments and industry efforts. The renewable energy sector in Africa has garnered attention due to its potential for addressing energy poverty and promoting sustainable development. Parawira (2009) recognized biogas technology as a promising avenue for leveraging renewable energy resources in sub-Saharan Africa.

Additionally, Tagwi (2022) investigated the impact of climate change and renewable energy consumption on agricultural economic growth in South Africa, underscoring the intricate relationship between environmental factors and economic development. The industrial performance and economic implications of energy pricing in specific sectors, such as mining, have also been a focal point of research in the African context. Mmutle et al. (2022) delved into the long-run relationship between energy pricing and mining sector performance in South Africa, shedding light on the intricate dynamics of energy costs and industrial output. Furthermore, Eke et al. (2020) highlighted the influence of institutional quality on the impact of renewable energy consumption on industrial performance in West Africa.

In South Africa, the electricity sector has been extensively analyzed, particularly in relation to industrial sectors and the impact of supply crises on electricity elasticities. Blignaut et al. (2015) estimated the price-elasticity of electricity for various industrial sectors of the South African economy. Additionally, Morris et al. (2021) scrutinized the dynamics of the wind energy global value chain and the localization of goods and services in South Africa, emphasizing the interplay between government policies, industrial interests, and local economic development.
Ghana's energy sector, dominated by petroleum and liquid fuels, faces challenges such as insufficient investments, infrastructure constraints, and environmental impacts (Kipkoech, 2022). The government has taken steps to address these challenges, including setting renewable energy targets and promoting private sector involvement (Aboagye, 2021). However, the country's energy industry operates a corporate utility model, which may hinder the penetration of renewable energy (Danquah, 2022). Despite the potential for renewable energy, its exploitation is limited due to barriers such as technology costs and financing issues (Kuamoah, 2020).

The Sustainability Concept

The earth's resources are under tremendous strain due to rising populations and economic expansion, and as a result, sustainability has become a focal point for countries around the globe (AlSanad et al., 2011). Mensah (2019), however, observes that despite the fact that the concept is becoming a dominant development paradigm, there is still a lack of clarity about what the concept is, what it means, and what it entails.

Basiago (1998) defines sustainability as the ability to maintain an entity, outcome, or process over a period of time. Shafii (2006) interprets sustainability as a never-ending process of meeting human needs in a limited manner that ensures that the ecosystem is not negatively affected. Yilmaz and Bakis (2015) also define sustainability as the use of natural resources in such a way that they do not decay, deplete, or become unrenewable and that they can be passed on to future generations by developing them. Simply put, sustainability seeks to ensure that today's needs are met in a way that ensures that the future generation has enough resources to meet their own environmental, social, and economic needs (WCED, 1987). While the idea of sustainability is being dismissed as a meaningful term in and of itself, it seems to have some function when preceded by a qualifier such as "ecological," "agricultural," or "economic" (Morelli, 2011).

The Sustainable Energy Concept

Sustainable energy refers to energy sources that are perpetual, such as solar, wind, hydropower, geothermal, and certain biomass. These renewable sources are able to meet present energy needs without compromising the ability of future generations to meet their needs (Sovacool and Brown, 2009). More broadly, sustainable energy is defined as energy generated and consumed in a manner that supports the three pillars of sustainable development: economic development, social development, and environmental protection (Cherp et al., 2018). Sustainable energy has been described as energy that does not undermine natural capital or the functioning of ecosystems (OECD, 2018). By this definition, sustainable energy must balance concerns of availability, reliability, economics, and environmental impacts. Renewable and sustainable energy sources such as solar, wind, hydropower, geothermal, certain biomass, and new nuclear power generation can satisfy these criteria. Solar, wind, hydropower, geothermal, and sustainable biomass are renewable natural resources whose replenishment rates far exceed consumption rates by humans (Tester et al., 2005).

Sustainable energy sources can be categorized based on their primary function as electricity generation sources or fuels for transportation and heating purposes. Electricity generation sources include solar photovoltaics, solar thermal, wind, hydro, geothermal, tidal/wave, sustainable biomass, and new nuclear power (Tester et al., 2005; Cherp et al., 2018). Transportation fuels include biofuels such as ethanol and biodiesel produced from plant material. Hydrogen fuel cells may also play a role when coupled with renewable hydrogen production (Sovacool and Brown, 2009). Heating fuels encompass direct uses of renewable sources such as sustainable biomass for cooking and space heating through combustion. Geothermal heat pumps utilize underground temperatures for building heating and cooling.

Sustainable energy also has a demand and supply component. On the supply side, sources must be continuously replenished without depletion. On the demand side, energy services must be delivered sustainably by conserving resources and adopting efficiency measures (OECD, 2018). For example, solar photovoltaic panels help supply electricity sustainably, while smart grids help optimize demand. Sustainable fuels supply transportation services, while electric vehicles optimize energy usage. A review by Tester et al. (2005) concludes that sustainable energy sources share several key attributes that distinguish them from non-renewable sources. Firstly, they are widely distributed geographically, meaning that energy independence is possible. Secondly, the generation of sustainable energy causes negligible environmental degradation and does not undermine ecosystems. Thirdly, sustainable energy sources have large uses, making a diverse mix practical. Lastly, the resources are replenished at rates exceeding consumption by many orders of magnitude, qualifying them as sustainable or perpetual.

While renewable and sustainable energy sources offer promise, integrating them on a large scale poses some important technical challenges (Sovacool and Brown, 2009). Variable generation from wind and solar may challenge grid reliability unless paired with storage or demand response. Connecting remote renewable projects requires considerable transmission costs, especially for offshore wind. Sustainable biofuels also face constraints on land, water, and fertilizer availability. Building public support and overcoming NIMBY attitudes demands sensitive policymaking around siting projects. The costs of sustainable energy must continue declining or face policy discontinuity risk. Technological leapfrogs are needed to double energy productivity while halving CO_2 per MWh. Addressing these challenges requires sustained research, development, and demonstration on a commercial scale, as well as sensible energy policies.

Sustainable Energy Technologies and Practices

With climate change and carbon emissions being major global issues, there is an urgent need to transition to renewable energy sources that are clean and sustainable. Several renewable energy technologies have emerged with the potential to replace fossil fuels, mitigate greenhouse gas emissions, and enable sustainable development. Key renewable technologies include solar, wind, geothermal, biomass, and marine energy (Hussain et al., 2017). Some of these sustainable energy technologies are solar photovoltaics, wind turbines, enhanced geothermal systems, and wave energy converters. Key emerging renewable technologies, their status, and challenges faced in wider adoption.

Solar PV and Solar Thermal

Solar power is considered one of the most promising renewable sources owing to its abundance and technological improvements leading to increased efficiency and reduced costs (Li et al., 2020). Solar PV panels and solar thermal collectors can be installed on household rooftops to generate electricity and heat water, respectively (Siksnelyte-Butkiene et al., 2020). Studies analyzing solar technologies using MCDM approaches include Seddiki and Bennadji (2019), who found PV to be the optimal choice for a residential building in Algeria, and Zeng et al. (2019), who determined solar thermal is the most suitable option for Lithuanian households when considering public and private impact factors.

Wind Power

Wind power utilizes wind turbines to generate electricity from kinetic wind energy. Global installed capacity exceeded 650 GW by 2019 (WWEA, 2021). Key innovations like taller towers, lighter materials, power electronics, and control systems have improved efficiency and grid integration. However, intermittency and variability in wind patterns can cause grid fluctuations. Other downsides include visual and land use impacts, noise pollution, and threats to wildlife. Market barriers, infrastructure limitations, and social acceptance issues, especially due to landscape impacts, are major adoption challenges (Jami and Walsh, 2017). Increased R&D, strategic siting, and policy measures are needed to boost grid-compatible deployment.

Enhanced Geothermal Systems

Enhanced geothermal technology harnesses heat energy stored underneath the earth's surface by extracting hot, dry rocks in subsurface fractures (Ghandi and Davidson, 2020). This provides constant base-load renewable power. By 2050, the potential for the entire world will be greater than 100 GW thanks to advancements in technologies like hybrid plants, CO_2 utilization, advanced drilling, and binary cycles (Ghandi and Davidson, 2020). However, technical feasibility, long payback times, policy limitations, and environmental impacts pose adoption hindrances. Further R&D, pilot testing, assessment tools, and conducive policies can aid large-scale implementation.

Wave Energy Converters

Marine energy technologies, such as wave energy converters (WECs), harvest electric power from ocean waves. Predictability, consistency, and high energy density confer inherent grid stability advantages (Hussain et al., 2017). However, only ~530 kW of wave energy capacity was installed globally as of 2018. Severe maritime conditions, intermittent operation, high infrastructure costs, negative environmental impacts, a lack of funding, and technological maturity limitations constrain viable commercialization currently. Collaborative research, policy incentives, and ocean testing facilities are essential steps before scalable adoption.

Heat Pumps

Heat pumps enable energy-efficient heating and cooling by transferring thermal energy between buildings and external air, ground, or water sources (Siksnelyte-Butkiene et al., 2020). As largely electrically powered systems, heat pumps can provide carbon savings when combined with renewable power generation. For example, Yang et al. (2018) found air-water heat pumps the second most suitable option for Danish households under a renewable heating strategy prioritization using TOPSIS analysis.

Biomass Heating

In biomass heating systems, renewable fuels like wood pellets and chips are burned to provide residential space and water heating (Siksnelyte-Butkiene et al., 2020). Modern pellet boilers and stoves can convert over 90% of fuel energy into usable heat. However, Ekholm et al. (2014) note that residual particulate emissions can still impact health relative to alternatives. Nonetheless, sustainable biomass retains an economic role and resource integration potential.

Socio-Economic Factors Influencing Sustainable Energy Technologies and Practices Adoption

According to the literature, supportive government policies and effective enforcement of standards and regulations are important for the successful adoption of renewable energy technologies. Uhunamure et al. (2019) showed that standards and certification of biogas systems by the government helped ensure adherence to design specifications and quality in South Africa. However, a lack of enforcement of these standards negatively impacted the quality of construction and functionality of the systems. Furthermore, Nape et al. (2019) emphasized the need for improved incentives and policies to strengthen biogas technology promotion in South Africa. Regulations are also necessary to support local ethanol production, transportation, and taxation policies, as shown for Brazil, Indonesia, and Madagascar (Practical Action Consulting, 2011).
Furthermore, the affordability of technologies and fuels was a key factor influencing adoption across the studies. Uhunamure et al. (2019) found that the high costs of biodigesters limited their uptake in South Africa. In the same vein, Gebremedhin and Tesfay (2015) also reported initial ethanol stove costs and fuel prices as barriers in Brazil and Ethiopia, respectively. Moreover, several studies also indicated that the ongoing LPG refilling costs and price volatility negatively impacted its adoption in Guatemala, India, Mozambique, and Sudan (Uhunamure et al. 2019). Mwirigi et al. (2009) saw value in subsidizing fuels to make them affordable alternatives to biomass. This affirms that cost-competitiveness with traditional fuels is important for technology uptake.

Access to loans, microcredit, subsidies, and incentives was determined to positively influence technology adoption across multiple studies. Bonokwane and Ololade (2022) found that the availability of credit, loans, and subsidies correlated with higher biodigester uptake in South Africa. Similarly, accessibility to loans and microcredit aided in the adoption of improved cookstoves in Bangladesh (Kabir et al., 2013) and biodigesters in Sri Lanka, Bangladesh, and Nepal (Kabir et al., 2013; Mwirigi et al., 2014; Uhunamure et al., 2019). Subsidies for initial biogas plant costs in Bangladesh, China, India, and Kenya were also identified as enabling factors for the technology (Kabir et al., 2013; Nape et al., 2019; Uhunamure et al., 2019). Studies on ethanol adoption in Brazil, Madagascar, and Ethiopia highlighted how microfinance schemes could assist disadvantaged farmers to acquire the technology (Gebremedhin and Tesfay, 2015; Practical Action Consulting, 2011). This affirms the importance of access to financing mechanisms.

Studies have emphasized that having sufficient and readily available biomass feedstock is important for successful household biogas adoption in Bangladesh, Sri Lanka, and India (Kabir et al., 2013; Uhunamure et al., 2019). This affirms that accessibility to raw materials influences biogas potential. Similarly, the availability of local feedstock for ethanol production facilitated its adoption, as shown in Ethiopia and Indonesia, where bioethanol was produced from sugar cane and cassava, respectively (Gebremedhin and Tesfay, 2015). This demonstrates how the availability of indigenous renewable resources aids technology diffusion.

Studies also establish that raising awareness and knowledge of technologies positively influences adoption. Some scholars affirm that awareness of biogas benefits increased its uptake in Nepal, Bangladesh, India, and South Africa (Kabir et al., 2013; Mwirigi et al., 2014; Uhunamure et al., 2019). Nape et al. (2019) similarly advanced that enhancing awareness could boost adoption of household biogas in South Africa. Better knowledge also facilitated ethanol adoption, as revealed for Ethiopia and Madagascar (Gebremedhin and Tesfay, 2015; Practical Action Consulting, 2011). Educational level equally matters, as higher literacy in sustainable energy technologies supports adoption. Kabir et al. (2013) found education influenced small-scale biogas adoption in Bangladesh. Again, Bonokwane and Ololade (2022) observed the same relationship for education and biodigester technology in South Africa and Nepal, respectively. Public awareness and consumer education are therefore pivotal to renewable dissemination, as emphasized across multiple studies.

The impact of location and population concentration on technology has also been identified as a factor. Studies have noted greater acceptance of innovations in densely populated urban areas, like ethanol in Ethiopia and Nigeria (Gebremedhin and Tesfay, 2015). However, others reported positive adoption even in remote rural communities in India, Bangladesh, and Nepal (Kabir et al., 2013; Mwirigi et al., 2009). Conversely, sparse populations were determinants for biogas in South Africa and solar home systems in Kenya, as grid electrification was difficult (Bonokwane and Ololade, 2019; Karekezi and Kithyoma, 2002). Overall, the findings indicate that while rural inhabitants face distinct challenges, population density alone may not have a clear positive relationship with renewable adoption.

According to some authors, biogas adoption in South Africa, Nepal, and India offered self-generated power, easing dependence on fluctuating electricity grids (Bonokwane and Ololade, 2022; Mwirigi et al., 2014). Furthermore, ethanol-fueled mini-grids also enhanced off-grid energy access, as reported in Brazil and Madagascar (Practical Action Consulting, 2011). Increased energy security has therefore emerged as a major perceived factor supporting renewable expansion efforts.

Some critics also argue that consumer preferences play an important role in energy choices. According to Carlsson et al. (2010), consumer preferences are heterogeneous and depend on characteristics like income, age, and education. They found that higher-income households are more likely to adopt green technologies, while younger and more educated households also show a stronger preference for renewable energy. Also, Banfi et al. (2008) analyzed consumer choice in Italy using a discrete choice model and found that renewable energy sources and time-of-day pricing are useful instruments to influence demand, especially for households that already show a willingness to pay higher prices for green attributes. Another important finding is that cost considerations dominate preferences for most households, though some are willing to pay more for increased environmental sustainability (Carlsson et al., 2010; Roe et al., 2001). Surveying American households, Kotchen and Moore (2007) found that preferences depend strongly on the specific environmental good in question. For example, consumers express stronger preferences for air pollution reductions than climate change mitigation.

Theoretical Framework

According to Ravitch and Riggan (2016), a theoretical framework outlines the aim of a study in terms of the contribution of knowledge. The need for a theoretical framework is influenced by studies like Cabezas and Fath (2002) and Sarkis et al. (2011), who assert that there is a need to underpin studies related to sustainability practices in theory. Therefore, this study is undergirded by the diffusion of innovation theory (DOI) and the technology acceptance model (TAM). The theory of DOI elucidates the rate at which novel technological advancements and ideas permeate within organizations, along with the underlying mechanisms and reasons for their dissemination (Radhakrishnan and Chattopadhyay, 2020). TAM aims to explain the determinants of information technology acceptance by users and their behavioral intentions across a broad spectrum of computing technologies (Davis et al., 1989). Moreover, TAM has been extended and adapted to incorporate external factors, such as trust, religiosity, and image, to provide a more comprehensive understanding of technology acceptance (Usman et al., 2022; Muflih, 2023). Furthermore, TAM has been instrumental in understanding the adoption of technology during crises, such as in retail technology adoption during crises, where it was integrated with prospect theory perspectives (Burgess et al., 2023).

Research Methodology

A scientific research methodology is based on a specific philosophical idea, which subsequently suggests tactics and techniques for the research (Saunders and Thornhill, 2016). The pragmatic philosophy was adopted for this study. This aligns with the findings of Elkjaer and Simpson (2011), who argue that, from a pragmatic perspective, the research process commences by identifying a problem and aims to provide practical answers that shed light on future practical applications. This study also adopted the quantitative method. This method uses mathematical expressions and operations like extrapolation and econometric modeling. The study was also conducted using a deductive research approach. Deductive research logic, according to Saunders and Thornhill (2016) and Melnikovas (2018), is the method of reasoning that proceeds from a general rule to a specific law-like inference. Deductive reasoning uses physical arguments and controls knowledge and functions (Melnikovas, 2018).

The study's population consisted of energy policymakers, energy experts, sustainable energy financiers, sustainable or green energy researchers and academicians, and sustainable energy investors. A research population is typically a sizable group of people or things that become the subject of scientific inquiry. The selection of these groups of people as the sample frame stems from the fact that they are the ones responsible for the financing, policymaking, and adoption of sustainable energy solutions. In addition to the sample frame, officers (MMDAs, Chief Executives, Directors, and CEOs of Ministerial Agencies) from both local government and central government levels were also considered because of the social responsibility of governments to their citizens. The precise size of the sample could not be ascertained due to insufficient data on sustainable energy specialists in Ghana. However, this study utilized Cochran's formula at a 95% confidence level and a 5% margin of error to determine an appropriate sample size for the study (Cochran, 1963).

$$\mathbf{n_o = \frac{Z^2pq}{e^2}}$$

Where n_o - sample size.

Z^2 – abscissa of the normal curve that cuts off an area $\propto$ at the tails (1-$\propto$ equals the desired confidence level, e.g. 95%).

e - desired confidence level of precision.

p - estimated population of an attribute that is present in the population.

$q = 1-p$

$$n_0 = \frac{(1.96)^2\,(.5)\,(.5)}{(.05)^2} = \mathbf{385}$$

To sample these 385 participants, purposive and snowball sampling techniques were used for this study's sampling. Purposive sampling is a non-probabilistic method that enables a researcher to gather data from a sample of a population they believe to be most knowledgeable about a given subject (Walliman and Walliman, 2005). According to Neville (2007), the snowball sampling technique involves the development of a sample using informants. This method starts with one individual, who then suggests the next responder, creating a chain-like pattern that continues.

Survey Questionnaire Administration

The study employed a self-administered structured comprehensive survey questionnaire through a combination of an online survey and the drop-and-pick method (Gyimah et al., 2024). The questionnaires were issued to the target groups: energy policy makers, energy experts, sustainable energy financiers, sustainable or green energy researchers and academicians, and sustainable energy investors. The questionnaires consisted of three parts: A, B, and C. Part A sought to secure informed consent from the participants by adhering to strict ethical procedures governing this research (e.g., strict confidentiality). Part B sought to elicit demographic information about respondents. A varied level of respondent expertise and professionalism was required for this research to authenticate the capacity of the respondents to partake in the study (Pandey and Pandey, 2015). Part C of the questionnaire required respondents to indicate on a five-point Likert scale if the socio-economic factors identified are principal in influencing the adoption of sustainable energy technologies and practices in Ghana. The respondents were asked to indicate their agreement with the identified socio-economic factors on a Likert scale ranging from 1 to 5. "1 = strongly disagree, 2=disagree, 3=neutral, 4= agree, and 5=strongly agree."

Data Analysis

To interpret the respondents' biodata, tables and figures were used. A mean score ranking descriptive analysis was employed to gauge the variables' central tendency and standard deviation to gauge the targeted population's responses' dispersion and variability. Finally, an inferential statistical analysis (exploratory factor analysis) was employed to categorize the identified socio-economic factors into principal factors. To perform these analyses, this study employed the Statistical Package for Social Sciences (SPSS) version 25.

Test for Reliability

A reliability test was undertaken using Cronbach's alpha coefficient to assess the internal consistency of the 338 responses obtained for the first goal of the study. According to Tavakol and Dennick (2011), the validation of a measuring instrument is crucial for the evaluation of research investigations. The authors emphasized that a scale is deemed to possess reliability if the Cronbach's alpha test yields a coefficient of 0.700 or above. Cronbach's alpha of 0.966 for the study was acquired; thus, the data collection instrument was deemed reliable for further analysis.

Descriptive Statistics

Descriptive statistics are commonly employed by researchers as a means to streamline, condense, and depict quantitative data obtained from empirical observations. The calculation of the standard deviation (SD) was performed in conjunction with the mean score rank to quantify the level of agreement among the provided replies. The concept of standard deviation is well recognized as a statistical measure of variability (Altman and Bland, 2005). The standard error (SE) quantifies the extent to which sample means deviate from the standard deviation (SD) of the sampling distribution. Rooshdi et al. (2018) assert that the use of the Relative Importance Index (RII) allows for the identification and prioritization of the most salient criteria by analyzing the replies provided by survey participants. Additionally, it serves as a valuable instrument for prioritizing the indicators that have been evaluated on the Likert scale employed in the study. In cases where multiple variables exhibit identical Relative Importance Indices (RII), the variable with the greatest mean value is assigned the top position. Moreover, in cases where many variables exhibit an identical mean, the variable with the smallest standard deviation is assigned the highest rank. This phenomenon can be attributed to the utilization of the standard deviation (SD) as a measure to assess the level of agreement among respondents' interpretations. Consequently, a lower value of the standard deviation indicates a higher level of consistency (Altman and Bland, 2005; Ahadzie, 2007).

Based on a hypothesized mean of 3.0 and a confidence level of 95%, which aligns with previous studies conducted by Aigbavboa et al. (2021) and Kuoribo et al. (2022), the findings presented in Table 1 indicate that all the socio-economic factors identified in the Ghanaian construction industry are significant influencers of sustainable energy technologies and practices adoption in Ghana. The means of these socio-economic factors were found to be equal to or greater than the hypothesized mean of 3.0, suggesting their statistical significance.

Table 6: Mean Score Ranking and RII of Socio-Economic Factors

Socio-Economic Factors	Mean	Std. Error	Std. Dev	RII	Rank
Government policies and regulations	3.75	.052	.962	0.750	**1st**
Access to financing and incentives	3.74	.066	1.212	0.748	**2nd**
Energy security and independence	3.70	.055	1.018	0.740	**3rd**
Consumer demand and preferences	3.60	.051	.939	0.720	**4th**
Availability of renewable energy resources	3.58	.072	1.328	0.716	**5th**
Environmental consciousness and concerns	3.57	.058	1.074	0.714	**6th**
Urbanization and population density	3.48	.055	1.005	0.696	**7th**
Energy infrastructure costs and investments	3.48	.065	1.191	0.696	**8th**
Social acceptance and support	3.46	.047	.865	0.692	**9th**
Energy prices and affordability	3.46	.071	1.310	0.692	**10th**
Technological advancements and innovation	3.45	.060	1.100	0.690	**11th**
Energy consumption patterns and habits	3.44	.067	1.236	0.688	**12th**
Public awareness and education	3.40	.058	1.058	0.680	**13th**
Energy market competition	3.38	.057	1.041	0.676	**14th**
Industry standards and certifications	3.30	.067	1.235	0.660	**15th**
Job creation and economic development	3.29	.062	1.131	0.658	**16th**
Energy efficiency standards and labeling	3.21	.065	1.193	0.642	**17th**
Socio-cultural norms and values	3.02	.049	.905	0.604	**18th**

Source: Field Survey (2023)

Table 1 shows the mean score ranking and RII of socio-economic factors influencing the adoption of sustainable energy technologies and practices in Ghana. The mean scores range from 3.02 to 3.75. All factors have means above the hypothesized mean of 3.0, indicating they are statistically significant influencers of adoption. The factor with the highest mean of 3.75 is "government policies and regulations," followed closely by "access to financing and incentives" with a mean of 3.74. This suggests these two factors have the strongest influence on adoption, according to respondents. The standard deviations range from 0.847 to 0.962. Lower values imply higher consistency in responses. "Government policies and regulations" and "Energy security and independence" have the lowest standard deviations of 0.962 and 1.018, respectively, indicating more consensus among respondents for these factors. The standard errors provide a measure of how close the sample means are to the true population means. The errors are low, ranging from 0.047 to 0.072. The RII values range from 0.604 to 0.750. Factors with RII closer to 1 have greater relative importance. "Government policies and regulations" has the highest RII of 0.750, followed by "access to financing and incentives" with 0.748.

Factor Analysis

Ismail (2008) suggests that in cases where there are numerous dependent variables, it is possible that some of these variables may have direct relationships and thus require the application of a reduction technique to determine which variables are measuring aspects of the same underlying facet. Ahadzie (2007) asserts that factor analysis is a valuable tool for identifying groups of interrelated variables, hence facilitating the consolidation of numerous variables into a smaller set that is more comprehensible.

Initial Considerations

Factor analysis is predicated upon the utilization of the correlation matrix of the variables under consideration, with the stability of those correlations typically contingent upon a substantial sample size. Therefore, the dependability of factor analysis is contingent upon the magnitude of the sample. According to Decoster (1998), to prevent computational challenges, it is important to have a minimum of 10 observations per variable. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO test) is a viable option provided by SPSS for assessing the sufficiency of a sample size. The Kaiser-Meyer-Olkin (KMO) statistic exhibits a range of values from 0 to 1. A value of zero signifies that the magnitude of partial correlations is significantly greater than the magnitude of correlations, suggesting a spread in the correlation pattern and rendering factor analysis unsuitable. When a value approaches 1, it signifies that patterns of correlations exhibit a high level of compactness, suggesting that factor analysis is likely to provide dependable components. According to Gyimah et al. (2024), a KMO value of 0.5 is deemed suitable for factor analysis.

In order to do factor analysis, it is necessary to have certain connections between variables. If the R-matrix were an identity matrix, it would imply that all correlation coefficients would be 0. The Bartlett's test is employed to assess the null hypothesis that the correlation matrix being examined is equivalent to an identity matrix (Shrestha, 2021). The null hypothesis, denoted as Ho, posits that the variables under consideration are orthogonal. In other words, the original correlation matrix may be represented as an identity matrix, suggesting that the variables are unrelated and hence not appropriate for detecting the underlying structure. The alternative hypothesis, denoted as H1, posits that the variables under consideration are not orthogonal, indicating a substantial connection between them such that the correlation matrix deviates noticeably from the identity matrix. According to Gyimah et al. (2024), a p-value less than 0.05 suggests that conducting a factor analysis on the dataset might be beneficial.

Table 7: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.570
Bartlett's Test of Sphericity	Approx. Chi-Square	10699.587
	Df	152
	Sig.	0.000

Source: Field Survey (2023)

It can be deduced from Table 2 above that the data from the survey on socio-economic factors influencing the adoption of sustainable energy technologies and practices is adequate. The data has 338 observations per variable, with a KMO value of 0.570, which is greater than 0.5. This suggests that distinct and reliable factors can be produced from the data set, and it is appropriate for factor analysis. The significance value in Table 2 is 0.000, which is less than 0.05, indicating the R-matrix is not an identity matrix and there are some relationships between variables that should be included in the analysis. Inferentially, the KMO and Bartlett's test results in Table 2 show that the data satisfies all conditions for appropriateness of factor analysis, and as such, the extraction of underlying factors from the data using this statistical technique is therefore reliable.

Communalities

The utilization of the notion of communality is applied as a means of evaluating the extent of correlation between a certain variable and other variables (Ahadzie, 2007). Communality is a statistical measure that quantifies the degree to which the underlying construct in a model replicates the variability seen in the measured variables (Field, 2000). Field (2005) asserts that for a dataset to be deemed acceptable, it is necessary for all variables to exhibit an extraction value over 0.50, as seen in Table 3.

Table 8: Communalities

Socio-Economic Factors	Initial	Extraction
Government policies and regulations	1.000	.626
Energy prices and affordability	1.000	.710
Access to financing and incentives	1.000	.635
Availability of renewable energy resources	1.000	.761
Public awareness and education	1.000	.740
Socio-cultural norms and values	1.000	.305
Social acceptance and support	1.000	.692
Urbanization and population density	1.000	.699
Energy security and independence	1.000	.810
Consumer demand and preferences	1.000	.738
Energy consumption patterns and habits	1.000	.932
Energy infrastructure costs and investments	1.000	.807
Environmental consciousness and concerns	1.000	.884
Energy market competition	1.000	.809
Energy efficiency standards and labeling	1.000	.897
Job creation and economic development	1.000	.815
Technological advancements and innovation	1.000	.910
Industry standards and certifications	1.000	.644
Extraction Method: Principal Component Analysis.		

Source: Field Survey (2023)

Scree Plot

The inclusion of an excessive number of components in an analysis may result in the introduction of unwanted, erroneous variance. Conversely, the exclusion of an insufficient number of factors may lead to the omission of significant shared variation. In the process of determining the appropriate number of components to extract, it is important to carefully consider and choose the most relevant criterion for your study. The utilization of eigenvalues and the scree test, specifically the scree plot, is employed to ascertain the appropriate number of components to maintain. One criterion that may be employed to ascertain the appropriate number of factors to maintain is Kaiser's criterion. This criterion, proposed by Kaiser in 1960, is considered a rule of thumb. According to this criterion, it is recommended to retain only those factors that possess eigenvalues greater than 1. The Guttmann-Kaiser rule and the Cattel scree test were employed to ascertain the optimal number of components to extract. Based on the application of these criteria, it is suggested that a total of two (2) primary components should be extracted.

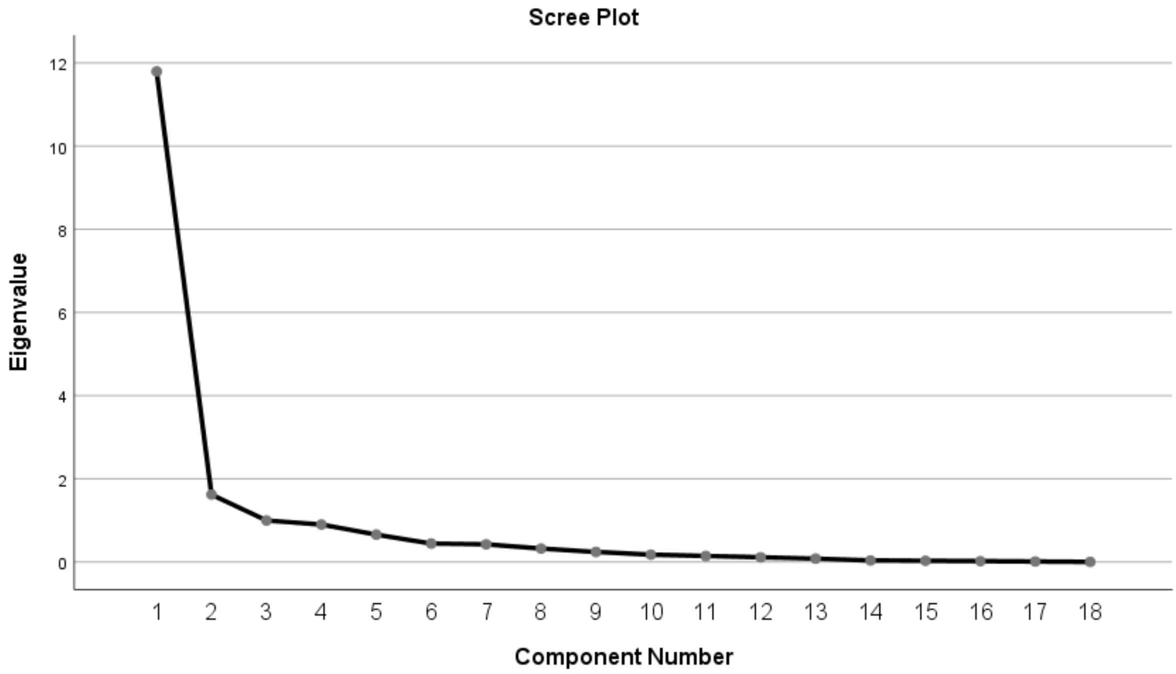

Figure 1: Scree Plot

Source: Field Survey (2023)

Total Variance Explained

Table 4 illustrates the cumulative variation accounted for in the research. The initial two components had eigenvalues over 1 (11.795 and 1.619), aligning with the findings of Cardoso and Cruz-Almeida (2016) and Gyimah et al. (2024), who argued that the eigenvalues should surpass a value of one (1) to indicate the presence of several factors. All two components had eigenvalues that exceeded a value of one. The first component explained the largest proportion of variation, accounting for 65.528%, and the second component accounted for 8.997% of the variance. Collectively, the cumulative extraction of all components accounted for 74.525% of the variability seen in the dataset. This satisfies the requirement for cumulative proportion of variance, which requires that the extracted components collectively explain a minimum of 50% of the observed variation.

Table 9: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	**Cumulative %**
1	**11.795**	**65.528**	**65.528**	**11.795**	**65.528**	**65.528**	**8.377**	**46.539**	**46.539**
2	**1.619**	**8.997**	**74.525**	**1.619**	**8.997**	**74.525**	**5.037**	**27.986**	**74.525**
3	.997	5.539	80.064						
4	.899	4.996	85.060						
5	.657	3.649	88.709						
6	.443	2.459	91.168						
7	.424	2.354	93.522						
8	.322	1.787	95.309						
9	.240	1.335	96.644						
10	.174	.966	97.610						
11	.143	.795	98.405						
12	.112	.622	99.027						
13	.080	.445	99.473						
14	.036	.200	99.672						
15	.028	.156	99.829						
16	.019	.107	99.935						
17	.010	.058	99.994						
18	.001	.006	100.000						

Extraction Method: Principal Component Analysis.

Source: Field Survey (2023)

Table 5 below presents the variables that load under each of the two components extracted as per the scree plot in Figure 1 above.

Table 10: Rotated Component Matrix

	Components	
	1	**2**
Component 1: Energy Consumption and Infrastructure Dynamics		
Public awareness and education	.788	
Urbanization and population density	.697	
Energy security and independence	.840	
Consumer demand and preferences	.738	
Energy consumption patterns and habits	.939	
Energy infrastructure costs and investments	.738	
Environmental consciousness and concerns	.728	
Energy market competition	.778	
Energy efficiency standards and labeling	.941	
Job creation and economic development	.835	
Technological advancements and innovation	.802	
Industry standards and certifications	.766	
Component 2: Policy, Market and Social Dimensions		
Government policies and regulations		.782
Energy prices and affordability		.797
Access to financing and incentives		.751
Availability of renewable energy resources		.807
Socio-cultural norms and values		.474
Social acceptance and support		.630

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

Source: Field Survey (2023)

Discussing the Principal Components

Component 1: Energy Consumption and Infrastructure Dynamics

This component encompasses variables related to energy consumption patterns, infrastructure, market dynamics, and technologies. It accounts for the largest proportion of variation, at 65.528%. This implies that over half the variability observed in the dataset is explained by factors related to energy consumption and infrastructure dynamics. Some possible reasons for it explaining the most variance are that energy consumption, both at household/individual and national levels, is a key determinant of sustainable energy transitions. Patterns and habits of consumption influence the adoption of clean technologies. Furthermore, adequate energy infrastructure is essential for supporting the deployment and uptake of sustainable solutions, as limitations or deficits in grids and distribution networks act as impediments. Market forces like competition and available technologies help drive demand for renewable options and determine their scalability. Public awareness, education, and consensus around sustainability issues are important in catalyzing behavior change relating to consumption and acceptance of new infrastructure and projects. Conclusively, factors around actual and planned consumption levels, quality of distribution networks, and market responsiveness to new offerings provide substantial explanatory power regarding Ghana's sustainable energy development landscape, according to the data analysis. Their leadership in accounting for the socio-economic factors' variance reinforces their importance in transition policies and strategies.

The finding that this component explains the most variance in the dataset corroborates with existing literature on the roles of energy consumption and infrastructure in sustainable energy transitions. Several studies have emphasized the importance of considering energy consumption trends and infrastructure quality in designing energy policies and strategies (Santarius et al., 2019; Gillingham et al., 2018). Energy consumption, both at the household level and on broader national scales, determines the nature and pace of transitions (Zhang et al., 2019). Patterns and habits of consumption influence the adoption of new clean technologies (Santarius and Soland, 2019; Gillingham et al., 2018).

Adequate energy infrastructure is likewise essential for supporting the deployment and uptake of sustainable options, as limitations or deficits in grids and distribution networks act as impediments (Butler and Neuhoff, 2008; Wang et al., 2018). The quality of infrastructure determines the scalability potential of technology rollouts with networks (Butler and Neuhoff, 2008; Jaccard, 2005). This aligns with findings from other studies that show that energy infrastructure costs and deficits pose major constraints on renewable scaling (Inglesi-Lotz, 2016). The dominance of 'Energy Consumption and Infrastructure Dynamics' in accounting for variability can be attributed to these core determinants heavily influencing how energy transitions unfold concretely. Actual and envisioned consumption levels coupled with the capacity of distribution infrastructure play enormous explanatory roles regarding Ghana's renewable landscape dynamics, according to the analysis (Santarius and Soland, 2018; Gillingham et al., 2018).

Their primacy reinforces their value as focal areas in transition strategies. Their emergence as the leading component also aligns with the principles of diffusion of innovation theory, which highlight compatibility with existing practices and infrastructure compatibility as major adoption factors (Rogers et al., 2004). It is inferred that realigning consumption trends and enhancing infrastructure quality are imperative for catalyzing renewables, according to participants. This affirms their significance as policy emphases moving forward.

Component 2: Policy, Market and Social Factors

This name encompasses the key variables under this component, which are related to: government policies and regulations; energy prices and affordability; access to financing and incentives; availability of renewable energy resources; socio-cultural norms and values; and social acceptance and support. It accounts for the least proportion of variation, at 8.997%. This can be attributed to energy consumption and infrastructure dynamics being core determinants of how sustainable energy transitions unfold. The quality and outreach of prevailing energy distribution networks play a huge role in facilitating or inhibiting the deployment and uptake of new sustainable offerings. Moreover, deficits impose major constraints as market forces like competition and accessible technologies help propel demand shifts towards renewable choices and influence their scalability over time with sensitization efforts. Concerted efforts around existing and intended consumption patterns, grids, and market forces provide extensive explanatory power regarding the dynamics underway in Ghana's sustainable energy landscape, according to the analysis findings. Their significance in describing the socio-economic variance endorses their significance as focal points in transition plans, policies, and tactics going forward.

The findings establish that government policies and regulations play a crucial role in facilitating renewable energy adoption. Multiple studies have emphasized that supportive policy frameworks and legislation are important for controlling factors like LPG price volatility and addressing issues of importation. Effective incentives and policies are also needed to strengthen the promotion of technologies like biogas (Nape et al., 2019). Regulations are necessary to support domestic ethanol production, transportation, and taxation policies. Access to financing and incentives is also a major theme emerging in literature. The availability of credits, loans, and subsidies increased the willingness to adopt biodigesters in South Africa, according to Uhunamure et al. (2019). Access to loans and microcredit aided the adoption of improved cookstoves in Bangladesh and biodigesters in multiple nations (Kabir et al., 2013; Mwirigi et al., 2014). Subsidies for biogas plant costs promoted technology in various countries (Nape et al., 2019; Kabir et al., 2013; Uhunamure et al., 2019).

The availability of local renewable resources was featured as an adoption driver. Sufficient biomass feedstock availability facilitated household biogas adoption (Kabir et al., 2013; Uhunamure et al., 2019). The availability of local feedstock aided ethanol production from sugarcane and cassava (Gebremedhin and Tesfay, 2015). Socio-cultural aspects also influenced technology choices. Biogas faced resistance from cultural taboos around animal waste handling in some nations (Kabir et al., 2013). Cultural preferences presented barriers to biogas and ethanol adoption, respectively, in multiple countries, including India and South Africa (Kabir et al., 2013; Uhunamure et al., 2019). Social interaction and support enhanced the diffusion of environmental technologies, as strong extended family bonds facilitated biogas adoption in South Africa, according to Nape et al. (2019)..

The emergence of Component 2 can be attributed to variables within it representing crucial policy and financial angles paired with societal dimensions, which the literature identifies as playing a core role in shaping renewable choices and transitions. As established in the policy and financial and socio-cultural evidence from prior studies reviewed, these determinants hold significant explanatory power regarding factors shaping sustainable energy adoption trends within the Ghanaian context according to participants' perspectives. While infrastructure and usage patterns account for more variation individually, as captured in Component 1, given their direct impacts, Component 2 still implies that policy support, market characteristics, financial accessibility, and social license to operate are highly influential adoption considerations, according to this research analysis.

Contribution to Theory and Practice

This study makes several important contributions to theory and practice regarding socio-economic factors influencing sustainable energy technology adoption.

On the theoretical front, the study contributes significantly to the diffusion of innovation theory and technology acceptance frameworks. By evaluating external socio-economic variables, it expands these theoretical lenses beyond their usual emphasis on attributes of innovation itself. The study also integrates these technology-focused theories with sustainability paradigms, which are crucial for understanding renewable energy choices. The use of statistical dimension reduction techniques further refines the theoretical contributions by identifying principal components from a wide array of adoption variables. Inferring two main dimensions of "energy consumption and infrastructure dynamics" and "policy, market, and social factors" advances conceptualizations in the domain by consolidating explanatory elements. Overall, integrating varied theoretical trajectories to elucidate renewable technology adoption decisions in a developing-world context expands scholarly platforms substantially.

Regarding practical contributions, the study's findings have meaningful implications for policymakers, renewable businesses, and financing institutions. Identifying government regulations and access to incentives as highly influential creates an evidence base for designing policies and programs to catalyze sustainable transitions through appropriate controls, subsidies, and credit channels. The prominence of energy consumption habits and infrastructure quality similarly informs intervention priorities around consumption management and grid upgrades to enable scaled adoption. Additionally, the role of availability of renewable resources, prices, and societal acceptance underlines focus areas like indigenous resource mapping, cost benchmarking with conventional fuels, and public engagement around sustainability issues. Overall, the multi-stakeholder sample provides a robust set of actionable insights for shaping conducive renewable energy landscapes in Ghana and analogous developing settings through coordinated efforts spanning regulation, business models, and social awareness.

Limitations

As with most research of this magnitude and type, it is impossible to avoid limitations. Given the nature of this study, the limited duration of this study constituted a severe constraint. Non-response error in the main data was also a significant constraint of this research. Nonetheless, the generalizability of the study's results is not limited since they may serve as a lesson for other developing nations, such as Ghana. Despite these limitations, the results and conclusions of this research were not significantly affected.

Directions for Future Research

Some relevant topics that this specific study could not cover were identified and observed during the research process, which included reviewing the literature, determining the research methodologies, formulating the analysis and discussions, and creating a list of these areas for future study or research. The following is a list of these potential study directions: exploring economic opportunities and skill requirements within the sustainable energy sector to promote green entrepreneurship and job prospects; and studying financing models for de-risking investments through instruments like green bonds to channel more private capital into sustainability projects.

Conclusions and Recommendations

This study explored the socio-economic factors influencing the adoption of sustainable energy technologies and practices in Ghana. The analysis reveals that government policies and regulations, along with access to financing and incentives, are the most influential drivers. Additionally, energy consumption patterns and infrastructure dynamics play an explanatory role by accounting for the largest variance. Furthermore, the availability of renewable resources, energy pricing, social acceptance, and policy frameworks comprise a secondary set of determinants. Some key conclusions can therefore be drawn.

To begin with, the prominence of government regulations and financial incentives implies that appropriately designed policies, subsidies, and credit channels can effectively catalyze adoption. The study findings establish government policies and access to incentives as principal adoption determinants, underscoring their significance as catalysts. Ghana's policy emphasis should therefore involve mapping indigenous renewable assets to expand exploitation opportunities, benchmarking renewable energy costs against conventional fuels to structure appropriate feed-in tariffs, and crafting competitive policy frameworks encompassing tax reliefs, import duty waivers, and capital subsidies to drive diffusion. Well-designed regulatory pushes and financial pulls can provide meaningful impetus.

Also, the major role of consumption habits and infrastructure quality suggests that efforts on consumption management, efficiency improvements, and grid upgrades can enable scalability. The study deduces that realigning consumption trends and enhancing infrastructure quality are imperative for propelling renewables. Interventions spanning public awareness campaigns, efficiency labeling programs, progressive block tariffs, grid reinforcement, and decentralized renewable integration can help match infrastructure capabilities with sustainability ambitions.

Furthermore, the significance of public attitudes and renewable potentials indicates that awareness campaigns paired with increased domestic renewable exploitation can accelerate adoption. The findings reveal that social acceptance and indigenous resource availability shape the speed of diffusion. Sensitizing the public regarding environmental impacts while concurrently reducing reliance on external energy sources through domestic renewable buildouts can therefore provide momentum.

Considering these conclusions, some key recommendations can be made drawn from the findings of the study.

i. Policymakers should focus on constructing holistic policy ecosystems encompassing indigenous renewables, grid connectivity, electric mobility, decentralized solutions and sustainability education.
ii. Financing institutions should target credit lines and low-cost loans towards renewable businesses and mini-grid infrastructure.
iii. Businesses should adopt circular models and demonstrate leadership by investing in emerging innovations, efficiency improvements and recyclable materials.
iv. Research institutions should identify consumption reduction pathways and evaluate storage solutions to manage variable generation.

Conclusively, this study provides robust evidence regarding major levers influencing Ghana's sustainable energy landscape. It emphasizes that coherent efforts across policy, financial, technical, and social dimensions are imperative for transitioning towards renewables aligned with national sustainable development goals. Further research can build on these conclusions by evaluating specific policy mechanisms, consumption behavior change models, and renewable storage technologies. Overall, the multi-stakeholder insights furnish actionable and timely guidelines for shaping an enabling renewable technology ecosystem.

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Do Socioeconomic Factors Impact Green Cities Development? An SEM Analysis

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Abstract

This study examines the impact of socioeconomic factors on the development of green cities. Green cities are urban areas that prioritize environmental performance and seek to minimize their ecological footprint. However, little research has explored how socioeconomic dynamics influence progress towards more sustainable and green cities. Using data collected through a survey of experts in Ghana, this study employs structural equation modelling to analyze relationships between socioeconomic factors and indicators of green city development. The results indicate that socioeconomic factors have a significant positive impact on green cities. 15 key socioeconomic determinants were identified based on literature review. Survey findings confirmed that these factors influence green city development to varying degrees. For example, awareness, environmental regulations, had large effects, while population pressures and income levels had weaker impacts. This research contributes new empirical evidence showing socioeconomics underpin progress towards sustainability objectives localized within cities. The findings have important implications. Urban authorities seeking to "green" local development must address socioeconomic dimensions, not just environmental factors. Targeted interventions addressing each socioeconomic driver can optimize promotion and implementation of green city projects. Acknowledging socioeconomic dynamics is critical for designing comprehensive solutions aligned with urban contexts. This study provides baseline data to inform integrated policy frameworks and interventions.

Keywords – socioeconomic, green city development, factors, impact

Introduction

Cities play a crucial role in socio-economic development, but this development also exerts enormous pressure on the environment (Zhang et al., 2021), however, cities are characterized by

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high population density, greater industrial activity, and large-scale infrastructure (Ürge-Vorsatz et al., 2018). Although cities cover only 3% of the Earth's land area, they consume approximately 60–80% of the total energy and emit over 70% of global greenhouse gases (Elmqvist et al., 2019). Urbanization and industrialization have contributed to the deterioration of the environment through the reduction of environmental performance, reduced water quality and quantity (Bai et al., 2017), obliteration of urban natural resources and green fields, fuel consumption and traffic congestion leading to increased journey time (Mondal and Palit, 2022). Rosenzweig et al. (2018) attributed 70% of greenhouse gas emissions in cities to urban transport. Cities make a significant contribution to global issues, including climate change and depletion of biodiversity (Debrah et al., 2021). In salvaging these problems associated with cities and urbanization, most researchers have agreed on the promotion of green cities as a concept. Hornweig and Freire (2013) posited that, the only path to sustainability is through the development of sustainable or green cities.

The concept of green cities may be traced back to the early 20th century, specifically to the establishment of urban subsistence gardens in United States (US) urban regions in the 1900s (Moore, 2006). Green city, eco-city, and liveable city, have emerged as interwoven concepts to mainstream sustainable development in urban areas (Singh., 2016). While eco-city is concerned with urban ecological health and liveable city is concerned with urbanites' well-being, green city is concerned with the relationship between the environment and human systems within the urban context (Hald, 2009). To various individuals, the word "Green City" means different things (Breuste, 2023). Branny et al. (2022), argues that there is no universally applicable approach that can be adopted in every city towards the development of green cities. Green cities exist in diverse forms due to adaptable, responsive, and inventive solutions that change from place to place, allowing us to appreciate the variety and dynamism of cities. (Desouza and Flanery,2013)

To provide thorough understanding of green cities, a variety of literatures explains the concept of green city from various ideological perspectives (Haughton, 2021). A green city is defined as one that prioritizes environmental performance over other factors, with the aim of optimizing social and economic advantages (Anderson, 2021). Sun (2021) defines a green city as an urban enclave where the preservation of the natural environment is given equal weight with the health and well-being of the city's residents on the social, economic, and environmental fronts. The concept of a green city is also highlighted by Ali et al. (2019) as a practical way to preserve both the environment and the standard of living for those residing in urban areas. All three definitions underline green city's social, economic, and environmental wellness as keys backing the concept.

The green city (GC) concept is one of the latest responses to the various initiatives and studies undertaken to solve the issues produced by the scattered model of city growth and to assist cities in becoming more sustainable, less dispersed, and more liveable. However, Brilhante and Klaas (2018) touched on the presence of a wide variety of environmental and other urban-related challenges within cities that led to the development of several green city definitions and methods which has hampered their acceptability and implementation. While some focus solely on environmental aspects, others include socioeconomic, environmental, and infrastructure elements, as well as policies, resilience, ICT technologies, and plans such as disaster risk plans, among others. Owusu-Manu et al. (2020 pp.4) also encompass the breadth of green cities in terms of "complexity as it covers sustainable development, sustainable communities, sustainable urban areas, bioregionalism, eco-cities, economic development, adequate technology, social ecology, green movement, green towns, and communities".

Globally, the research on green cities on green city has encompassed sustainable urban planning, which integrates social, economic, and environmental factors (Hameed, 2020). This involves the use of environmentally friendly materials and systems, as well as the creation of a green framework within the city (Hameed, 2020).These measures can help combat climate change and create a more just and sustainable society (Hameed, 2020),urban ecology, environmental justice, and the preservation of natural areas (Putra, 2022), development of concepts which have been translated into methods and tools such as benchmarks to measure environmental and/or sustainability performance (Zong *et al*.,2019; Kawakubo *et al*., 2018). The focus both for assessment tools and within academic discussion tends to be on the environmental and, to a lesser extent, the economic aspects of sustainability, rather than on social sustainability (Robinson and Cole, 2015).

Within the Ghanaian context, research has been conducted on green cities which includes barriers to green cities development (Debrah *et al*., 2020) drivers of green cities (Debrah *et al*., 2021), sustainability content underpinning green cities (Debrah *et al*., 2023), attributable indicators for measuring the level of greenness of green cities (Owusu-Manu *et al*., 2020).From the foregoing, the present trend of study in green cities have focused on the environmental dimension since this can readily be seen and measured neglecting the socioeconomic dimension. While Eizenberg and Jarabben (2017) postulated a framework for social sustainability which was underpinned by risks. Hornweig and Freire (2013) concur that to make urban arears green (in this case green cities), there is the need to encourage behavioural and psychological changes at the individual, corporate, local, and public levels which are social in nature. The extent of these socioeconomic factors underpinning green cities development thus, still remains under-explored. To fill this gap, the study is to assess the impact of the socioeconomic factors on green cities in the bid towards green city development through a quantitative approach. The results herein will contribute to the understanding and development of appropriate frameworks towards the implementation of GC projects.

Socioeconomic Factors Affecting Green Cities

It has been well established from literature that many factors promote or impede the adoption of green cites in Ghana (Debrah et al., 2021; Guribie et al., 2022). Due to the fact that the negative impacts of construction is clearly seen on the environment, most research has focused on promoting environmental sustainability whilst leaving the social and economic aspects (Oliveira et al., 2019). Hence this research is positioned to bridge the gap between the environmental impact and socioeconomic impact.

The term "Socioeconomic" is derived from the combining of social and economic issues, indicating that it encompasses both aspects. This research aims to precisely identify the social and economic aspects in terms of social sustainability and economic sustainability, respectively.
Therefore, social variables are the determinants that either facilitate or hinder the safeguarding of individuals from risks by encouraging the implementation of fair and impartial social, economic, and environmental policies (Eizenberg and Jabareen, 2017). Economic factors are the determinants that either facilitate or hinder the implementation of strategies that foster sustainable economic development, while avoiding any adverse effects on the social, environmental, and cultural dimensions of the community (University of Mary, Washington, 2009). Extant literatures have highlighted barriers and drivers to green city development (Debrah et al., 2021; Chan et al, 2017; Ametepey et al., 2015; Wu et al., 2019).

According to Debrah et al., (2022) some of t the barrriers in the Ghanaian context includes; Lack of awareness of the benefits of a green city, environmental degradation, insufficient policy implementation efforts, excessive generation of solid waste, poor waste water collection and treatment, financial constraints and revenue shortfalls of the governmen. According to Debrah et al., (2021), through exploratory factor analysis drivers for green city develpoment included health and wellbeing, green governance and management, green attraction and social inclusion and green environment and materials. This also in the Ghanaian context. Acoording to Wu et al, (2019) in China, low economic efficiency, poor market environment, weak environmental awareness of stakeholders, imperfect industrial policies, and lack of relevant technical support are the barriers to green buildings development after the factors were compressed through Exploratory factor analysis. According to Ametepey et al., (2015) financial barriers, political barriers, management/ leadership, technical barriers, socio-cultural barriers, knowledge/ awareness barriers are the barriers to green buildings adapatation in Ghana. Guribie et al., (2022) opined that the lack of demand of green buildigs is as a result of improper communication channels, attitudinal/perception barriers, experts/ technology shortfalls, cost-related barriers, industry and market characteristics, stakeholders constitute a significant obstacle to the development of the GB market (Chan Attitudinal/perception barriers. Attitudinal and behavioral barriers by clients and project stakeholders constitute a significant obstacle to the development of the GB market (Chan et al.,2017). Attitude constitutes a behavioral pattern which makes a significant difference in stakeholders constitute a significant obstacle to the development of the GB market (Chan et al.,2017). Attitude constitutes a behavioral pattern which makes a significant difference in innovation**.** Table I below is a summary of all the identified socioeconomic factors from extant literature.

Table I: Socioeconomic factors

Code	Socioeconomic factor	Source
A2	Awareness	Wu *et al.*, (2019); Owusu-Manu *et al.*, (2020)
ER2	Environmental regulations	Wu et al., (2019); Owusu-Manu *et al.*, (2020); Ametepey *et al.*, (2015)
DF2	Finance (Digital finance)	Owusu-Manu *et al.*, (2020); Ametepey *et al.*, (2015)
GMM2	Green market mechanism	Wu *et al.*, (2019); Ametepey *et al.*, (2015)
GCP2	Green city planning (Urban planning)	Owusu-Manu *et al.*, (2020); Ametepey *et al.*, (2015)
IT2	Innovation and technology	Ametepey *et al.*, (2015)
SE2	Stakeholder engagement	Wu *et al.*, (2019); Owusu-Manu *et al.*, (2020); Ametepey *et al.*, (2015); Debrah *et al.*, (2020)
CPT2	City planning (transportation)	Owusu-Manu *et al.*, (2020); Debrah *et al.*, (2020)
IC2	Income levels of clients	Owusu-Manu *et al.*, (2020); Debrah *et al.*, (2021); Ametepey *et al.*, (2015)
RU2	Risks and uncertainties	Ametepey *et al.*, (2015)
P2	Population	Owusu-Manu *et al.*, (2020)
PI2	Policy implementation.	Owusu-Manu *et al.*, (2020); Debrah *et al.*, (2021); Ametepey *et al.*, (2015); Wu *et al.*, (2019)
C2	Culture	Ametepey *et al.*, (2015); Gurubie *et al.*, (2021); Chan *et al.*, (2017)
GIF2	Green Investment/ finance	Owusu-Manu *et al.*, (2020); Ametepey *et al.*, (2015)
H2	Housing	Owusu-Manu *et al.*, (2020)

Source: Author's construct (2023)

Working Hypothesis

The latent variables in this study are Socioeconomic factors (SEF) and Green Cities Development (GCD). The indicators for the Socioeconomic latent variable have been shown in Figure 1 already. According to research by Owusu-Manu et al., (2020) eight indicators were identified which serves as the indicators for measuring the level of greenness green cities. The research adopted the Partial Least Squares Structural Equation Modelling (PLS-SEM). These indicators were adopted as the indicators for measuring green cities. Table II below is a summary of the indicators for green city development as adapted form Owusu-Manu et al., (2020)

Table II: Green city Indicators

Code	Indicator
AQ	Air quality
WQ	Water quality
S	Sanitation
LU	Land Use
HS	Health and Safety
E	Energy
BC	Building Construction
T	Transportation

Source: Owusu-Manu et al., (2020)

Working Hypothesis

The hypothesis for the study is that socioeconomic factors have a positive impact ($\beta \geq 0.5$) on green cities development as shown by Figure 1 below.

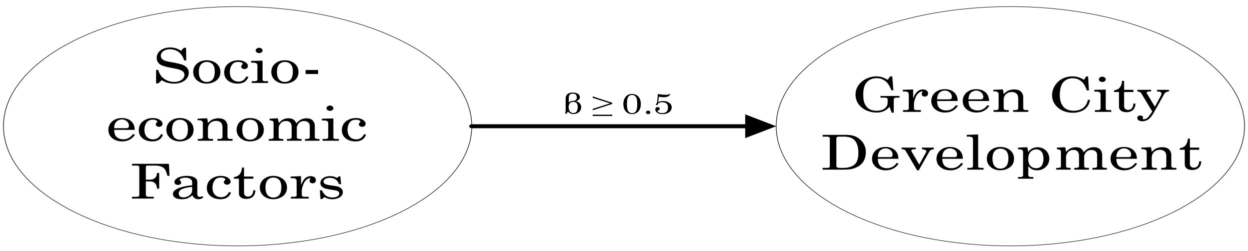

Figure 1: Working Hypothesis

Source: Author’s construct (2023)

Methodology

This study aims to investigate the influence of socioeconomic factors on the creation of environmentally sustainable cities. This study utilized a positivistic philosophical viewpoint. Positivism is a deterministic philosophy that posits that "causes" likely determine "effects" or "outcomes" (Creswell, 2009). This results in the formulation of rules that demonstrate the correlation between the variables (Fellows and Liu, 2015). The study employed a deductive research approach. The deductive research approach operates within the confines of pre-existing knowledge, with the researcher aiming to validate or adhere to previously established truths. Azungah, (2018). Deductive reasoning ensures that the conclusion is necessarily true if the premises are true (Hayes et al., 2018). Therefore, the validity of the premises assures the truth of the conclusion, reinforcing knowledge (Hayes et al., 2018). An extensive and thorough literature review was initially carried out to determine the socio-economic aspects that impact the development of green cities.

The study employed a quantitative research technique (Mohajan, 2020) to establish the empirical relationship between socioeconomic factors and green cities. The study sample comprised individuals from many sectors, including education (including sustainability professors), business and finance, government, energy and health, environment, water and sanitation, and infrastructure and planning. All of these individuals possess the necessary expertise about environmental concerns in urban areas. As there was a lack of available population data regarding individuals knowledgeable about green cities, the study utilized a non-probability sampling technique (specifically purposive and snowballing sampling techniques) (Vehovar and Steinmetz, (2016) to determine the sample size. Purposive sampling is employed in this research to ensure that participants possess the necessary knowledge in sustainability issues, which is essential for achieving the study's objective (Campbell et al., 2020). The snowball method (Naderifar, and Ghaljaie, (2017). is employed due to the absence of readily accessible data regarding individuals (such as lecturers, NGOs, and construction companies) who possess knowledge of sustainability and actively implement it in Ghana. In purposive sampling, the researcher deliberately chooses specific individuals who possess the necessary expertise and experience to participate in the study, based on what information is needed (Campbell et al., 2020). Neville (2007) highlighted that the snowball technique for sample generation relies on subject matter experts as informants. It begins with one individual who subsequently recommends the next participant, and this process continues iteratively.

Survey Administration

A questionnaire survey study design was chosen due to the reliance on statistical sampling McLafferty, (2016). Complete population surveys are rarely used or preferred, as they are not practical (Ball, 2019). By using surveys, representatives from the sample can be obtained Ponto, (2015). The study utilized a self-administered structured comprehensive survey questionnaire, which was distributed by both an online survey and the drop-and-pick approach (Debrah et al., 2020). The questionnaire consisted of three distinct sections, labeled as A, B, and C.

Part A aimed to get informed consent from the participants by following rigorous ethical protocols that govern this research, such as ensuring tight secrecy (Ibbett and Brittain 2020). Part B aimed to obtain demographic data from the participants. This research requires respondents with different levels of skill and professionalism in order to verify their ability to participate in the study (Pandey and Pandey, 2015). Part C gathered data on the influence of socioeconomic factors on the development of environmentally-friendly cities. Participants were requested to assess and prioritize the socioeconomic elements that influence the development of a sustainable city using a five-point Likert scale. The Likert scale assigns a value of 1 for not significant, 2 for less significant, 3 for moderately significant, 4 for significant, and 5 for very significant. Out of the 120 questionnaires distributed, 81 replies were obtained, resulting in a response rate of %. According to Davidoff et al. (2002), a response rate of 60% is considered adequate, acceptable, or marginal. A response rate of 70% is seen reasonable or preferable, while a rate of 80% is considered desired or good. Finally, a response rate of 67.5% is considered adequate in surveys. Therefore, for this current investigation, the rate at which participants responded was considered sufficient.

Data analysis

Structural Equation Modelling

SEM plays a significant role in empirical research in construction, particularly in the assessment of factors affecting the success of construction projects. A SEM has two main components for performing data analysis: the measurement and the structural models (Hair et al., 2020). The measurement model refers to the relationships between the construct and its indicators (outer model), while the structural model refers to the relationship between the constructs (Hair et al., 2020; Hair et al., 2010). The valid dataset was then analysed with SEM by using SmartPLS 3.3.2 software. The figure below shows the relationship between the indictors and the constructs.

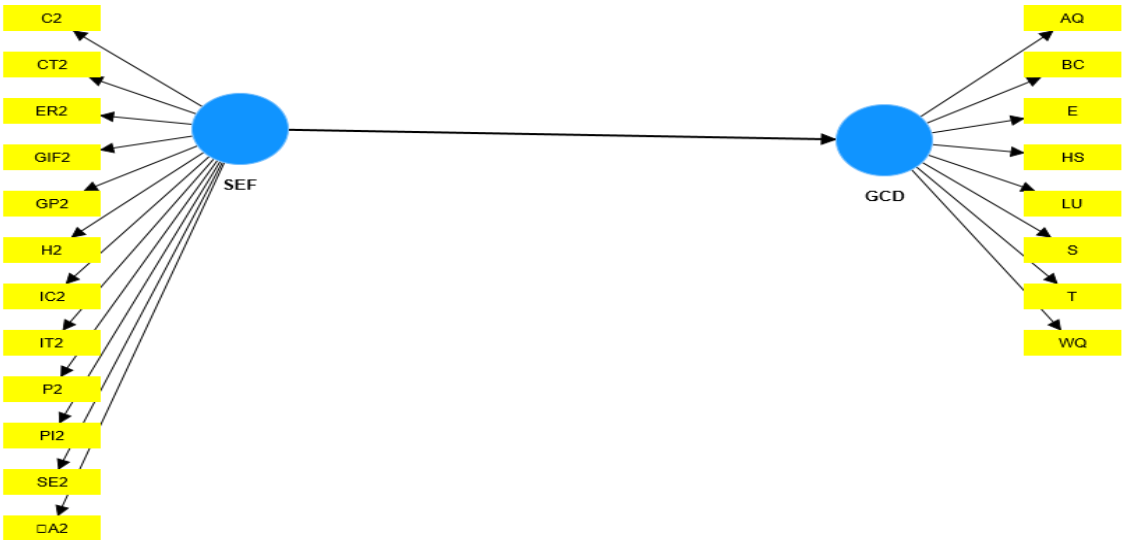

Figure 2: Diagram of Latent Variables
Source: Author's construct (2023)

Evaluation of Measurement model

Reliability testing

According to Hair et al., (2010), the reliability of the construct can be measured in two ways– Cronbach's alpha (α) and composite reliability (CR). The rule of thumb for both reliability criteria is that they need to be above 0.70 as the indicators are not equally reliable. Composite reliability, which is weighted, is more accurate than Cronbach's alpha (unweighted), and therefore CR should be assessed and reported. In this study, Cronbach's alpha (α) and composite reliability (CR) were tested to measure the reliability of model constructs. Construct reliability reflects the degree to which the items consistently demonstrate the latent constructs.

In the study, Cronbach's alpha for all constructs/latent variables for both the impact of socioeconomic factors and indicators of green cities surpassed the recommended cut-off of 0.70 and its value was 0.873 for Green city development (GCD) and 0.906 for Socioeconomic factors (SEF). The Composite Reliability values also surpassed the 0.70 cut-off point and were 0.881 and 0.925 for GCD and SEF respectively. It can be observed that the CA and CR values surpassed the cut-off values of 0.70, hence the data is reliable to be considered for further analysis. Both are shown in Table III below.

Table III: Validity Test

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)
GCD	0.873	0.881	0.900
SEF	0.907	0.919	0.922

Source: Survey (2023)

Validity testing

After reviewing for reliability, the data was checked for validity. Items loadings are an essential reliability test of a load of each item on its respective construct. It reflects the level to which items of the same construct are consistent with each other. The more consistency there is, the higher the factor loading will be. Individual item reliability checks the correlation with assigned latent variables. When outer loading is less than 0.4, the items should be omitted, however where factor loading is greater than 0.4 and less than 0.7, the items can be retained in exploratory research if AVE is satisfied (Garson, 2016). The variables with factor loadings less than 0.50 were deleted. The new table after the variables were deleted is shown in Table IV below

Table IV: Factor loadings

	GCD	SEF
AQ	0.688	
BC	0.722	
C2		0.692
CT2		0.722
E	0.820	
ER2		0.787
GIF2		0.606
GP2		0.761
H2		0.845
HS	0.606	
IC2		0.583
IT2		0.718
LU	0.763	
P2		0.626
PI2		0.813
S	0.713	
SE2		0.611
T	0.701	
WQ	0.799	
A2		0.648

Source: Survey (2023)

The average variance extracted (AVE) measures the average percentage of the variance commonly extracted from the observed variables. The recommended standard value of AVE, as set out by Hair et al., (2011) and Hair et al., (2016) is ≥ 0.50 to ensure that, on average, the latent variable can explain more than half of its indicator variance, indicating a sufficient degree of convergent validity. As presented in Table V below, AVE values were 0.532 for GCD and 0.499 for SEF respectively. It can be observed that the AVE for GCD and SEF are good hence further analysis can be carried out.

Table V: Average Variance Extracted

	Average variance extracted (AVE)
GCD	0.532
SEF	0.499

Source: Survey (2023)

There are two ways for measuring discriminant validity. One is by the Fornell-Lacker Criterion which makes use of the square-root of the AVE. The other is the cross loadings test which makes use of the loadings of each construct being greater than the loadings between the constructs. Discriminant validity is usually evaluated through the square root of AVE. The discriminant validity was assessed by assuming that the AVE's square roots are higher than the construct's highest squared correlations with other latent constructs (Fornell-Lacker criterion). The AVE's square root can be used to assess discriminant validity in each latent variable if this value is greater than other correlation values (Hair et al., 2010). Table VI below shows that the AVE's square root for each construct surpassed the correlations between the construct and the other constructs and met the criterion of discriminant validity. The test for the cross-loading is that the loadings for each construct should be greater than between the constructs. Table VII below shows that the cross-loadings for each construct is greater than between the constructs.

Table VI: Discriminant Validity (Fornell-Lacker Criterion)

	GCD	SEF
GCD	0.729	
SEF	0.675	0.706

Source: Survey (2023)

Table VII: Discriminant Validity (Cross Loading test)

	GCD	SEF
AQ	0.688	0.478
BC	0.722	0.529
C2	0.437	0.692
CT2	0.530	0.722
E	0.820	0.531
ER2	0.615	0.787
GIF2	0.363	0.606
GP2	0.511	0.761
H2	0.587	0.845
HS	0.606	0.382
IC2	0.259	0.583
IT2	0.449	0.718
LU	0.763	0.492
P2	0.368	0.626
PI2	0.520	0.813
S	0.713	0.459
SE2	0.363	0.611
T	0.701	0.423
WQ	0.799	0.600
A2	0.532	0.648

Source: Survey (2023)

The measurement model of the study was tested in line with suggestions from the SEM literature. Thus, convergent validity to measure the construct indicators' internal consistency was checked and found to exceed the recommended values of outer loading, CR and AVE. The measurement model fulfilled the reliability tests and the criteria for the validity of measurement model assessment. Discriminant validity was used to determine the degree to which items were distinct using a cross-loading matrix of constructs. The variable association was tested by looking at the AVE square root. The results indicate that all values were higher than other off-diagonal values. The discriminant validity test, therefore, successfully demonstrated the validity of the measurements.

Evaluation of Structural model

After examining the reliability and validity of the measurement model, the next step was to test the structure. As recommended by Urbach and Ahlemann (2010), Hair et al., (2016) and Ramayah et al., (2018) three separate tests were carried out to determine the inner model: coefficient of determination (R2), impact size (f2), and path coefficients. In the subsections below, each test is addressed separately.

A central criterion in assessment of the structural model is the coefficient of determination known as R2. The R2 value reflects the amount of variance that can be clarified by one or more exogenous variables in the endogenous variable(s). The structural model's quality depends on the R2 values, which show the capacity of the exogenous variables to describe the endogenous variables. Urbach and Ahlemann (2010), consider R2 values greater than 0.67 as high and values between 0.33 and 0.67 as moderate, while 0.19 to 0.33 are considered weak and R2 values less than 0.19 are unacceptable. Similarly, Hair et al., (2016) count a substantial model if

R2 = 0.75, moderate if R2 = 0.50 and weak if R2 = 0.25. The resulting R2 value is 0.455 as shown in Table VIII below, putting it in the moderate range.

Table VIII: Quality Criteria (R2)

	R-square	R-square adjusted
GCD	0.455	0.449

Source: Survey (2023)

The next step is to determine the change in R2 by assessing the effect size (f2) to see whether a particular exogenous variable substantially influences an endogenous variable. The effect size (f2) is a measure if an independent latent variable is impacting a latent dependent variable. The f 2 is ranked based on its value as small, medium and large, values above 0.02 and up to 0.15 are considered small; values of 0.15 and up to 0.35 are medium, and values 0.35 and above are large effects Hair et al (2010) based on Cohen's. The f 2 values of effect size which is 0.798, as shown in Table IX below, indicate SEF has a large effect on GCD.

Table IX: Quality Criteria (f2)

	GCD	SEF
GCD		
SEF	0.836	

Source: Survey (2023)

The final phase in evaluating the structural model is to examine the research hypotheses through assessing the path coefficient. A bootstrapping test allows for consideration of the estimated coefficient for significance. On that basis, the bootstrapping analysis helps a researcher to evaluate the research hypotheses statistically. The criterion, however, for evaluating whether the supposed relationship is significant is based on the t-value. Commonly used critical values are 1.65 at a significance level of 10%, 1.96 at 5% and 2.57 at 1%. Researchers also assume a significance level of 10% when a study is exploratory. Nevertheless, instead of t-values, researchers routinely report p-values corresponding to the probability of erroneously rejecting the null hypothesis (Hair et al., 2011), which also was applied in the present study. This research has one hypothesis and the testing results of the hypothesis are as follows:

H1: Socioeconomic factors have a strong positive impact on green cites development.
As shown in table X, all p values = 0.0000 (hence the hypothesis is supported), t-values within the range of 0.777 and 3.944, and β= 0.675 as shown in table XI.

Table X: Cramér-von Descriptives

Indicators	Cramér-von Mises test statistic	Cramér-von Mises p value
AQ	3.188	0.000
BC	3.944	0.000
C2	1.129	0.000
CT2	1.085	0.000
E	3.846	0.000
ER2	1.460	0.000
GIF2	1.021	0.000
GP2	1.659	0.000
H2	1.634	0.000
HS	2.469	0.000
IC2	0.777	0.000
IT2	1.739	0.000
LU	1.927	0.000
P2	1.052	0.000
PI2	1.593	0.000
S	3.016	0.000
SE2	2.162	0.000
T	1.658	0.000
WQ	3.618	0.000
A2	2.836	0.000

Source: Survey (2023)

Table XI: Path Coefficients

	Path coefficients
SEF -> GCD	0.675

Source: Survey (2023)

Results and Discussions

Demographic Background of Respondents

In terms of demographic profile, 5 respondents (6.1%) are professionals in the business and finance field, while another 5 respondents (6.1%) are professionals in the health and safety sector. Additionally, 13 respondents (15.9%) work in the education sector, 41 respondents (50.0%) are construction professionals, 1 respondent (1.2%) is from the governance sector, 4 respondents (4.9%) are experts in environment, water, and sanitation, 2 respondents (6.1%) are energy experts, and 6 respondents (7.3%) are experts in infrastructure and planning. Two respondents, accounting for 2.4% of the total, belong to professions not included in the aforementioned list. The diverse range of respondent knowledge and professions chosen for this research study aligns with Hammer et al.'s (2011) assertion that the evaluation of green city development should encompass technical, stakeholder, and political viewpoints.

The majority of respondents (37.8%) had less than 5 years of experience, with 31 out of 82 respondents falling into this category. 29 respondents (35.4%) had 6-10 years of experience, 11 respondents (13.4%) had 11-15 years of experience, 6 respondents (7.3%) had 16-20 years of experience, and 5 respondents (6.1%) had more than 20 years of experience. According to

Leksakundilok (2004), having a diverse range of experiences is important in order to effectively represent the community or city.

The highest educational qualification of the respondents is as follows: 32.9% hold a Bachelor's Degree, 53.7% hold a Master's Degree, 12.2% have a Doctorate Degree (PhD), and 1.2% hold a Higher National Diploma. The data suggests that most of the participants hold a Master's Degree. According to Hegarty's (2011) research, academic qualifications can enhance one's knowledge for both professional and organizational growth. Regarding familiarity with the green city concept, 40 respondents (48.8%) were familiar with it, while none of the respondents were unfamiliar. 5 respondents (6.1%) were less familiar, and 37 respondents (45.1%) were familiar with the concept of green cities. The demographic background of respondents is shown in table XII below.

Table XII - Respondents profile

Professional Background	**Frequency**	**Percent**	**Valid Percent**	**Cumulative Percent**
Business and Finance	5	6.1	6.1	6.1
Health and Safety	5	6.1	6.1	12.2
Education	13	15.9	15.9	28.0
construction professional	41	50.0	50.0	78.0
Others	2	2.4	2.4	80.5
Governance	1	1.2	1.2	81.7
Environment, water and sanitation	4	4.9	4.9	86.6
Energy	5	6.1	6.1	92.7
Infrastructure and planning	6	7.3	7.3	100.0
Total	82	100.0	100.0	
Years of Experience				
1-5 years	31	37.8	37.8	37.8
6-10 years	29	35.4	35.4	73.2
11-15 years	11	13.4	13.4	86.6
16-20 years	6	7.3	7.3	93.9
Above 20 years	5	6.1	6.1	100.0
Total	82	100.0	100.0	
Highest Academic Qualification				
Bachelor's Degree	28	34.1	34.1	34.1
Master's Degree	44	53.7	53.7	87.8
Doctoral Degree	10	12.2	12.2	100.0
Total	82	100.0	100.0	
Familiarity with green city concept				
Not familiar	0	0	0	0
Less Familiar	5	6.1	6.1	6.1
Familiar	40	48.8	48.8	54.9
Very Familiar	37	45.1	45.1	100.0
Total	82	100.0	100.0	

Source: Survey (2023)

Discussion of Findings

This is foremost research on the impact of socioeconomic factors on green cities development. The results of this study enable deeper understanding of how the green city concept from the lenses of socioeconomic factors can be can be applied in the achievement of sustainability for cities in the attainment United Nations' of SDG Goal 11.The result of the research indicates that socioeconomic factors plays a significant role in the development of green cities as its impact on green cities is high and hence socioeconomic factors should be considered in the effort of achieving sustainability for cities through the green cities concept.

According to research conducted by (Chen et al., 2021) using cities as unit of analysis conducted over 371 Latin cities, it was found that socio-economic status of cities with GDP as the economic measure had positive correlation with the level of greenness overtime (from 2000 to 2015) whilst the socioeconomic status had negative correlation with the average greenness of the cities. This, they attribute to the fact that urban development generally improves socioeconomic conditions of its residents, but this process also reduces green spaces through converting natural land to built-up areas (Buhaug and Urdal 2013). Compared with smaller cities, larger cities in Latin America tend to have higher SES due to their concentration of economy, population, services, health care, and educational resources (Aroca and Atienza 2016, Faraji et al 2016). At the same time, large cities are often more urbanized with relatively less green space, leading to the negative association between SES and average greenness that we observed. The positive city-level association between SES and greening might indicate that cities with better SES are more resourceful to preserve and recover green space, and that Latin American cities overall may have less demand and space for adding built-up areas their already high urbanization levels. Second, the positive association between greening and city-level SES suggests that purposeful urban greening should be addressed in development agendas of low SES cities, as these cities are likely to spiral into unplanned and scattered urbanization since they are bedeviled with greater pressure for economic and land development. Greening these low SES cities also tackles socioeconomic disparity issues in green space planning, which are likely to be overlooked in the region (Chen et al., 2021). It can therefore be inferred from the above that the in the attainment of sustainability for cities, the green city concept must be captured in the process of economic development and urbanization, if not the city will develop to high economic status with no green city development initiatives and this will lead to the traditional spiraling effects of urbanization on the environment.

Awareness: Awareness is defined as an emotional capacity to perceive and focus on the presence of an object and its attributes (Bower, 1990). Theoretical underpinnings such as the theory of planned behaviour explains the importance of awareness as facilitating the consumption of green product (Maqsoom et al., 2023). The Theory of Planned Behaviour (TPB) proposes that behavioral intentions and the factors immediately preceding behavior are influenced by three psycho-social elements: individuals' attitudes towards adopting the behavior of interest, subjective norms, and perceived behavioral control (Maqsoom et al., 2023). This theory proposes that individuals with more positive perceptions of the outcomes associated with a behavior, greater social approval, and more control over the behavior are likely to have stronger intentions to engage in that behavior (Maqsoom et al., 2023). Moreover, a stronger intention to perform a behavior is often indicative of a higher likelihood that an individual will actually engage in the behavior. Hence individuals with higher level of awareness about green buildings and its benefits has greater behaviour of purchasing green building products. The Theory of Planned Behavior has been effectively applied to many areas of pro-environmental behavior, including the sustainable consumption of available resources (Vermeir and Verbeke., 2008). Research conducted by Maqsoom et al., (2023) found that an individual's understanding and recognition of environmental issues can influence their actions towards being more environmental. Other research shows that knowledge of the environment and awareness of sustainability greatly influence green behavior (Yadav and Pathak, 2016). Other studies have examined the impact of environmental awareness on green behavior and found that greater knowledge and awareness positively influence green behavior in the workplace (Fu et al., 2020; Sekhokoane et al., 2017).

People with a high level of environmental knowledge are more likely to have a deeper concern for the environment, form positive attitudes towards environmental protection, increase behavioral intention, and act environmentally sustainable, which leads to more green behavior (Maqsoom et al., 2023).Employees' behavioral intentions, knowledge, and awareness have been recognized as the principal determinants of green behavior adoption, leading to environmentally sustainable economic development for any organization, regardless of scale (Wu and Chen, 2014). All these gives support to the fact that awareness plays an integral pivotal role in the development of green cities.

Environmental regulations: Ciner and Doan-Salamtimur, (2019) encourages stakeholders to observe several environmental regulations such as Efficient use of energy, water, and other resources, the use of renewable energy, reduction of pollution and waste, enablement of reuse and recycling, use of materials that are non-toxic, ethical, and sustainable, good indoor environmental quality to be implemented in green building which will further promote green city development. Research by (Fang et al., 2021) measured the impact of environmental regulation on green innovation efficiency (GIE), which is a metric representing the ratio of the output and input of an organization's innovation activities considering its environmental pollution, reflecting the contribution of unit innovation input to output, therefore, it is a green index of innovation quality (Zhang et al., 2021). The research concluded that environmental regulations does have an impact on green innovation efficiency. It stated that the environmental regulation intensity has a positive impact on urban green efficiency; this was a case in China. Since a mitigating factor to green cities development is lack of innovative technology (Debrah et al, 2020), environmental regulations geared at promoting innovation can promote green city development. Innovation in technology is aided in investment in research and education which is socioeconomic in nature (Fang et al., 2021).

Stakeholder engagement: According to a research by (Alamoudi and Abidoye, 2022) which was carried in Saudi Arabia, using multiple linear regression to assess the impact of Stakeholder management measures on citizen level participation in the adoption of smart sustainable cities, it was evident from the research that stakeholder management along four lines of predictor variables (regulation, legislation, collaboration and control) had a strong correlation with citizen level participation in the adoption of smart sustainable cities. A significant reason why many cities have developed climate change programs and others have not is likely due to, among other things, the nature of interactions between diverse stakeholders and the contexts in which they occur (Portney and Berry 2010; Daley et al. 2013).

These stakeholders have a direct or indirect vested interest in approaches that can reduce Green House Gas (GHG) emissions within their locality. Developing an effective stakeholder framework can help us to understand the multifaceted stakeholder dynamics around climate change communication at the municipal level and can be a critical contribution to theory and subsequently, to policymaking by helping decision makers become aware and knowledgeable about their constraints and opportunities in addressing climate change within their urban context (Fiack and Kamieniecki, 2015).. Hence the inclusion of stakeholders in green cities development will yield a positive result since it yielded for reduction in greenhouse gas generation which is an indicator in green cities.

Population: Worldwide, the percentage of people living in urban areas will increase from 50% in 2010 to nearly 70% by 2050 (United Nations, 2013). This will result in expansion and/or densification of urbanised areas (Haaland and van den Bosch, 2015).Urban sprawl can be defined as urban development with low-density housing, both residential and commercial, segregated land-use, high level of automobile use combined with lack of public transport, which is in high demand for land (Haaland and van den Bosch, 2015). A number of studies find that growth in population density – whether compact inner-city growth or dispersed sub-urbanization on the urban fringes is inevitably connected to negative outcomes such as a reduction in vegetation cover (Elmqvist et al., 2018; Wolff and Haase, 2019). Garg (2017) also highlighted the various environmental implications of overpopulation because of rural-urban migration which has affected land use pattern which is having serious implications leading to deforestation, loss of ecosystems that sustain global atmospheric oxygen, and carbon dioxide balance (Garg, 2020).

Rapid population with its effect of urban sprawl reduces the availability of spaces that can be planned as green areas (Haaland and van Den Bosch, 2015). Population growth has led to greater energy demand by the buildings sector, especially for residential buildings (Nejat et al., 2015). Generally, with increasing population in developing countries, the demand for resources goes up and thus leading to environmental challenges unless population is accurately managed (Cohen, 2006).

Income levels: Income levels as a socioeconomic factor and its impact on green cities differ from developed countries to developing countries, as income levels alone cannot drive green consumption except it is reinforced with green awareness (Sulemana et al., 2016). Debrah et al., (2021) highlights the possibility that income levels could be a factor in determining the success of green city development initiatives, as lower-income communities may face greater challenges in accessing and implementing green technologies and practices Goldenberg and Destouni, (2018) found a clear relationship between income level and access to green areas, suggesting that higher income residents are more likely to have access to such spaces.

Green city planning (transportation): The implementation of green transportation can significantly contribute to the development of low carbon cities, with a focus on the role of government incentives and infrastructure development (Senin et al., 2021). Global Environment Facility, (2022) establishes a Greening Transportation Infrastructure Development Integrated Program which aims to enable countries such as Ghana to develop sustainable transportation infrastructure projects at national or land/seascape levels and by so doing ensure that transportation infrastructure projects will emphasize and produce biodiversity, avoid land degradation, and acquire climate change mitigation benefits. (Li, 2016) also suggest promoting green transportation amongst stakeholders and by so doing may experience benefits such as the efficient use of road resources, reduced traffic congestion, decreased energy consumption, improved air quality, and improved citizen health. (Li, 2016) further elaborates the need for effective encouragement and guidance measures to be provided to actively guide citizens to consciously choose green travel modes, reduce over-dependence on cars, and advocate low-carbon living modes.

Green city planning: According to Khalil, (2009) local governments should promote the use of energy efficiency in cities including urban patterns, land use distribution, transportation networks, building layout and renewable energy use and by showing awareness and responsiveness and depletion of conventional resources, this will provide a solid base for more action and strategies on proper urban planning. Promoting green urbanization requires green city planning (Yu, 2021). High-standard, high-level urban planning is very important to green city development (Yu, 2021). There are some problems in the development of cities, such as focusing only on urban construction and neglecting management and maintenance (Yu, 2021). Urban planning in the 21st century is an important milestone in the shift of classical urban planning science to science that is more responsive to technological developments, innovation and the existence of global development goals (SDGs) (Wahyudi et al., 2022). The planning and construction of green cities is an effective way to improve people's quality of life (Yu, 2021).Without scientific demonstration of urban planning, construction and development, urban expansion will form a vicious circle, making it difficult to improve the urban environment (Yu, 2021). The initial stages of the embodiment of green city focuses on 3 (three) attributes, namely: green planning and design, green open space, and green community. Green city planning forms the basis of green city development (Hoornweig and Friere, 2013). According to Hornweig and Frier, (2013) a green city is a holistically planned environment hence without the initial stage of green city planning green cities cannot be developed.

Policy implementation: According to a research by (Yuan et al., 2019), it was suggested that to promote green development, Achieving a balance among the economy, society and environment is possible through the use of policy tools. Furthermore, in response to the impacts of the different influencing factors on green development, reasonable policy measures must be developed and deployed. A lack of policy and industry guidance is one of the most important barriers for green buildings development as posited by (Wu et al., 2019) in China. (Debrah et al., 2020) identifies insufficient policy implementation efforts as one of the barriers to green city development in Ghana and further suggests the effective policy implementation efforts is needed to improve green city development in Ghana. (European Bank for Reconstruction and development, 2020) highlights policy implementation should be based on a clear understanding of the local context, stakeholder engagement, and capacity building, mentioning the need for monitoring and evaluation of policy implementation to ensure that the desired outcomes are achieved. Ali et al. (2021) also recommends that policy makers develop strategies that can help take advantage of the strengths and opportunities while serving as solutions to weaknesses such as weak institutions, inadequate funding for green technologies innovations, inadequate long-term policies for green strategies.

Innovation and technology: Innovation is related to how consumers perceive an idea, a practice, a product, or an object as a new thing, and begins with consumers' awareness of the innovation. Han et al.(2012) proposed the conceptual vision of a sustainable urban future in 2050(Goi, 2017). To achieve a low carbon society, various technological advances in transportation, buildings, and industries are among those that can contribute towards this end(Goi, 2017). In general technological innovations help to enhance urban eco-efficiency hence green cities (Zhang et al., 2018). The government should continue to support and provincial capitals with patent resources to improve the marginal effect of invention patents on urban green development (Zhang et al., 2018). Overall, the impact of technological innovation has a positive impact on building a more sustainable city, especially in terms of environment, social, and economy(Goi, 2017) Thus, authorities, especially local government and city planners, should not neglect the importance of technological innovation (Goi, 2017).

Culture: The engineering and construction sector has not kept pace in terms of technological opportunities that can help improve production and productivity, resulting in a stagnation of labour productivity as well (Livotov et al., 2019). Several internal and external challenges are responsible for this situation, including the industry dealing with consistent fragmentation, trouble in recruiting a workforce with the right talent, insufficient links to contractors and suppliers, and inadequate transfer of knowledge from one project to another (Maskuriy et al., 2019).The construction industry is noted as an industry that does not pace up with technological innovations and incorporation of new methods of doing things as compared to the manufacturing and engineering sectors (Pheng and Hou, 2019). The industry is resistant to change and does not want to adopt new ways doing things which will enhance sustainability in the sector (Ametepey et al., 2015). Despite the industry's vast potential, increasing efficacy and productivity can only result from digitalization, new techniques for construction, and innovations which includes but not limited to prefabrication (Maskuriy et al., 2019). These digitalization and innocations have their ability to promote sustainability in the construction industry (Maskuriy et al., 2019). Attitudinal and behavioural patterns by clients and project stakeholders constitute a significant obstacle to the development of the green building market (Chan et al.,2017).

Housing: According to Gupta (2017), the concept of green buildings to create healthy and natural environment is further nullified as long as the residential houses are not designed keeping in mind the green architecture as they constitute a huge percentage of built environment. In most developing countries the production of adequate and green housing for citizens remains a problem due to the high level of population growth coupled with scattered and unsustainable urbanization. This was reiterated by Acioly (2012) who said urbanization equals informal housing formation for Sub-Saharan African countries. This has led to urban dwellers to resort to living in unhealthy, overcrowded, and often relatively expensive informal housing in slums and informal settlements (French and Lalande, 2012). Money can be saved and emissions reduced when buildings are designed and constructed with efficiency and sustainability in mind, even by using currently available technologies (French and Lalande, 2012). The focus on the housing must be strategies which synergistically provide reductions in greenhouse gas emissions attributable to housing across their life cycle (French and Lalande, 2012).

Gupta (2017), elaborated on a step undertaken by the Indian government to build sustainable houses for the poor in which the buildings were designed to harvest rainwater for use and solar panels to provide electricity, from measuring the building performance it was ascertained to be 40% lower in energy use as compared to the normal residential buildings. Thirty

(30) houses were retro-fitted with green building technologies by the Green Building Council of South Africa, incorporating rainwater collection tanks, energy-saving lights, solar water heaters, and a special heat insulation cooker; the street was fitted with efficient Light Emitting Diode (LED) streetlights. Ceiling insulation improved the thermal conditions in the low-income housing units and reduced operating costs. This was done for low-income households(French and Lalande, 2012). This show the sustainability gains that will be realized when housing is designed and planned with the backbone of green city planning principles.

Green investment finance: According to Eyraud et al., (2013) green investment refers to the investment necessary to reduce greenhouse gas and air pollutant emissions, without significantly reducing the production and consumption of non-energy goods. The literature on the economic consequences of green investment finds that whether firms invest in green technology depends on the size between the investment cost and the benefits of emission reduction (Yang et al., 2018), and firms only invest in green technology when they are profitable (Stucki, 2018). Inderst et al., (2012) acknowledges that green investment is a very broad term that is being referred to at all levels such as green technology, green infrastructure and green financing. Therefore, by promoting and integrating green investment strategies can improve environmental performance which in turn promotes green city development (Chen and Ma, 2021). A collaborative governance between administrations and citizens on relevant experiences of Green Infrastructures will ensure successful implementation and promotion amongst the different social actors involved in investments (Sturiale and Scuderi, 2018). (Tu Tran, 2020) makes recommendations to consider when adopting green investments such as: assessing banks green investment support policy, recommending to the Government and banks to make it easier to access loans for green investment projects, planning to implement green investment projects in the near future.

Contributions to theory and practice

The principal aim of the research was to determine if socioeconomic factors impact the development of green cities. This was due to the research gap in literature in which various scholars have focused exclusively on the barriers and drivers of green city development with no research on the socioeconomic factors that impact the development of green cities. This is a foremost and original research which throws light on green cities development from the socioeconomic stand point as being an impact on the development of green cities as most researchers on green cities focused their research on the environmental aspects due to the apparent impact of construction on the environment and ignoring the socioeconomic aspect which impacts the wellbeing and economic development of communities. From a theoretical perspective this research shall guide the efforts of various stakeholders in green cities development by informing them of the various social and economic factors that impact the development of green cities and hence these factors will need utmost consideration in policy in the bid towards green cities development. Also, this research has shed more light on the socioeconomic aspect of green cities which have not been researched due to the fact that the study on green cities has always focused on the perspective of environmental factors since this is clearly evident form the environment due to the negative impact of the construction cities on the environment and as a result provided insight into the impact of socio-economic factors on green cities. From a practical point of view, in the bid to the development of green cities towards the attainment of the Sustainable Development Goal: Goal 11, the construction industry, stakeholders and the government must focus on the socioeconomic dimension of green cities as this is also fundamental and pivotal to the development of green cities.

Limitations

Certain limitations should be considered in interpreting the findings of this study. Notwithstanding the fact that these limitations did not affect the reliability and the findings, the data used for the study was based on a small sample. The sample composition however was sufficiently heterogenous in relation to knowledge on green cities which was deemed adequate to provide reliable results considering the novelty of green city concept in Ghana. Due to Ghanaians making up the majority sample, the results obtained from the survey may differ from that of other countries as a result of various cultural, political, social and legal factors. Despite this limitation, the findings of the study offer a universal set of the impact of socioeconomic factors on green cities.

Directions for future research

Within the sustainability research area, further research works will be necessary to concrete socioeconomic factors in the bid towards the development of green cities. To begin with, potential research should be conducted to explore green consumer impact on green cities development. Also, the impact of stakeholder engagement on the adoption of green cities should be researched into. The findings of these studies will help identify the strategies that can adopted facilitate the development of green cities.

Conclusions and recommendations

This study provided a quantitative survey result on the impact of socioeconomic factors on the development of green cities. The research showed that socioeconomic factors have a great impact on the development of green cities. In line with this, socioeconomic factors should also under girth the basis for the design, planning and construction of green cities. When these socioeconomic factors are integrated in the planning and development of green cities are adopted the path towards sustainability through green cities will be achieved and this will provide the solution to the canker of urbanization, climate change and its associated challenges; towards the attainment of the United Nations' Sustainability Development Goal 11: Sustainable Cities and Communities.

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TRACK 8: ENVIRONMENTAL AND SOCIAL GOVERNANCE SYSTEMS FOR SUSTAINABLE DEVELOPMENT OF AFRICA

Determinants of Leadership Development in an Emerging Economy: The Role Emotional Intelligence

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Abstract

The purpose of this paper is to examine the determinants of leadership development in the context of the emerging economy and to analyse the extent to which emotional intelligence (EI) moderates the determinants of leadership development, with a focus on the Ghanaian construction industry (GCI). Limited research has been conducted regarding the status and role of emotional intelligence as a moderator of leadership development determinants within the GCI, an emerging economy. The study adopted a quantitative research approach and a survey-based design. A structured questionnaire has been used to solicit data from a cross-section of the Ghanaian construction industry's workers, including architects, engineers, quantity surveyors, project managers, and site supervisors. Our hypotheses have been tested using partial least square (PLS) Models. The study has revealed that leadership education, technological usage, stakeholder participation, and entrepreneurial orientation are important determinants of leadership development. Moreover, the study has revealed that emotional intelligence significantly moderates the determinants of leadership. This paper has implications for leadership development in the context of the emerging economy by considering contextual factors such as leadership education, technological usage, and stakeholder participation. Besides, entrepreneurial orientation facilitates leadership development determinants in the Ghanaian construction industry. Again, stakeholders could be guided by these outcomes to formulate robust policies to enhance leadership growth and development in Ghana in order to encourage growth in the sector.

Keywords: Leadership Development Determinants, Emerging Economy, Emotional Intelligence

Introduction

Leadership development is a comprehensive competency that is an integral part of human resource development. Leadership development programmes must address at least three leadership

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competencies: self-management, soft skills, and mediation. Leadership development focuses on 'the process of developing knowledge, skills, and competencies related to leadership. Exploring the implicit beliefs and assumptions of different actors about key elements of the leadership development process, or implicit theories of leadership development, is a promising area of leadership development research (Meng et al., 2015; Antunes & Franco, 2016; Qiu & Dooley, 2019; Utami et al., 2020). Leadership development refers to leadership training that focuses on providing knowledge and training to improve performance in leadership roles and offers proven solutions to known problems. Development refers to individuals in specific roles and can be defined as a process by which individuals in leadership roles learn the interrelated skills and competencies (i.e., capabilities) needed to work effectively. Leadership development can be defined as the process of improving an individual's skills and abilities to function effectively in a leadership role. It is based on the premise that by developing their knowledge, skills, and competencies, leaders will be able to perform their leadership duties more effectively (Megheirkouni, 2016; Ewest, 2018; Chappell et al., 2019; Jackson, 2019).

Leadership development focuses primarily on human capital and improving the capabilities that enable people to think and act in new ways. It focuses on individual leaders, and development refers to the knowledge, skills, and abilities of the individual that are primarily related to the effective performance of formal leadership functions. In this sense, leadership development is based on a clear distinction between the leader and the led. It is often assumed that leadership development is desirable for all employees and that it has a positive impact on organisational development. Prior studies (Anning-Dorson, 2018; Chang et al., 2020; Imam et al., 2020; Knezović & Drkić, 2021) have reported that even in well-designed leadership development programmes, participants can become disengaged from the organisation or even leave, which can be the result of a simplistic individual approach that does not take into account the complex context (Khoreva & Vaiman, 2015; Chou & Ramser, 2019; Qiu & Dooley, 2019; Imam et al., 2020). Leadership development can be described as a non-linear process of influencing individuals. Leadership development at the collective level refers to the ability of individuals to work with others, focusing on networks and shared meanings (Callahan & Rosser, 2007; Gagnon et al., 2012; Mishra & Tikoria, 2021). Leadership development must therefore be 'contextual, cultural, decentralised, and social. Leadership development is a collective and social process and is therefore most effective when it is local, addresses real issues, and takes into account all the complex challenges facing leaders today. The leadership development process extends from the identification of organisational gaps to the adoption and implementation by leaders and managers of specific leadership development programmes to address these gaps (Thakadipuram, 2010; Muir, 2014; Knezović & Drkić, 2021). Leadership development programmes can be an effective tool for developing key self-management competencies such as assertiveness, self-management, adaptive style, and resilience, and therefore leadership development programmes can also be a sensitive tool for developing psychological competencies (Edwards & Turnbull, 2013; Imam et al., 2020; Wijayati et al., 2022).

Emotional intelligence, as defined by Mayer and Salovey (1997), refers to an individual's ability to recognise, express, comprehend, utilise, and regulate emotions in oneself (personal intelligence) and in others (social intelligence), ultimately leading to adaptive behaviour and effective leadership. Emotional intelligence is the ability to be keenly aware of one's own emotional state and to recognise the emotional cues displayed by others in the dynamic context of an interaction. Remaining aware of the emotional state of others and oneself during a contentious exchange enables one to navigate that particular situation effectively (Murdock, 2020). Emotion refers to the effective component, whereas intelligence refers to the cognitive component (Kanesan & Fauzan, 2019). Employees in the construction industry consider emotional intelligence essential and believe that management must possess emotional intelligence to achieve success (Satchwell & Smallwood, 2016). Developing emotional self-awareness is essential for effective leadership, as it forms the foundation for emotional and social intelligence. Emotional self-awareness assists leaders in connecting their emotions to how effectively they engage with others (Jastzabski, 2020). Goleman (1995) state that '*people with all-developed emotional skills are also more likely to be content and effective in their lives, mastering the habits of mind that foster their own productivity: people who cannot marshal some control over their emotional life fight inner battles that sabotage their ability for focused work and clear thought'.* Goleman (2006) define emotional intelligence as consisting of four components; self-awareness, self-management, social awareness, and relationship management. Emotional intelligence positively influences organisations and is crucial for successful relationships and interactions that benefit all parties involved. Individuals with great emotional intelligence can handle many situations more effectively (Ivanova, 2016).

The purpose of this paper is to examine factors that influence leadership development determinants in the context of the emerging economy and to analyse the extent to which emotional intelligence moderates the determinants of leadership development, with a focus on the Ghanaian construction industry. This paper offers tremendous contributions in terms of policy, practice, and theory to fill knowledge gaps in the Ghanaian construction industry. Theoretically, the study has employed transactional leadership theory, which is complemented by situational theory, to explain the determinants of leadership development. Transformational leadership focuses on the change and transformation of a person. Therefore, it deals with emotions, values, ethics, norms, and long-term goals. Transformational leaders are highly charismatic and able to focus their followers around a common vision. By extension, these theories have been expanded by the inclusion of entrepreneurial orientation and technological usage in the context of developing countries. Empirically, the study has contributed to contextual factors such as leadership education, technological usage, stakeholder participation, and entrepreneurial orientation, which are important determinants of leadership development. Moreover, the study has also contributed to the extent to which emotional intelligence significantly moderates the determinants of leadership (Murphy & Johnson, 2011; Gagnon et al., 2012; Edwards & Turnbull, 2013; Muir, 2014; Ardichvili et al., 2016; Megheirkouni, 2016). Practically, the stakeholders in the construction industry in Ghana could be guided by these outcomes to formulate robust policies to enhance leadership growth and development in Ghana and to enhance productivity and growth in the sector**.** This paper has been organised into six sections, as follows: Section 1 presents the introduction to the paper, including gaps in the literature, objectives, and contributions; Section 2 presents the literature review and hypotheses development; Section 3 presents research methodology; Section 4 presents results, section 5 the findings finally the conclusions and implications are presented in Section 6.

Literature Review and Hypotheses Development

The available empirical evidence (Callahan & Rosser, 2007; Thakadipuram, 2010; Tharnpas & Sakun, 2015; Anning-Dorson et al., 2017; Edelman & van Knippenberg, 2018; Azim et al., 2019; Sharma et al., 2019; Franco & Antunes, 2020; Wijayati et al., 2022) suggests that numerous studies have applied different theories to investigate leadership development determinants. A number of leadership theories were examined to determine the factors influencing leadership development in the manufacturing sector of a developing country. While there are different types of leadership development theories and models, this study used transformational and situational theories. Transformational leadership focuses on the change and transformation of a person. Therefore, it deals with emotions, values, ethics, norms, and long-term goals. Transformational leaders are highly charismatic and able to focus their followers around a common vision. They communicate well with others and help their followers realise their full potential. In addition, situational leadership theory states that effective leaders must be able to adapt to different situations. Based on this assessment, leaders should adapt their supportive and mentoring behaviours to the needs of their followers. These two theories work to complement each other in collaboration and offset each other's weaknesses. Drawing on these theories, the research framework illustrated in Figure 1 has been developed to guide the study of the determinants of leadership development and the role of emotional intelligence.

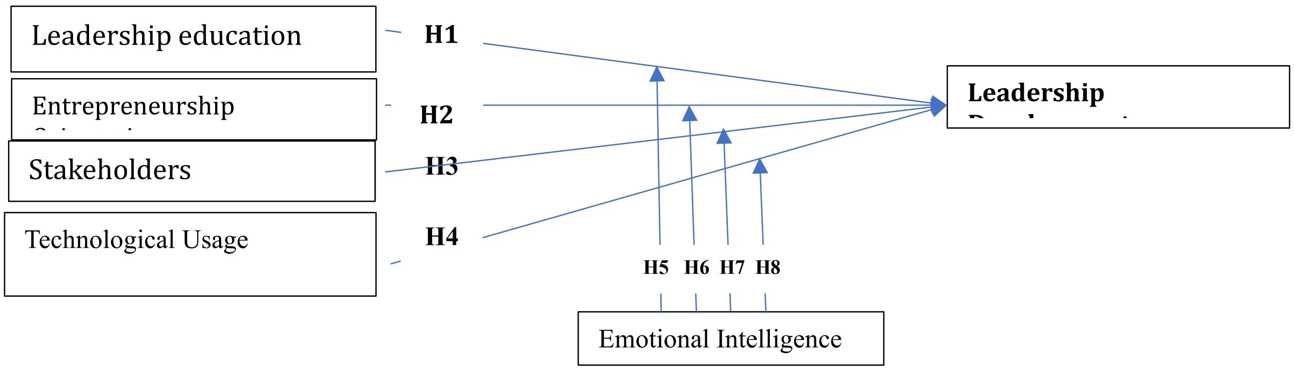

Figure 1: Conceptual Framework

Leadership Education and Leadership Development

This paper assumes that leadership education is a determinant of leadership development (Meng et al., 2015; Antunes & Franco, 2016; Qiu & Dooley, 2019; Utami et al., 2020). Leadership education programmes can provide individuals with an effective organisational tool to optimise their performance, which may have contributed to the widespread adoption of leadership development programmes in higher education (Brungardt, 1997). Leadership education programmes lead to learning outcomes in the areas of knowledge acquisition and application, human and social engagement, personal development, interpersonal development, and practical skills (Seemiller & Whitney, 2011). Leadership development is a positive psychological state characterised by (1) a sense of self-efficacy in overcoming complex challenges and the effort required to achieve success, (2) positive attributes about current and future success (optimism), (3) taking responsibility for goals, striving to achieve them, changing direction when necessary (hope), and commitment to success, and (4) overcoming, tolerating, resisting, and even overcoming challenges and setbacks (resilience) to achieve organisational goals (Luthans et al., 2007). Based on the arguments presented herein, we propose the following:

H1: Leadership education has positive and significant association with leadership development

Entrepreneurship Orientation and Leadership Development

Another assumption of the paper is that entrepreneurship orientation is a determinant of leadership development (Anning-Dorson, 2018; Chang et al., 2020; Imam et al., 2020; Knezović & Drkić, 2021). Entrepreneurial orientation is a behavioural concept that encompasses the decision-making styles and approaches a company uses to differentiate itself from its competitors. Entrepreneurial orientation refers to organisations that use entrepreneurial behaviours to better adapt their operations to the dynamic competitive environment, exploit market opportunities, or enter new markets (Covin & Slevin, 1989). Entrepreneurial orientation reflects the extent to which a firm's growth objectives are determined by identifying and exploiting previously untapped market opportunities (Baker & Sinkula, 2009). Entrepreneurial orientation is 'the creation of distinctive value by investing the necessary time and effort, taking financial, psychological, and social risks, and obtaining economic and personal satisfaction' (Hisrich & Peters, 1992). Entrepreneurial orientation refers to a product or service provider's motivation to seek out and invest in new innovations in the market, even if they involve high risk. Entrepreneurial orientation is a key factor for successful new product development, good economic and non-economic performance, and good social performance (Miller, 1983). At an organisational level, entrepreneurial orientation is defined as "the process of formulating a strategy that will achieve higher profitability, better financial performance, and competitive advantage (O'Regan & Ghobadian, 2005). Based on the arguments presented herein, we propose the following:

H2: Entrepreneurship orientation has positive and significant association with leadership development

Stakeholder Participation and Leadership Development

Again, this paper assumes that stakeholder participation is an enabler of leadership development (Culyer & Lomas, 2006; Jones et al., 2008; Uzoma, 2012; Khoreva & Vaiman, 2015; Chou & Ramser, 2019; Qiu and Dooley, 2019; Imam et al., 2020). A stakeholder is 'any group or individual who may be affected or influenced by the objectives of the organisation' (Freeman, 1984). Stakeholder engagement helps reduce conflict and build consensus in the political system (Connick & Innes, 2001) and plays a significant role in identifying gaps and holding politicians and key stakeholders accountable (Jones et al., 2008; Culyer & Lomas, 2006). To be considered a stakeholder, a group or individual must have a direct interest in the organisation (Donaldson & Preston, 1995). Stakeholders are direct and indirect representatives who have an interest in a proposed project and can contribute (Takim, 2009). Individuals and groups who influence or have the power to influence an organisation in order for them to achieve their objectives are known as stakeholders (Uzoma, 2012). Individuals or groups who are owners and have interests and rights in the activities of an organisation are known as stakeholders (Clarkson, 1995). Based on the arguments presented herein, we propose the following:

H3: Stakeholders participation has positive and significant association with leadership development

Technological Usage and Leadership Development

Moreover, the paper assumes that technological usage is a determinant of leadership development (Seyal et al., 2000; Bhagwat & Sharma, 2007; Anning-Dorson, 2018; Chang et al., 2020; Imam et al., 2020; Knezović and Drkić, 2021). Ashrafi and Murtaza (2008) include technologies to include products and services, such as laptops, desktops, tools for management, wired intranets and wireless, and software for productivity, which include network securities, storage of data, software, spreadsheets, and editors. Information and communication technologies are used to create, design, analyse, process, update, and disseminate information within and between organisations (Seyal et al., 2000; Bhagwat & Sharma, 2007). ICT refers to any technology or device that can receive, store, process, and transmit information, including personal computers, the Internet, mobile devices, and e-mail (Steinmueller, 2000). ICT can improve access to information by enhancing workers' ability to store and process information (Migliarese & Paolucci, 1995) and can increase productivity by improving workers' ability to gather and analyse information effectively. In particular, the emergence of the Internet as a source of information has revolutionised the way employees gather information (Dewett & Jones, 2001). Based on the arguments presented herein, we propose the following:

H4: Technological orientation has positive and significant association with leadership development

Emotional Intelligence as a Moderator

Another assumption of this paper is that emotional intelligence could moderate the other determinants of leadership development (Salovey et al., 2002; Clarke, 2011; Azim et al., 2019; Sharma et al., 2019; Franco & Antunes, 2020; Wijayati et al., 2022). Emotional intelligence is the ability to perceive and express emotions accurately, to use emotions in reasoning and problem solving, to understand the causes of emotions and the connections between emotional experiences, and to manage one's own emotions and the emotions of others (Salovey et al., 2002). According to Goleman et al, (2020), emotional intelligence is the ability to recognise and evoke emotions in oneself and others and to manage emotions in oneself and in relationships. It is also defined as the ability to perceive and express emotions, the ability to internalize emotions in the mind, the ability to understand and infer emotions, and the ability to regulate emotions in oneself and others. Cherniss and Adlet (2000) describe emotional intelligence as the ability to accurately recognise and understand emotions in oneself and others (Cherniss & Adlet, 2000). They add that emotional intelligence includes the ability to regulate emotions, make good decisions, and act effectively (Clarke, 2011). It is the capacity of perceiving and accessing emotions in order to kindle the thinking and understanding of one’s emotions and that of others, so as to regulate them and support the development of emotion and intellect (Mayer & Salovey, 1997). Based on the arguments presented herein, we propose the following:

H5-8: *Emotional intelligence significantly moderates the associations with leadership development and its determinants (leadership education, technological usage, stakeholder's participation, and entrepreneurial orientation)*

Research Methodology

This paper uses a quantitative research method and explanatory design to explore the critical determinants of leadership development and the role of emotional intelligence, with a focus on the construction sector in Ghana. Quantitative research is ideal for studies that seek to measure numerical results or observations using mathematical and statistical applications, while explanatory design seeks to explore causal relationships among constructs. This study uses statistical and mathematical applications and assesses causal relationships between predictor variables and outcomes. For example, it examines the extent to which changes in management knowledge, stakeholder engagement, succession planning, technical skills, and information and communication technology can lead to significant changes in management development in the Ghanaian construction industry.

The overall survey sample consists of small, medium, and large construction companies in Ghana. They are legally registered and have been in operation for at least one year. The inclusion of small and large construction companies is motivated by the researchers' desire to identify and outline the actual factors of management development in the industry as a whole. During the survey, some one thousand (1,000) questionnaires were distributed to a target group that included architects, engineers, contract managers, project managers, surveyors, construction managers, and professors. A total of 520 usable responses were obtained and used in the survey. A stratified sampling method was used to randomly select all respondents, initially creating strata based on company size (e.g., small, medium, and large). Structured questionnaires were used to collect all the required data. Measurement tools were taken from previous studies and adapted. For example, management knowledge was measured with 8 questions, succession planning with 14 questions, stakeholder engagement with 9 questions, technology use with 7 questions, professional competence with 16 questions, and management development with 13 questions, which were adopted and adapted from previous studies. All instruments were measured using a five-point Likert scale ranging from 5 (strongly agree) to 1 (strongly disagree).

Analyses were conducted using a partial least squares model with the Statistical Package for the Social Sciences (SPSS) version 25 and Andrews' macro procedure. The analysis was carried out in three phases. In the first phase, descriptive analysis was conducted using frequencies, percentages, means, and standard deviations. In the second phase, the measurement scale was tested for convergent and discriminant validity. The converging validity of the scale was checked using factor loadings and Cronbach's alpha values. To achieve acceptable convergent validity, factor loadings and Cronbach's alpha must reach a minimum acceptable value of 0.70. In addition, discriminant validity was assessed using the average variance extracted (AVE), comparing AVE squares with the correlation between conditions. The third step involves a saturation model with path coefficients and T-values, used to test the study's hypotheses.

Results

Demographic Information

Table 1 presents demographic information about the participant. The results have revealed that almost 90 percent of the participants were males and 10 percent were female. Moreover, 30.4 percent of the participants were aged between the ages of 25 and 30, 20.2 percent were aged between 31 and 35, 22.0 percent were aged between 36 and 40, 14.9 percent were aged between 41 and 45, and just 12.4 percent were aged between 46 and above. Again, 4.4 percent of the participants had a doctorate degree, 25.6 percent had a master's degree, 36.0 percent had a first degree, 27.6 percent had an HND or diploma, and just 6.4 percent had a certificate. To sum up, 31.3 percent of participants had 1–5-year experience, 26.7 percent had 6–10-year experience, 18.2 percent had 11–15 years' experience, 10.4 percent had 16–20 years' experience, 11.1 percent had 21–25 years' experience, and just 2.2 percent had 26 years and above experience. Moreover, 5.3 percent of participants were academics, 4.0 percent were architects, 22.4 percent were engineers, 6.0 percent were managers, 16.2 percent were in other professions, 9.8 percent were into projects, 20.9 percent were into quantity, and 15.3 percent were into site supervision.

Table 1: Demographics

Demographic	Frequency (n=450)	Percentage
Gender		
Male	401	89.1
Female	49	10.9
Age Category		
25-30 years	137	30.4
31-35 years	91	20.2
36-40 years	99	22.0
41-45 years	67	14.9
46 years and above	56	12.4
Education		
Doctorate degree	20	4.4
Masters degree	115	25.6
First degree	162	36.0
HND/Diploma	124	27.6
Certificate	29	6.4
Experience		
1-5 year	141	31.3
6 - 10 years	120	26.7
11 - 15 years	82	18.2
16 - 20 years	47	10.4
21 - 25 years	50	11.1
26 years and above	10	2.2
Profession		
Academic	24	5.3
Architect	18	4.0
Engineer	101	22.4
Managing	27	6.0
Others	73	16.2
Project	44	9.8
Quantity	94	20.9
Site Sup	69	15.3

Descriptive Statistics

Descriptive statistics of the results have been assessed using means, standard deviations, minimum and maximum values. For instance, leadership education has been assessed using 7 research items and obtained a means score of 3.8244 and standard deviation score of 1.02652. Stakeholder participation has been assessed using 9 research items and obtained a means score of 3.6489 and standard deviation score of 1.07256. Information and communication technology has been assessed using 7 research items and obtained a means score of 4.1533 and standard deviation score of 1.05360. Entrepreneurial orientation has been assessed using 22 research items and obtained a means score of 3.8400 and standard deviation score of 1.07252. Emotional intelligence has been assessed using 13 research items and obtained a means score of 3.6289 and standard deviation score of 1.14731. Leadership development has been assessed using 12 research items and obtained a means score of 3.7244 and standard deviation score of 1.06976.

Table 2: Descriptive Statistics

Constructs	Min	Max	Mean	Std. D	Rank
Leadership education	1	5	3.87	1.03	3rd
Stakeholder participation	1	5	3.82	1.05	5th
Information and communication technology	1	5	4.04	1.06	1st
Entrepreneurial orientation	1	5	3.87	1.05	3rd
Emotional intelligence	1	5	3.83	1.07	4th
Leadership development	1	5	3.91	1.04	2nd

Convergent Validity and Discriminant Validity

To validate the scale of measurement adopted for the study, convergent and discriminant validities have been assessed. To determine convergent validity, both factor loadings and Cronbachs' Alpha values have been assessed. The acceptable minimum requirement for Cronbach Alpha and factor loadings is 0.7 or better. The results for leadership education have revealed factor loadings ranging from 0.851 to 0.918, with a Cronbach's Alpha score of 0.957. Again, stakeholder's participation results have revealed factor loadings ranging from 0.779 to 0.894 with a Cronbach's Alpha score of 0.951. Moreover, information and communication technology results have revealed factor loadings ranging from 0.832 to 0.910 with a Cronbach's Alpha score of 0.954. In addition, entrepreneurial orientation results have revealed factor loadings ranging from 0.766 to 0.915 with a Cronbach's Alpha score of 0.980. Furthermore, emotional intelligence results have revealed factor loadings ranging from 0.810 to 0.894 with a Cronbach's Alpha score of 0.972. Last but not least, leadership development results have revealed factor loadings ranging from 0.805 to 0.894 with a Cronbach's Alpha score of 0.971.

Table 3: Exploratory Factor Analysis

Leadership Education	Factor loading
LDED1	.893
LDED2	.851
LDED3	.918
LDED4	.886
LDED5	.901
LDED6	.897
LDED7	.894
Eigenvalue	5.565
% of Variance	79.495
Cronbach Alpha	0.957
Average Variance Extracted (AVE)	0.794
KMO=0.926, X^2=3309.697, df=21, p-value=0.000	
Stakeholder Participation	Factor loading
STP1	.801
STP2	.779
STP3	.866
STP4	.859
STP5	.835
STP6	.877
STP7	.894
STP8	.845

STP9	.888
Eigenvalue	6.504
% of Variance	72.264
Cronbach Alpha	0.951
Average Variance Extracted (AVE)	0.722
KMO=0.938, X^2=3638.605, df=36, p-value=0.000	
Information and Communication Technology	Factor loading
ICT1	.832
ICT2	.897
ICT3	.888
ICT4	.903
ICT5	.910
ICT6	.889
ICT7	.887
Eigenvalue	5.507
% of Variance	78.670
Cronbach Alpha	0.954
Average Variance Extracted (AVE)	0.786
KMO=0.929, X^2=3119.695, df=21, p-value=0.000	
Entrepreneurial Orientation	Factor loading
ENTO1	.813
ENTO2	.803
ENTO3	.801
ENTO4	.861
ENTO5	.766
ENTO6	.838
ENTO7	.852
ENTO8	.835
ENTO9	.818
ENTO10	.808
ENTO11	.896
ENTO12	.902
ENTO13	.915
ENTO14	.788
ENTO15	.832
ENTO16	.841
ENTO17	.873
ENTO18	.874
ENTO19	.882
ENTO20	.865
ENTO21	.802
ENTO22	.821
Eigenvalue	15.568
% of Variance	70.762
Cronbach Alpha	0.980
Average Variance Extracted (AVE)	0.707
KMO=0.959, X^2=12024.322, df=231, p-value=0.000	
Emotional Intelligence	Factor loading
EMI1	.810
EMI2	.813
EMI3	.878
EMI4	.836
EMI5	.880
EMI6	.863
EMI7	.858
EMI8	.894
EMI9	.851

EMI10	.834
EMI11	.872
EMI12	.848
EMI13	.880
EMI14	.893
Eigenvalue	10.312
% of Variance	73.657
Cronbach Alpha	0.972
Average Variance Extracted (AVE)	0.736
KMO=0.957, X^2=7125.767, df=91, p-value=0.000	
Leadership Development	Factor loading
LDDEV1	.805
LDDEV2	.854
LDDEV3	.857
LDDEV4	.889
LDDEV5	.871
LDDEV6	.891
LDDEV7	.823
LDDEV8	.842
LDDEV9	.885
LDDEV10	.871
LDDEV11	.860
LDDEV12	.857
LDDEV13	.894
Eigenvalue	9.657
% of Variance	74.281
Cronbach Alpha	0.971
Average Variance Extracted (AVE)	0.742
KMO=0.960, X^2=6347.133, df=78, p-value=0.000	

Table 4: Correlation

	AVE	LDED	STP	EMI	ENTO	ICT	LDDEV
LDED	0.794	***0.891***					
STP	0.722	.611	***0.849***				
EMI	0.736	.661	.685	***0.857***			
ENTO	0.707	.705	.595	.722	***0.840***		
ICT	0.786	.749	.603	.680	.778	***0.865***	
LDDEV	0.742	.712	.663	.666	.744	.751	***0.861***

AVE=Average Variance Extracted, LDED=Leadership Education, STP=Stakeholder Participation, EMI=Emotional Intelligence, ENTO=Entrepreneurial Orientation, ICT=Information and Communication Technology, LDDEV=Leadership Development

Table 10: Partial Least Square Models

	LDDEV	LDDEV	LDDEV	LDDEV	LDDEV	LDDEV	Collinearity Statistics	
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6		
	Beta (t-value)	Beta (t-value)	Beta (t-value)	Beta (t-value)	Beta (t-value)	Beta (t-value)	Tolerance	VIF
Control variables								
Age	-.239(-0.585^{ns})							
Education	.451(0.753^{ns})							
Experience	.150(0.719^{ns})							
Direct effect								
LDED		.323(4.109***)					0.377	2.654
STP		.336(6.464***)					0.560	1.787
ENTO		.165(6.098***)					0.349	2.865
ICT		.469(5.489***)					0.307	3.254
Interaction effect								
LDED * EMI			.014(22.200***)				1.000	1.000
STP * EMI				.011(20.807***)			1.000	1.000
ENTO * EMI					.005(22.984***)		1.000	1.000
ICT * EMI						.015(24.262***)	1.000	1.000
Model Indices								
R	0.047	0.827	0.724	0.701	0.736	0.754		
R Square	0.002	0.683	0.524	0.491	0.541	0.568		
Adjusted R Square	-0.004	0.680	0.523	0.490	0.540	0.567		
Δ R Square	0.002	0.683	0.524	0.491	0.541	0.568		
Δ F	0.330	239.997	492.826	432.951	528.282	588.640		
Df	3	4	1	1	1	1		
F-statistics	0.330	239.997	492.826	432.951	528.282	588.640		
Sig.	0.804	0.000	0.000	0.000	0.000	0.000		
Durbin-Watson	1.891	1.790	1.880	1.697	1.756	1.812		

EDU=Education, EXP=Experience, LDED=Leadership Education, STP=Stakeholder Participation, EMI=Emotional Intelligence, ENTO=Entrepreneurial Orientation, ICT=Information and Communication Technology, LDDEV=Leadership Development, *p<0.05; **p<0.01; ***p< 0.001; ns=not significant

The study has revealed that LDED has a positive and significant effect (Beta=0.323, T-value, 4.109) on LDDEV. Again, the study has revealed that STP has a positive and significant effect (Beta=0.336, T-value=6.464) on LDDEV. Furthermore, the study has revealed that ENTO has a positive and significant effect (Beta=0.165, T-value=6.098) on LDDEV. Also, the study has revealed that ICT has a positive and significant effect (Beta =0.469, T-value=5.489) on LDDEV. Moreover, the study has revealed that EMI significantly moderates (Beta=0.014, T-value = 22.200) the relationship between LDED and LDDEV. Besides, the study has revealed that EMI significantly moderates (Beta=0.011, T-value = 20.807) the relationship between STP and LDDEV. To sum up, the study has revealed that EMI significantly moderates (Beta=0.005, T-value= 22.984) the relationship between ENTO and LDDEV. Lastly, the study has revealed that EMI significantly moderates (Beta=0.015, T-value= 24.262) the relationship between ICT and LDDEV.

Summary of the Hypotheses Testing

Hypothesized Paths	Beta Values	T-Values	Decision
H1: LDED → LDDEV	0.323	4.109	Supported
H2: STP → LDDEV	0.336	6.464	Supported
H3: ENTO → LDDEV	0.165	6.098	Supported
H4: ICT → LDDEV	0.469	5.489	Supported
H5: LDED * EMI→ LDDEV	0.014	22.200	Supported
H6: STP * EMI→ LDDEV	0.011	20.807	Supported
H7: ENTO * EMI → LDDEV	0.005	22.984	Supported
H8: ICT * EMI→ LDDEV	0.015	24.262	Supported

The study proposed that LDED is a determinant of LDDEV, which has been supported; therefore, H1 is accepted. The study proposed that STP is a determinant of LDDEV, which has been supported; therefore, H2 is accepted. The study proposed that ENTO is a determinant of LDDEV, which has been supported; therefore, H3 is accepted. The study proposed that ICT is a determinant of LDDEV, which has been supported; therefore, H4 is accepted. The study has revealed that EMI significantly moderates the relationship between LDED and LDDEV, which has been supported; therefore, H5 is accepted. The study has revealed that EMI significantly moderates the relationship between STP and LDDEV, which has been supported; therefore, H6 is accepted. The study has revealed that EMI significantly moderates the relationship between ENTO and LDDEV, which has been supported; therefore, H7 is accepted. The study has revealed that EMI significantly moderates the relationship between ICT and LDDEV, which has been supported; therefore, H8 is accepted.

Findings

The results showed that all participants are proficient in their respective professions and have experience in leadership development. The convergent validity of the variables was confirmed through the assessment of factor loadings and Cronbach's Alpha values, indicating a positive and significant impact on leadership development. Hypotheses for the variables were also supported. The study's findings also show a positive correlation between the variables and their successful impact on leadership development performance, with emotional intelligence significantly moderating their effects. This is supported by the works of Ivanova (2016), Kanesan & Fauzan (2019), Qiu & Dooley (2019), Utami et al. (2020), Jastzabski (2020), Mishra & Tikoria (2021), and Wijayati et al. (2022).

Conclusions

Leadership development is a collective and social process and is therefore most effective when it is local, addresses real issues, and takes into account all the complex challenges facing leaders today. The leadership development process extends from the identification of organisational gaps to the adoption and implementation by leaders and managers of specific leadership development programmes to address these gaps. The main focus of this paper was to examine the determinants of leadership development in the context of the emerging economy and to analyse the extent to which emotional intelligence moderates the determinants of leadership development, with a focus on the Ghanaian construction industry. The paper concludes that leadership education, technological usage, stakeholder participation, and entrepreneurial orientation are critical determinants of leadership development. Moreover, the study concludes that emotional intelligence significantly moderates the determinants of leadership. The implications of the study will be discussed in the next section.

Implications

Theoretically, the study has employed transactional leadership theory, which is complemented by situational theory, to explain the determinants of leadership development. Transformational leadership focuses on the change and transformation of a person. Therefore, it deals with emotions, values, ethics, norms, and long-term goals. Transformational leaders are highly charismatic and able to focus their followers around a common vision. By extension, these theories have been expanded by the inclusion of entrepreneurial orientation and technological usage in the context of developing countries. Empirically, the study has contributed to contextual factors such as leadership education, technological usage, stakeholder's participation, and entrepreneurial orientation, which are important determinants of leadership development. Moreover, the study has also contributed to the extent to which emotional intelligence significantly moderates the determinants of leadership (Murphy and Johnson, 2011; Gagnon et al., 2012; Edwards & Turnbull, 2013; Muir, 2014; Ardichvili et al., 2016; Megheirkouni, 2016). Practically, the stakeholders in the construction industry in Ghana could be guided by these outcomes to formulate robust policies to enhance leadership growth and development in Ghana and to enhance productivity and growth in the sector.

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Corporate Governance System and Procurement Compliance in Ghana

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Abstract

The focus of the study was to examine corporate governance systems and how it influences public procurement compliance. The paper underscores how implementation of corporate governance practices, including transparency, accountability, independence, fairness, social responsibility, and evaluation of management, are essential components of an effective corporate governance framework for addressing procurement compliance challenges in the public sector of Ghana. Quantitative analysis with descriptive survey design was adopted for the study. A total of 335 respondents from 27 Ministries were considered for the study using census. Analysis of the relationship between corporate governance systems and procurement practices was conducted using partial least squares-sequential equation modelling (PLS-SEM). The findings demonstrated that transparency and accountability, efficient contract management, and upholding integrity have significantly contributed to curbing procurement breaches among public procurement entities in Ghana. The study concludes that there is a need for the enhancement and improvement of the existing system to facilitate the adoption of effective corporate governance practices. These practices are essential for addressing and mitigating the ongoing violations of procurement rules and regulations within the public sector. The paper further concludes that it is imperative to broaden the scope of the conversation to include the private sector, as this would facilitate knowledge transfer from public sector institutions to acquire valuable insights and adopt sustainable methods for adopting effective business practices. The paper highlights the importance of strengthening corporate governance system to enhance procurement compliance within the public sector. This is because efficient and effective procurement practices are an antecedent of value for money and efficient use of public resources.

Keywords: Corporate Governance, Procurement, Compliance, Procurement Systems, Accountability, Transparency.

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Introduction

Corporate governance is a broad concept within the context of organisational or institutional management. The Organisation for Economic Cooperation and Development (OECD) offers a comprehensive explanation of corporate governance, characterising it as a collection of practices and systems that govern the guidance, administration, and oversight of firms (Otera, 2020; Sandada, & Kambarami, 2016). This means that corporate governance is a system that distributes the rights and responsibilities of stakeholders to promote the efficient operation of the business and the achievement of its goals. Corporate governance is a framework that delineates the duties, protocols, legal requirements, and principles that facilitate the endeavours of all parties involved in an organisation to attain its objectives. Corporate governance encompasses several aspects, like as leadership, strategic direction, stewardship, and control, as highlighted by the OECD and Kovermann and Velte (2019). These elements are crucial in ensuring the efficient utilisation of resources.

The principal aim of corporate governance is to provide a structure that guarantees adherence to legal and regulatory requirements while also offering systematic advice to all stakeholders in order to pursue organisational goals efficiently. The extant body of literature indicates that a range of stakeholders are involved in the organisational context, including the board of directors, chief executive officers (CEOs), members of management, shareholders, employees, and consumers (Boachie, 2023; Abdallah and Ismail, 2017). The central claim posits that the board of directors must provide management with authority to formulate and implement policies within the confines of the organisation (Sarpong-Danquah et al., 2018; Abdallah and Ismail, 2017; Al-Najjar and Clark, 2017; Amartey, Yu, and Chukwu-lobelu., 2019).

The effective functioning of the organisation is contingent upon the capabilities and actions of its management (Liedong and Rajwani, 2018). However, it is crucial to ensure that the management is not handed unfettered authority. The implementation of checks and balances is crucial for the effective governance of management actions, as it serves to alleviate the issues that arise from agency costs. It is expected that the managerial competencies exhibited within corporate governance systems would yield positive results within organisations.

In public institutions, it is expected that established efficient corporate governance systems ensures that proper procurement practices are followed. Boachie, (2023) intimated that effect practices requires that laid down procedures for public procurement are always complied by public entities. Public procurement refers to the systematic procedure employed by public entities to utilise public funds for the purpose of procuring works, products, and services to meet the needs and requirements of the broader public. Public procurement, as defined by Agyabeng-Mensah et al. (2019), is the practice of awarding government contracts and projects to private sector organisations in fields like healthcare, education, defence, and infrastructure development. The concept of procurement in a particular country, as discussed by Owiredu and Kwakye (2020), pertains to utilising available resources to obtain the necessary equipment, materials, logistics, services, and supplies that are essential for an organisation to achieve its core developmental and business goals. Consequently, the procurement process comprises multiple stages, namely strategic planning, contract formation, negotiation, and direct purchase from the primary source of supply. The procurement process includes distinct individuals with varying personalities at different phases.

According to Adeabah et al. (2019), it is imperative to subject persons engaged in the procurement process to thorough inspection in order to ensure accountability. Moreover, according to Grandia and Meehan (2017), the public procurement process in any given nation comprises a range of important procedures, such as the invitation to bid, submission of bid, bid security, bid validity periods, and bid rejection. Therefore, these processes must conform to stringent standards and uphold transparency. In addition, the public procurement process utilises a range of strategies in order to attain accountability, transparency, cost-effectiveness, efficacy, and robust competition. The measures encompassed in this framework encompass various stages of the procurement process, such as the withdrawal and modification of tenders, the thorough examination of bids, the formal opening of bids, the acceptance of bids, the consideration of domestic preferences, the collection of fees for mobilisation, the calculation of interest on delayed payments, the requirement of a contract performance guarantee, and the diligent maintenance of a comprehensive record of all procurement proceedings (Owiredu and Kwakye, 2020).

Literature Review

Organisational management, irrespective of its scale (small or large) or type (public or private), adheres to established frameworks that guide the organisation's functioning. Consequently, the fundamental elements of corporate governance, known as the frameworks, serve as the foundation for corporate governance. Grandia and Meehan (2017) claim that a corporate governance framework serves as a self-regulating system, ensuring that directors exercise sound judgement, fostering responsibility among directors and management, and providing incentives for improved performance by management. Moreover, Hyacinth and Yibis (2017) argue that corporate governance structures are designed to mitigate inefficiencies resulting from moral hazards and information asymmetry. Corporate governance frameworks are implemented in order to safeguard the interests of individuals who provide the necessary resources for the operation of a corporate entity. Owusu and Weir (2018) suggest that in the context of economies that are progressively driven by knowledge and technology, the significance of corporate governance frameworks as predictors of a company's present and future performance, as well as its value and growth, is growing. Corporate governance systems play a pivotal role in ensuring the alignment of interests between management and shareholders, as well as generating value for the firm that ultimately benefits all stakeholders. Corporate governance systems play a crucial role in protecting the interests of many stakeholders associated with the organisation. Shareholders, as exemplified by Asare and Prempeh (2017), exhibit a primary concern for maximising their investment returns. This study focuses on the topic of public service and highlights the significance of a corporate governance framework in safeguarding the public interest. By promoting the effective utilisation of public funds, such a structure plays a crucial role in guaranteeing the optimal allocation of resources.

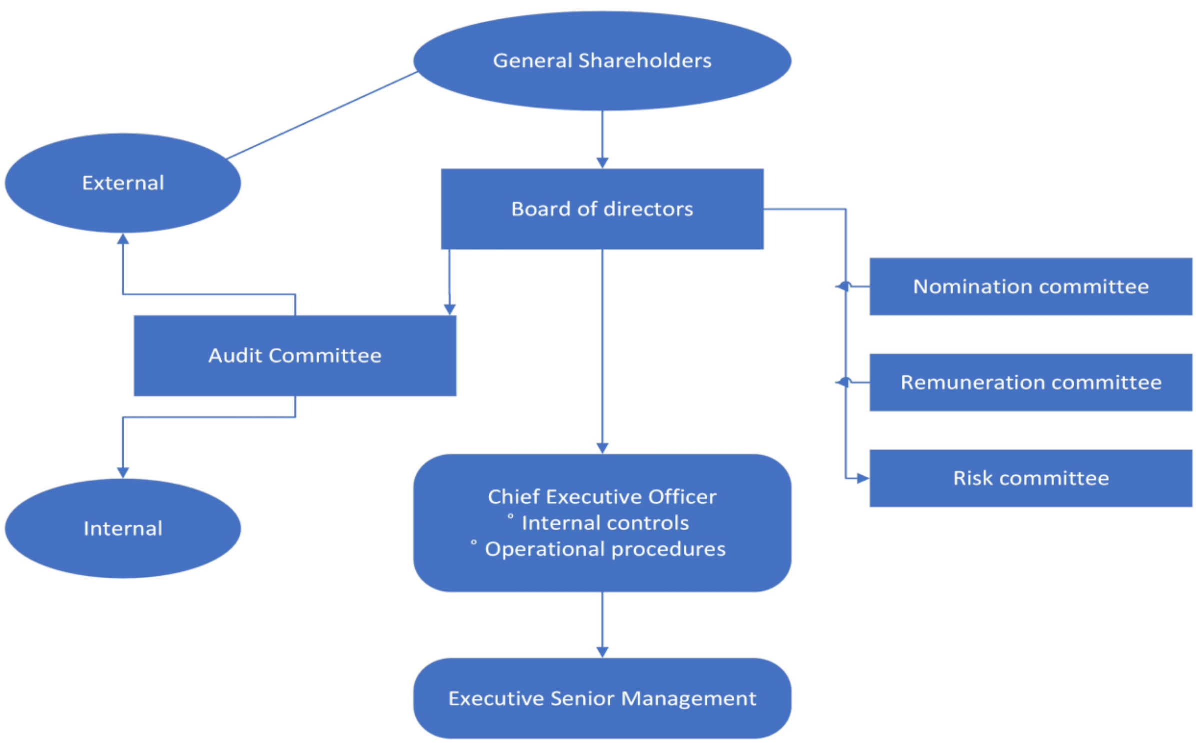
Corporate governance encompasses a range of internal and external mechanisms designed to regulate the conduct of various actors involved in corporate governance, including owners, directors, and executive management. Therefore, it is imperative to establish and categorise corporate governance systems to guarantee efficient oversight of the organisation. The effective implementation of corporate governance mechanisms, both internal and external, plays a crucial role in ensuring that procurement rules are adhered to inside an organisation, hence serving the best interests of shareholders. This section provides an examination of the overall structure of corporate governance. The assessment, as mentioned above, is thereafter associated with the extent to which the functioning of said loop system effectively contributes to the improvement of procurement practices of high quality.

A multitude of scholarly investigations have been dedicated to the analysis of corporate governance and procurement research. Numerous scholarly investigations have been conducted to examine the phenomenon of corporate governance across different countries, with some research specifically concentrating on particular aspects within this domain. The process of reviewing previous studies serves the purpose of addressing gaps in the existing literature and extracting valuable insights. The research undertaken by Aguilera et al., (2018) in Ghana examined the prevalence of fraudulent practices in the public procurement of infrastructure projects. The study was to identify and mitigate corruption in order to attain the expected economic benefits. The research utilised an extensive examination of relevant scholarly sources, such as the 2007 Annual Report of the Public Procurement Authority and the Public Procurement Act, 2003 (Act 663) as amended, together with later revisions. Furthermore, the inclusion of additional citations to established scholarly works and publicly accessible datasets was undertaken.

The study revealed that the infrastructure project delivery system in Ghana demonstrated instances of corrupt practices, including conflicts of interest, bribery, embezzlement, kickbacks, manipulation of procurement processes, and fraud. They also detected occurrences of corruption in the procurement processes for structural infrastructure projects. According to Aguilera et al. (2018), the magnitude of corruption practices calls for the exploration of innovative approaches to provide economically efficient infrastructure projects. The authors further posited that in order to effectively manage corrupt practices, organisations must establish a robust procurement system and implement pro-social justice policies. These policies must be designed to facilitate effective governance, encourage corporate social responsibility, enhance transparency and accountability, ensure prudent allocation of public funds, and foster national advancement.

Kovermann and Velte (2019) surveyed to examine the attributes of e-government procurement (E-GP) that could potentially improve the governance of government procurement by employing e-auction processes. The survey was conducted on managers responsible for e-government procurement in Thailand and involved 169 specialists representing 67 governmental institutions.

The present study has effectively discovered a comprehensive set of five variables related to governance and procurement. The factors above encompass transparent e-procurement, committed public administrators and political authorities, trustworthy suppliers, and specific regulations and legislation. The development of openness in the e-procurement process plays a crucial role in advancing governance practices by fostering cost-effectiveness accountability and preventing vendor collusion. The lack of honesty on the part of vendors has a negative impact on collaboration. The implementation of regulations and policy requirements that are supportive contributes to the enhancement of cost-effectiveness, accountability, and law enforcement. The outcomes of the study suggest that the adoption of corporate governance practices has a beneficial effect on the improvement of public procurement. Corporate governance practices among entities are structured as shown below.



Source: Adapted from Marubeni (2015).

Methods

Exploratory research associated with quantitative approach was adopted for the study (Bhattarai, 2020; Mohajan, 2018). This is because the quantitative approach follows the natural scientific paradigms' techniques and standards while considering social reality to be a real, external reality (Tabatabaei et al., 2016). As a result, in quantitative research, impartiality is a critical criterion (Lozano et al., 2020; Mohajan, 2018; Tabatabaei et al., 2016). The primary objective of this process involves the collection and conversion of data into numerical format, enabling the application of statistical computations and the formulation of informed conclusions. The predominant data-gathering methodologies employed in quantitative research encompass questionnaires, tests, and pre-existing databases. (Mohajan, 2018; Tabatabaei et al., 2016).

Descriptive survey was utilised for the study. The utilisation of a survey as the chosen data collection method in this study is justified by the presence of pre-existing variables in prior research, as well as the nature of the current investigation, which aims to validate an established premise. Again, the adoption of survey for the study was also borne out of the fact that the objectives of the study which specifically focused on identifying the corporate governance practices among public procurement entities, the behavioural and institutional factors affecting public procurement entities in is very paramount.

Measurement of variables

Comparable to Rasch scaling, the majority of studies on construction management use either frequency scales or Likert-type scales. Zikmund et al. (2013) These scales make use of response formats that are fixed-choice to investigate attitudes or beliefs. The levels of agreement and disagreement are measured using ordinal scales. According to Zikmund et al. (2013), a Likert-type scale operates under the presumption that experience can be quantified linearly, from strong agreement to strong disagreement, and that attitudes can be evaluated. The respondents will select anywhere from five to nine precoded responses, with "neutral" meaning they neither agree nor disagree with the statement. Despite the scale's unequal spacing, it is still possible to determine a person's relative evaluation of an item using it. Even though it is straightforward, this strategy is enough to use until a more involved model can be developed (Vaioleti, 2016).

An aggregation of the targeted staff population who are directly involved in procurement activities stood at 1,624 according to the ministries' databases. This total number of workforces formed the estimated sample frame for the study based on which the sample size was determined. Therefore, a sample size of 400 respondents were used for the study.

The right respondents were chosen for research. The relevant people from whom the data was obtained were chosen using two non-probability sampling procedures. These were top management including the Chief Directors and deputies, the Heads of Accounts and Human Resources and Administration. Again, the middle management officers including Heads of Procurement Units and their deputies, the Head of Stores and deputies, the Head of Internal Audit and deputies and the Head of Estates and deputies. These units/department were purposively selected because of their direct involvement in daily procurement activities. In all, a total of 27 ministries were involved in the study.

Variables descriptions

The variables considered for the study are corporate governance practices and its associated constructed as depicted in figure 1 and procurement compliance.

Variable/ Construct	Description	Source
Corporate Governance Practices	Corporate governance encapsulates the processes by which business entities are directed, managed, and controlled. Corporate governance encompasses various critical aspects of leadership, strategic guidance, stewardship, fairness, accountability, transparency, legislative documents and control that are implemented inside organisations to facilitate the most efficient utilisation of resources.	(Rashid, 2018; Chen, Li, and Shapiro, 2011; Mulili and Wong, 2011)
Procurement compliance	This deals with the deliberate failure of public institutions to follow or obey laid down rules and regulations in the purchases of works, goods, and services by public institutions with the use of public funds to meet the needs of the citizenry.	Agyemang and Castellini (2013); Grandia and Meehan (2017); Osei-Tutu et al., (2010)

Analysis of Data

The work employed the partial least squares structural equation modelling (PLS-SEM) technique to examine the proposed hypotheses (Hair et al., 2020; 2019). This is because Partial least squares structural equation modelling (PLS-SEM) demonstrates resilience by employing main components analysis and ordinary least squares regressions to estimate partial model structures (Ridgon, Sarstedt, & Ringle, 2017). Moreover, According to Saari, Damberg, Frombling, and Ringle (2021), PLS-SEM is a widely recognised and extensively utilised multivariate data analysis technique in the fields of business, social science, and behavioural research According to Roldan and Sanchez-Franco (2012) and Cepeda-Carrión et al., (2019), the application of Partial Least Squares Structural Equation Modelling (PLS-SEM) is prevalent in the fields of organisational research, information management, knowledge management, and general management studies.

Demographic Characteristics of Respondents

As indicated in the methodology section, the study targeted a total sample size of 400 respondents. However, 335 responses were obtained from the respondents which represents a response rate of 88.7%, hence an adequate representation of the population.

Table 1: Profile of Respondents

Characteristic	Option	N=335	Percentage
Sex	Male	246	73%
	Female	89	27%
Age	18-29	10	3%
	30-39	100	30%
	40-49	124	37%
	50-60	74	22%
	+60	27	8%
Educational Qualification	Diploma	60	18%
	Bachelor	168	50%
	Master's/PhD	107	32%
Rank	Senior Management	78	23%
	Line management	151	45%
	Low management	106	32%
Year Work Experience	Less than 1 year	8	2%
	1-5 years	70	21%
	6-10 years	134	40%
	11-15 years	77	23%
	Above 15 years	45	14%

Source: *Field Survey, (2023)*

Table 1 reveals that the male participants comprised 73% of the total sample size, while the female participants made up 27%. Considering the notable imbalance of males in the public sector labour, it was plausible to anticipate the possible emergence of this trend. The results also showed that 30% of the participants were between the ages of 30 and 39, while 37% were between the ages of 40 and 49. Furthermore, 22% of the individuals were between the age range of 50 to 60, whereas just 8% and 3% were aged between 18 and 29, respectively. Applicants for these posts are often anticipated to be 60 years of age or beyond, since highly productive individuals are routinely awarded contracts after reaching the required retirement age. The statistics indicate that 50% of the participants held undergraduate degrees, while 32% held postgraduate degrees, either at the master's or doctorate level. Only 18% of the individuals have degrees in their particular areas of expertise.

With respect to the seniority of the respondents, 45% were classified as belonging to the line management level, 23% were classified as belonging to the senior management level, and 32% were classified as belonging to the lower management level. Moreover, the results revealed that 40% of the participants had job experience spanning from 6 to 10 years. In addition, 23% and 21% of the participants stated that they had job experience ranging from 11 to 15 years, while 21% of the respondents claimed having work experience spanning from 1 to 5 years.

Table 2: Descriptive Results

Variables	N	Min	Max	Mean	Std. Dev.
Management Transparency	335	1	5	4.62	0.28
Management Accountability	335	1	5	4.09	.87
Management Independence	335	1	5	4.36	.62
Management Fairness	335	1	5	4.28	.68
Management Social Responsibility	335	1	5	4.14	.80
Management Evaluation	335	1	5	3.78	1.61
Corporate Governance Practices	335	1	5	4.10	.86
Public Procurement	335	1	5	4.18	0.74

Source: Field Survey, (2023)

The results in table 2 showed that the data for the study was normally distributed with no outliers. Data for the study was normally distributed in a sense that all the constructs have means values between 3.78 and 4.62 and low standard deviation ranging between 0.28 and 1.61. From the results Management Transparency has the highest mean score value of 4.62 and SD of 0.28 whiles Management Evaluation had the least mean score of 3.78 and SD of 1.61.

Inferential Results

The results on indicator loadings in Table 3 showed that all the construct variables in the measurement models have higher values above 0.70, which indicates acceptance of the indicator reliability of the model. Table 2 displays the outcomes of an evaluation conducted to determine the reliability of indicators for various constructs in a corporate governance framework that pertains to corporate procurement practices within public procurement entities. The specific components comprising each construction are delineated in the table provided, along with the corresponding loading values associated with each respective component. The loading values serve as indicators of the degree of association between each item and its underlying construct. As the loading value increases, there is a proportional increase in the reliability of the indicator as a representation of the construct. The effectiveness of the measurement model in effectively capturing the desired ideas must be validated, and this assessment is crucial to this process. The following table provides a collection of many constructs that each reflect a different facet of corporate governance practices that are utilised by public procurement entities.

Table 3: Indicator Reliability

Construct	Item	Loading
Management Transparency	MT1	0.722
	MT2	0.852
	MT4	0.816
	MT5	0.745
	MT6	0.854
Management Accountability	MA1	0.845
	MA2	0.883
	MA3	0.872
	MA4	0.879
	MA5	0.797
Management Fairness	MF1	0.927
	MF3	0.873
	MF4	0.847
Management Social Responsibility	MSR1	0.862
	MSR2	0.870
	MSR3	0.859
	MSR4	0.892
	MSR5	0.891
Management Efficiency	ME1	0.872
	ME2	0.894
	ME3	0.866
	ME4	0.903
	ME5	0.895
Procurement compliance	PPC3	0.795
	PPC4	0.780
	PPC5	0.753
	PPC6	0.726

Source: *Field Survey, (2023)*

Table 4: Reliability and Convergent Validity

Variables	Cronbach's Alpha	rho _A	Composite Reliability	Average Variance Extracted (AVE)
Management Accountability	0.908	0.910	0.932	0.732
Management Evaluation	0.931	0.932	0.948	0.785
Management Fairness	0.858	0.866	0.914	0.780
Management Independence	0.905	0.911	0.933	0.778
Management Social Responsibility	0.923	0.924	0.942	0.765
Management Transparency	0.858	0.870	0.898	0.640
Procurement Processes and Compliance	0.920	0.924	0.935	0.643

Source: *Field Survey, (2023)*

Table 4 presents the findings of the Cronbach Alpha analysis, which demonstrate a high level of internal consistency reliability. This is due to the fact that the threshold values for all of the indicator variables of the constructs fall within the range of 0.70 to 0.95, as stated by Hair et al. (2019). All of the average variance extracted (AVE) values exceed the critical threshold of 0.5, indicating that the constructs exhibit convergent validity. This finding further supports the notion that the constructs can be deemed valid in a comprehensive manner. The findings, as presented in Table 3, are in accordance with the research conducted by Henseler et al. (2015). Within the framework of this study, Table 3 presents a comprehensive evaluation of the reliability and convergent validity of various variables. These metrics are essential for evaluating the quality of the measurement model as well as the consistency of the data that was gathered. The values of Cronbach's Alpha in this table exhibit a range from 0.858 to 0.931, suggesting that all values are relatively high. The values lend credence to the hypothesis that the constituent elements within each variable exhibit internal consistency and offer a dependable means of measuring the intended constructs.

Structural Model Results

The structural model was evaluated to ensure its robustness in achieving the desired outcomes. Consequently, the utilisation of the Variance Inflation Factor (VIF), as well as the assessment of the significance and relevance of the path coefficient, serves the purpose of examining the presence of collinearity within the construct, as well as evaluating the predictive and explanatory capabilities of the structural model

Table 5: Inner Variance Inflation Factor (VIF) Results

Construct	VIF
Management Accountability	2.106
Management Evaluation	2.157
Management Fairness	2.070
Management Independence	2.435
Management Social Responsibility	2.519
Management Transparency	2.502

Source: Field Survey, (2023)

In Table 5, the largest inner VIF is 2.51, which shows that collinearity is not at a critical level. The findings of the Inner Variance Inflation Factor (VIF) analysis for various constructs in the study are displayed in Table 4 The Variance Inflation Factor (VIF) analysis is employed to evaluate the presence of multicollinearity among the predictor variables in a regression model. The table lists several constructs, each corresponding to a specific aspect of the study's focus. These constructs include Management Accountability, Management Evaluation, Management Fairness, Management Independence, Management Social Responsibility, and Management Transparency. The Variance Inflation Factor (VIF) quantifies the degree to which the variance of the estimated regression coefficient is augmented as a result of multicollinearity among the predictor variables. In lay terms, it evaluates the extent to which the existence of one predictor variable can be anticipated based on the other predictor variables. A high variance inflation factor (VIF) indicates a strong correlation between predictor variables, which may result in instability in the outcomes of a regression model.

The VIF values represent the extent of multicollinearity for each construct. The VIF value is calculated for each predictor variable, indicating how much the variance of that variable is inflated due to correlations with other predictor variables. In this table, the VIF values range from 2.070 to 2.519 for the various constructs. Generally, VIF values below 5 are considered acceptable, as they indicate a relatively low level of multicollinearity.

Table 6: Path results

Direct paths	Estimates (β)	T Statistics (|O/STDEV|)	p values	Outcome
Management Accountability -> Corporate Governance Practices	1.62	13.62	0.00	Confirm
Management Efficiency -> Corporate Governance Practices	0.32	16.16	0.061	Unconfirmed
Management Fairness -> Corporate Governance Practices	1.89	18.78	0.00	Confirm
Management Legislation -> Corporate Governance Practices	23.10	18.33	0.012	Confirm
Management Social Responsibility -> Corporate Governance Practices	1.58	18.99	0.00	Confirm
Management Transparency -> Corporate Governance Practices	0.25	3.85	0.00	Confirm

Source: Field Survey, (2023)

Based on the findings presented in Table 5, it can be observed that there is a significant relationship between management accountability and significant corporate governance (β = 1.62, p = 0.00). Similarly, the results indicate a significant association between management fairness and significant corporate governance (β = 0.32, p = 0.00), management independence and significant corporate governance (β = 1.89, p = 0.012), as well as management social responsibility and significant procurement (β = 0.25, p = 0.00). These outcomes provide empirical support for the importance of these corporate governance practices. However, the analysis of management evaluation in relation to corporate governance practices, as depicted in Figure 2, indicates that it did not demonstrate statistical significance (p = 0.061, β = 0.32).

Discussions

Public procurement management institutions are dedicated to the notion of fairness in their procurement issues since it is a strong corporate governance practice. As was shown, organisations responsible for public procurement agreed to provide fair treatment to the customers, workers, and general residents they serviced. These organisations put forth every effort to ensure fair competition, fair payment, and remuneration packages for their workers and clients or suppliers, and they do not have a preferred choice of clients or suppliers for their procurement operations. This remark that was made by the findings has a solid foundation in the most recent research that has been done. (Boateng et al., 2019; Owusu-Manu et al.,2011) asserted in their respective research papers that the principle of fair shareholder treatment is a favourable aspect of corporate governance. Equitable treatment of shareholders is a fundamental principle that aims to ensure fair and just treatment for all shareholders, including minority owners and foreign shareholders. When their rights are infringed upon in the course of the procurement process, each of these stakeholders, as implicated, must have the ability to seek adequate remedies.

The study additionally demonstrated that the incorporation of social responsibility within the board of directors and management is a crucial element of corporate governance within Ghana's public procurement agency. As was said, the majority of public procurement organisations place a high level of importance on the environmental elements of their procurement processes.

Furthermore, these entities are typically concerned with the safety and conservation of the environment in which they operate. In a similar vein, the board of directors and management do implement insurance programmes for workers and their families, and they do seek and insist that consumers and the general public have access to high-quality goods and services using appropriate procurement. This conclusion is consistent with the observation that was made by Agyei-Mensah (2016) and Fiador (2016), who suggested that most people have grasped that they do not function in isolation; rather, they all live in a society, and as a result, they are required to display some level of responsibility towards the community. This result comes in line with the observation that was made by Agyei-Mensah (2016) and Fiador (2016).

Based on the research results, it has been observed that corporate governance practices play a crucial role in mitigating procurement violations. Factors such as transparency and accountability, procurement planning, efficient contract management, and integrity have been found to have a substantial and positive impact on the reduction of procurement violations. The use of transparency and accountability measures guarantees adherence to procurement protocols, ethical standards, and regulatory frameworks, as well as efficient documentation and accurate dissemination of information to relevant stakeholders. This was further demonstrated by the results. The use of these best practices can assist procurement entities in mitigating, reducing, or preventing procurement breaches. In line with this conclusion, the study conducted by Otera (2020) demonstrates that corporate governance practices such as accountability, corporate responsibility, and transparency have a favourable impact on procurement compliance in organisations. In a study conducted by Williams and Ehiabhi (2021), it was discovered that the implementation of transparent practices within the Nigerian Civil Service had a positive and statistically significant impact on public procurement. This discovery aligns with the preceding one.

Furthermore, meticulous strategic planning of procurement activities ensures that each procurement procedure within the public sector optimises the value derived from the allocated financial resources. It also assures the use of suitable procurement tools, the hiring of skilled professionals in the formulation of procurement strategies and contract agreements, and the provision of advisory and technical services. The significance of adequate procurement planning in mitigating security breaches is underscored by the research undertaken by Namukasa (2017), which highlights the importance of specifying the items to be purchased, the responsible parties involved, and the appropriate timing. According to Osei-Kyei and Chan (2017), effective planning enables an organisation to carry out procurement activities in accordance with established legal and regulatory frameworks.

Conclusions and Recommendations

This study conducted a comprehensive analysis of corporate governance practices and procurement processes and compliance within procurement firms in Ghana. The results of the study indicate that the implementation of corporate governance practices, including transparency, accountability, independence, fairness, social responsibility, and evaluation of management, are essential components of an effective corporate governance framework for addressing procurement compliance challenges in the public sector of Ghana. As established, these practices play a critical role in the conduct of public officials when it comes to procurement processes and compliance. For instance, the findings demonstrated that transparency and accountability, efficient contract management, and upholding integrity have significantly contributed to curbing procurement breaches among public procurement entities in Ghana.

Nevertheless, the findings provide substantial evidence indicating that the existing corporate governance structure is marked by institutional and human elements that impede the implementation of certain commendable practices. As previously observed, the existing system is marked by a lack of adherence to the execution of effective corporate governance principles. In instances where public officials successfully implement effective corporate governance practices, their ability to maintain such practices over a significant duration is often hindered by factors such as leadership transitions or external influences. There is a need for the enhancement and improvement of the existing system in order to facilitate the adoption of effective corporate governance practices. These practices are essential for addressing and mitigating the ongoing violations of procurement rules and regulations within the public sector.

To ensure compliance with the principles and criteria outlined in the framework, government authorities should conduct a thorough evaluation and reform of existing procurement regulations and laws. The implementation of this measure will establish a solid legal framework to support the adoption of enhanced governance practices. Additionally, the promotion of collaboration and transparency is crucial in facilitating effective cooperation among public procurement entities, regulatory authorities, and civil society organisations. This collaborative effort has the potential to augment transparency, facilitate the exchange of information, and promote accountability within procurement procedures.

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Benefits of Sustainable Corporate Social Responsibility (SCSR) in Construction Business - Literature Review

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Abstract

The construction industry is exposed to a wide range of risks that can have detrimental impacts on the construction business, environment, and society. Sustainable Corporate Social Responsibility (SCSR) is a risk mitigation strategy that can help to mitigate such risk from the construction businesses and at the same time chip in the best interest of society and the environment. This review highlights the benefits of integrating SCSR practices into the Construction Business. The findings revealed that SCSR can help mitigate construction business risks on construction projects, society, and the environment. Furthermore, it is found that SCSR practices can enhance reputation, reduce legal costs, improve ethical practices, foster stakeholder engagement, and ultimately improve project performance. The review also identified the limited studies on Construction SCSR benefits and emphasized the need for more empirical studies for the implementation of SCSR in the Construction business. Overall, this paper provides insight into the potential benefits of SCSR practices.

Keywords: Sustainable Corporate Social Responsibility, SCSR, Benefit, Construction, Business.

Introduction

The construction project faces various risks that can adversely impact its success (Kim, 2021). These risks include environmental concerns, social issues, stakeholder resistance, and regulatory compliance (Boachie and Tetteh, 2021; He and Tritto, 2022). Sustainable Corporate Social Responsibility (SCSR) can be an effective strategy to mitigate these risks and create sustainable value for construction projects (Amoatey *et al.*, 2017; Chatterjee *et al.*, 2018). The construction industry faces many risks that can cause project cost overruns, project delays, reputational damage, and even project failure (Lenssen et al., 2014). The risks that arise from the environmental, social, economic, cultural, and ethical dimensions of Sustainable Corporate Social Responsibility (SCSR) are crucial for the enterprise to pay detailed attention (Ishaq et al., 2023).

The risk arises from environmental like resource depletion, pollution, and social issues like community engagement, stakeholders' resistance, labour rights, respect for the culture, and regulatory compliance obligations are all typical external risks that affect most construction projects if not managed well, especially those capital project in developing counties (Kolk, 2016).

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These risks can be controlled and mitigated through the implementation of Sustainable CSR practices in the construction sector because many sectors like banking, mining, telecommunication, and general business have used CSR and SCSR as a tool for risk mitigation to enhance the sustainability of company reputation and customer retention (He and Tritto, 2022). Studies have shown that sustainable CSR practices are an effective construction external risk mitigation mechanism that does not follow the traditional ways of risk management but it is equally or even better at managing external construction risk than the traditional approach (Boachie and Tetteh, 2021).

Sustainable CSR practices minimize risk impacts through efficient and effective resource management, adopting eco-friendly technologies, and reducing waste (Cheng, et al., 2022; Gao *et al.*, 2023). This approach not only mitigates environmental risks but also deepens the project's reputation and strengthens stakeholder relationships (Adomako, 2020). Managing Social issues such as local community engagement, public health, labour rights, and safety are critical social risks in construction projects. Sustainable CSR practices promote fair employment practices, ensure the well-being of workers and surrounding communities, and establish community development (Nguyen *et al.*, 2020; Cezarino et al., 2022).

Stakeholder engagement is one of the social aspects of risk that is essential for the success of construction projects (Velte, 2022). SCSR practice involves effective communication with stakeholders in decision-making processes to help the company by continuously building trust, reducing conflicts, and minimizing the issuers of public opposition (Oetzel and Miklian, 2017; Amo-Mensah, 2019). In general, by addressing this social phenomenon, construction companies can gain community support, prevent stakeholder resistance, and reduce social risk (Gao *et al.*, 2023). Regulatory compliance in the construction sector is a complex framework, but following sustainable CSR which is also the same as adopting transparency and responsible practice ensures compliance with environmental and social legislations (Andrés *et al.*, 2019; Shayan *et al.*, 2022).

By staying ahead of regulatory requirements, construction companies can mitigate the risks associated with non-compliance, penalties, and legal disputes (Lu *et al.*, 2019). One of the approaches to managing cultural and political risk in developing countries is by hiring local experts who understand the political landscape and cultural clashes (Ishaq et al., 2023). Hiring local experts has many advantages because, they are already adapted to the local customs and practices of the project area (Fatima, 2023). These simple ways of SCSR help mitigate political and cultural risks in the construction industry (He and Tritto, 2022). This review has shown that Sustainable Corporate Social Responsibility (SCSR) practices are an emerging potential approach to mitigate numerous external risks by integrating environmental, Social, Economic, Culture, Political, and Ethics into construction project planning and execution (Gao *et al.*, 2023). This review explores the existing research on the benefits of Sustainable CSR in general business (Afiuc *et al.*, 2020). This is very limited in the CSR research in the construction industry, especially in developing countries. The Construction sector was limited in Sustainable CSR studies and also there is a limited study in the sector that has established the benefits of SCSR in the construction business, with only 1% of the articles that had drawn the researcher's attention to SCSR. This was confirmed by (Damoah et al., 2019) 0.9%. This is a knowledge gap and Population gap in the construction business to empirically establish the benefits of Sustainable CSR. There are limited empirical and case studies as shown by this study.

Research Methodology

A systematic literature review approach was adopted to identify the Benefits of Sustainable Corporate Social Responsibility (SCSR) (Coelho and Ferreira, 2023; Fatima, 2023; Siddique, 2023). A comprehensive search was conducted in various academic databases, and studies published between 2013 and 2023 were used because there was a limited literature review on a decade paper on sustainable CSR (Amo-Mensah, 2019). The procedure adopted for the search was as follows: First, the aggregators with the most coverage were searched for easy identification of the papers, for example: Google scholar, Publish or Perish, and JANE (Amo-Mensah, 2019). Second, all the papers selected were extracted from these academic databases; Scopus, Wiley, Sage, JSTOR, ProQuest, EbscoHost, Science Direct, Emerald Insight, and Taylor and Francis (Creswell, 2016; Nguyen *et al.*, 2020).

Finally, Snowball sampling was used to search for papers from the bibliography of the first selected papers (Ansu-mensah *et al.*, 2021). 94 papers were found based on Prisma model guidelines, during the review 23 papers were rejected because the theme was not conforming directly to sustainability corporate social responsibility benefits. The other 3 papers were rejected as a result of the date of publication because we were interested in papers that are not more than that decade old. Articles that focused on Sustainable CSR and benefits were 68 in number that were selected for the review, see Figure 1 for the number of publications per year (Amo-Mensah, 2019, 2021;). By following the (Damoah et al., 2019) content analysis procedure, all 68 studies searched from sectors, sustainability theme, CSR theme, and sustainable CSR practices and finally identified, the potential of sustainable CSR for risk mitigation in management see Figure 2 shows sectors details of the papers.

Results

Sustainable CSR Publish articles

The result section presents and discusses the findings from the study which encompasses the benefits of sustainable CSR in the construction business. This section solved the research questions of the study: What are the benefits of sustainable CSR to the construction business? As stated earlier, the review was limited to a decade. However, the study found 68 Journal papers published between 2013 and 2023 See Table 1. The search and screening processes were carried out from January to December 2023 and therefore the year 2023 was the latest at the time the study was being carried out.

Table 1. Published articles on Sustainable CSR

Author(s)	Author No.	Date	Cited	Journal
Sachs, J. D., Schmidt-Traub, G., Mazzucato, M., Messner, D., Nakicenovic, N., and Rockstrom, J.	6	2019	1509	Nature Sustainability
Gillan, S. L., Koch, A. and Starks, L. T.		2021	1197	Journal of Corporate Finance
Kolk, A. (2016)		2016	997	Journal of World Business
Baumgartner, R. J.	1	2014	919	Corporate Social Responsibility and Environmental Management,
Andrés, M., Agudelo, L., Johannsdottir L. and Davidsdottir,	4	2019	824	International Journal of Corporate Social Responsibility
Maretno, H. and Laksmane, I.	2	2018	370	Journal of Business Ethics
Shad, M. K. Lai, F. W., Fatt, C. L., Klemes, J. J. and Bokhari, A.	5	2019	337	Journal of Cleaner Production
Boubaker, S., Cellier A., Manita, R. and Saeed, A	4	2020	272	Economic Modelling

Schönherr, N., Findler, F. and Martinuzzi, A.	3	2017	225	Transnational Corporations
Nguyen, H. T., Le, D. M. D., Ho, T. T. M., and Nauyen, P. M.	4	2020	210	Social Responsibility Journal
Elalfy, A., Palaschuk N., El-Bassiouny D, Wilson J., Wilson, J. and Weber, O.	6	2020	187	Sustainability
Adomako, S.	1	2020	177	Journal of Business Research
Kuo, T. C. and Smith, S.	2	2018	166	Journal of Cleaner Production
Frederiksen, T.	1	2018	148	Resources Policy
Devie, D., Liman, L. P., Tarigam, J. and Jie, F.	4	2020	126	Social Responsibility Journal
Bhattacharya, A., Good, V, Sardashti H., and Pelozo J.	4	2020	103	Journal of Business Ethics
Kim, S. (2021)	2	2021	98	Strategic Management Journal
Oetzel, J. and Miklian, J.	2	2017	90	Multinational Business Review
Lu, J., Ren, L., Ren, L., Qiao, J., Yao, S., Strielkowski, W. and Streimikis, J. (2019)	7	2019	87	Sustainability
Raulinajtys-grzybek, M.	1	2021	79	Corporate Social Responsibility and Environment
Neitzert, F. and Petras, M.	2	2022	77	Journal of Business Economics
Kong, L., Sial, S. M., Ahmad, N., Sehleanu, M., Lai, Z., Zia-Ud-Din, M. and Badulescu D.	7	2021	75	Sustainability
Lenssen, J. J., Dentchev, N. A. and Roger, L.	3	2014	74	Corporate Governance
Ansu-mensah, P., Mafo, E. O, Awuah S. L. and Amoako O.	4	2021	72	International Journal of Corporate Social Responsibility
Landi, G. C., Iandolo, F., Renzi, A. and Rey, A.	4	2022	70	Corporate Social Responsibility and Environmental Management
Li, G., Clay, W. and Jr, F.	3	2021	70	Production and Operations Management
Eldin, A. G.	1	2019	69	Journal of Sociology and Social Policy
Lu, H., Liu, X. and Falkenberg, L.	3	2022	62	Business and Society
Amoako, G. K.	1	2017	55	International journal of bank marketing
Frynas, G.	1	2015	52	Annual International Cryptology Conference
Coram, P. J., Haji, A. A. and Troshan, I.	3	2022	48	Forthcoming in Accounting, Auditing & Accountability Journal.
Debnath, B., Shakur, M. S., Bari, A. B. M. M. and Karmaker, C. L. (2023)	4	2023	46	Decision Analytics Journal
Cezarino, L. O., Liboni, L. B., Hunter, T., Pacheco, L. M. and Martins, F. P.	5	2022	35	Journal of Cleaner Production
Coelho, R. and Ferreira, J. J.	2	2023	35	Corporate Social Responsibility and Environmental Management,
Curado, C. and Mota, A.	2	2021	35	Sustainability

Olubunmi, A. O., Omotayo, T., and Saka, N.	3	2021	32	Sustainability Production and Consumption
Ortiz-martínez, E, Marin-Hernandez, S. and Santos,-Jaen, J. M.	3	2023	28	Sustainable Production and Reporting
Afiuc, O., Bonsu, S. K. and Manu, F.	3	2020	27	Journal of Consumer Marketing
Amoatey, C. T., Famiyeh, S. and Andoh, P.	3	2017	23	Journal of quality in maintenance engineering
Gomez-valencia, M., Gonzalez-Pere, M. A., and Gomez-Trujillo, A. M.	3	2021	19	Business Strategy and the Environment
He, Y. and Tritto, A.	2	2022	17	Third World Quarterly
Ishaq, M. I., Sarwar, H., Franzoni, S, Palermo, O. (2023)	4	2023	11	IJOEM
Damoah, O. B. O., Peprah, A. A. and Cobla, G. M. (2019)	3	2019	8	Business Strategy and Development
Boachie, C. and Tetteh, J. E.	2	2021	5	International Journal of Ethics and Systems
Amo-Mensah, M.	1	2019	4	European Journal of Business and Management
Ayangbah, F.	1	2017	4	Journal of Economics, Management and Trade
Keyvanfar, A., Khorami, M., Moya, G. et al.,	26	2018	4	The IIOABJ Journal
Pérez, C., Esther, C. and Puente, D. Q.	3	2023	4	Eurasian Business Review
Amo-Mensah, M.	1	2021	3	International Journal of Business Management
Amo-Mensah, M.	1	2022	3	British Journal of Business Management
Cheng, W. Y., Chang, Y. and Chen, K. H.	3	2022	3	LI and CSR, NTU Management Review
Fatima, T., and Elbannq, S.	2	2023	3	Journal of Business Ethics
Gao, Y., Amalia, D, Rahmawati, D. H., Rizky, A., Rangga M., and Frisco, M. R.	6	2023	3	Jurnal ilmu komunikasi
Shayan, N. F., Mohabbati-Kalejahi, N., Alavi, S, and Zahed, M. A.	4	2022	3	Sustainability
Shu, O., Hashmi, H. B. A., Xiao Z., Haider, S. W., and Nasir, M.	5	2022	14	Journal of Business Ethics
Siddique, N.	1	2023	6	Sustainability
Singh, K., Abraham, R., Yadav, J, Agrawal A. K., and Kolar, P.	5	2022	38	Sustainability, Accounting, Management, and Policy Journal
Torres, L, Ripa, D., Jain, A., Herrero, J., and Leka, S	5	2023	14	Safety Science
Velte, P. (2022)	1	2023	175	Management Review Quarterly
Wu, A.	1	2023	3	Business Strategy and the Environment
Yang, Y. and Jiang, Y.	2	2023	20	Journal of Business Research

Zhao, G., Ahmed, R. I., Ahmad, N., Yan, C., and Usmani, M. S	5	2021	57	Energy Strategy Review
Zhao, S., Teng, L., Arkorful, V. E. and Hu, H.	4	2023	3	Technological Forecasting and Social Change
Zhuang, X., and Junshan, D.	2	2023	3	International Journal of Emerging Markets

Network visualization map of the keywords

The analysis shows that countries such as China, South Korea, the United States, the United Kingdom, Canada, and Denmark have dominated the research, implementation, and practices of sustainable corporate social responsibility and its benefits, with little research in developing countries. Figure 1. Shows how the keywords interlinked from each other on the VOS viewer network visualization map. Social responsibility is a predominant term that attention has been drawn to as shown in red in the map below.

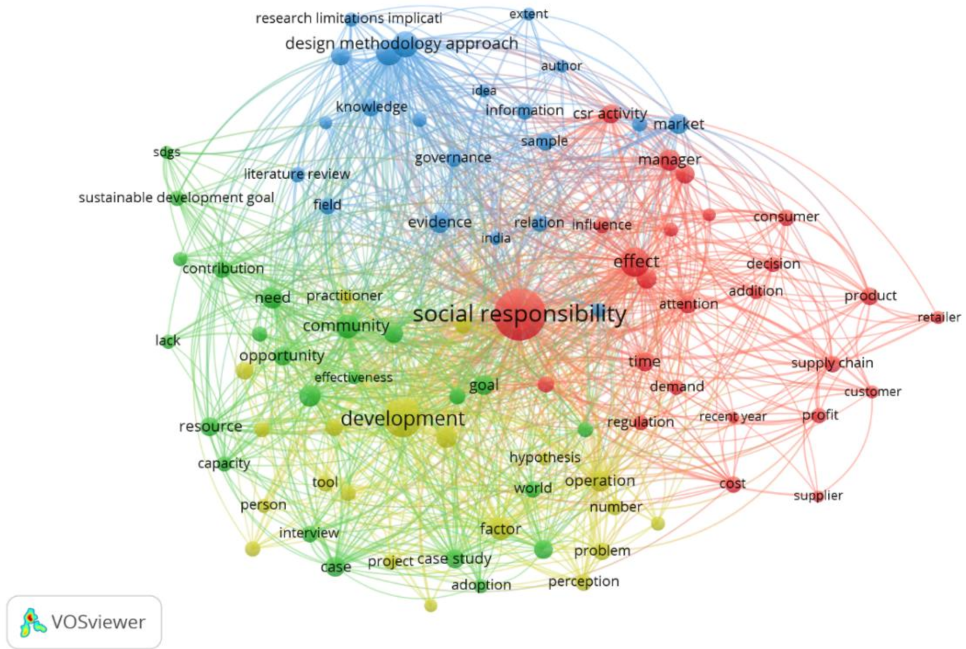

Figure 1. Sustainable CSR benefits keywords

The trend of articles Published from 2013 to 2023

Figure 1 shows the frequency of a decade of research published articles between 2013 to 2023 that have some elements of sustainability, corporate social responsibility, and business risk mitigation. There is a sign of research increase over the past decade with a uniform distribution in the year 2015, 2016, and 2019, 2020 where equal papers were published that relate directly to three or more of the keywords: Sustainable Corporate Social Responsibility, Corporate Social Responsibility, Benefit of CSR, Construction Business Risk, Sustainable Practices. The number fluctuates yearly but there is a general upward trend. In 2014, there were 2 articles, 2015 there were 1, 2016 there were 1 article, 2017 there were 4 articles, 2018 there were 4 articles, 2019 there were 8 articles, 2020 there were 8 articles, 2021 there were 12 articles, 2022 there were 13 articles, 2023 there were 15 articles. From 2013 to 2023, we observed an increasing trend in the number of articles within the decade, with a notable continued spike from 2016. The growth in frequency over time may be attributed to various growing issues on sustainability and CSR by the United Nations Sustainable Development Goals (SDGs).

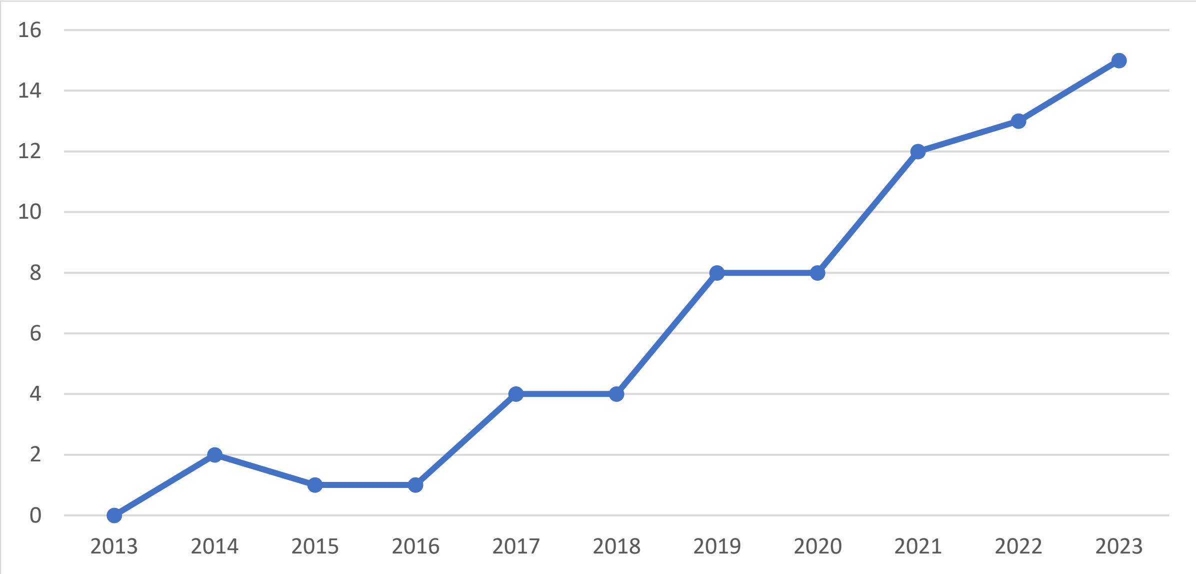

Figure 1: Number of Publication per year

Distribution of Articles Across Sectors

The sectors covered in these decade articles are shown in Figure 2. The breakdown of sectors is as follows: multi-sector: 52%, Banking: 13%, Telecommunication: 12%, Mining: 9%, Engineering: 6%, Tourism and Hospitality: 3%, Construction: 1%, and others: 4%. The majority of the decade articles focused on the multi-sector precisely the studies from the business schools, accounting for 52% of the publications this confirmed the (Damoah et al., 2019) synthesis of the literature. This suggests a broad range of topics and industries covered in these articles, possibly examining multiple sectors or cross-sector trends. Banking received 13% of the articles, indicating a focus on the banking sector's evolution, such as regulatory changes, eco-innovation, CSR as a marketing strategy, and potential impact on the economy.

This was also supported by (Damoah et al., 2019). Telecommunication accounted for 12% of the articles, suggesting an interest in studying the advancements and innovations in the field, including the impact on communication networks and services. Mining sector articles made up 9% of the total, indicating some attention on the mining industry's trends, environmental concerns, and potential changes over the decade. These confirmed studies by (Amo-Mensah, 2019; Damoah et al., 2019) that Banking, Telecommunication, and Mining are part of the three dominant sectors in developing Countries' CSR research, implementation, and practice. Engineering had a slightly higher presence with 6% of the articles, indicating some analysis of the developments and advancements in the field. Tourism and Hospitality sector articles were relatively few, making up only 3% of the publications, suggesting a lesser focus on this industry in the decade review articles. The Construction sector was almost lacking in Sustainable CSR studies and also there is a limited study in the sector that has established the benefits of SCSR in the construction industry, with only 1% of the articles that had discussed the benefits of SCSR. This was confirmed by (Damoah et al., 2019) 0.9%. This is a research gap in the construction business research to empirically establish the benefits of Sustainable CSR. Lastly, other sectors like Forestry, Agriculture, Energy, and Health, accounted for 4%. This indicates the wide coverage of this study to conclude the frequency of decade article papers.

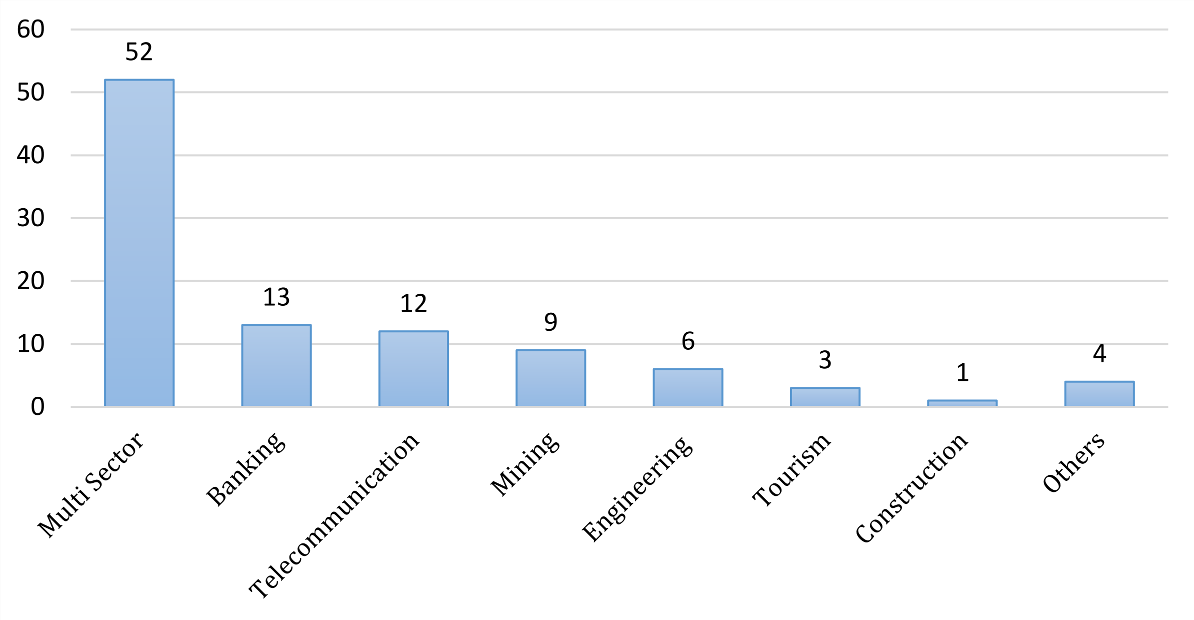

Figure 2 Percentage distribution of sector research

The benefits of Sustainability CSR

Despite studies that have established the relationship between sustainability and CSR, its benefits cannot be overlooked in the construction business (Sachs et al., 2019; Elalfy et al., 2020). This review tries to trace the benefits of sustainable CSR in the construction business. Through systematic review. The most occurring benefits are listed in Table 2 (Sachs et al., 2019; Elalfy et al., 2020). This study first such the explanation of the term sustainable CSR based on the article and their explanations, sustainability is often referred to as the three dimensions of sustainability or the triple bottom line (People, Planet, and Profit) (Nguyen et al., 2020). The Environmental benefits represent the planet (Ortiz-martínez et al., 2023). This refers to the conservation and protection of natural resources, biodiversity, and ecosystems. It encompasses reducing the negative impact on the environment, minimizing pollution, promoting renewable energy, and reducing waste.

Social benefits also represent the people (Kong et al., 2021). This dimension of Sustainable CSR focuses on the well-being of individuals and communities (Kong et al., 2021; Torres et al., 2023). It involves ensuring justice, social equity, and inclusivity, as well as promoting human rights, education, health, and access to basic needs and services as suggested by Abraham Maslow's hierarchy of needs (Kolk, 2016; Shayan et al., 2022). The last group of benefits is categorized under Economic sustainability, which represents the profit component of sustainability (Ayangbah, 2017; Shad et al., 2019). This aspect considers the long-term economic viability and prosperity (Eldin, 2019). It emphasizes sustainable practices, responsible production, efficient use of resources, responsible consumption, and the promotion of fair and ethical trade (Yang and Jiang, 2023).

All these sustainability CSR benefits are interconnected to corporate social responsibility (CSR) practices and studies have shown that there is a relationship between sustainability CSR practices and its benefits (Wang et al., 2020). The review clearly shows that companies adopting Sustainable CSR practices in their business reduces their risk directly or indirectly on the environment, society, economy, and the business as well. This calls for empirical research to establish; Sustainable CSR practices, and their associated benefits.

Table 2. Benefits of sustainable corporate social responsibility

Item	Sustainable CSR benefits	References
1	Mitigate reputational risk	R2, R5, R10, R11, R12, R13, R14, R15, R16, R17, R18, R46, R47, R48, R49, R50, R51, R52, R58-T, R59, R60, R61, R62, R63, R64, R32, R33, R34
2	Mitigate ethical risk	R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R20, R21, R22, R23, R24, R25, R26, R27, R28, R29, R30, R42
3	Enhanced brand reputation and image	R1, R4, R5, R6, R7, R8, R10, R11, R30, R31, R32, R34, R46, R47, R51, R52, R53, R55, R58, R59, R60, R61, R62
4	Mitigate operational risk	R1, R2, R3, R35, R3, R37, R38, R40, R41, R42, R43, R45, R46, R47
5	Mitigate financial risk	R1, R46, R47, R48, R49, R51, R53, R55, R57, R59, R61, R63, R64
6	Mitigate Social risk	R28, R29, R30, R31, R32, R35, R45, R45, R46, R47
7	Mitigate technical risk	R47, R48, R49, R50, R51, R52, R53, R54, R55, R60
8	Enhance long-term resilience	R12, R16, R18, R25, R26, R27, R35, R59, R62, R64
9	Enhance relationship	R1, R2, R3, R4, R26, R26, R28, R29, R32, R40, R43,
10	Access to new markets and customers	R5, R7, R19, R26, R30, R31, R37, R38, R42, R64
11	Strengthened stakeholder relationship	R7, R9, R11, R43, R44, R49, R50, R57, R61, R63
12	Reduced environmental impact	R6, R7, R8, R12, R25, R26, R42, R62, R63, R64
13	Cost savings from energy efficiency measures	R14, R18 R20, R22, R23, R30, R37, R49, R60
14	Mitigate political risk	R5, R9, R10, R13, R14, R38, R39, R40, R41,
15	Improved employee morale and retention	R1, R13, R23, R24, R25, R40, R63, R64
16	Attract retention of talent	R14, R15, R18, R19, R20, R44, R51, R64
17	Strengthened relationships with stakeholders	R12, R17, R32, R43, R44, R47, R48, R49
18	Increased customer loyalty	R22, R27, R33, R45, R46, R51, R52, R55
19	Competitive advantage in the market	R2, R4, R7, R19, R53, R57, R59, R60
20	Reduced waste and resource consumption	R17, R20, R22, R56, R61, R64, R8
21	Positive impact on local communities	R13, R19, R21, R22, R25, R41, R59
22	Compliance with regulations and standards	R8, R11, R13, R33, R37 R60, R63
23	Enhance Innovation in products and services	R6, R9, R10, R16, R45, R57
24	Long-term business resilience	R33, R41, R44, R61, R62, R64
25	Access to new markets and customers	R12, R21, R43, R47, R48, R49,
26	Enhanced supply chain management	R14, R20, R22, R24, R35, R61
27	Improved risk management	R21, R22, R24, R25, R27, R42
28	Increased transparency and accountability	R8, R9, R10, R21, R43, R49

29	Positive impact on shareholder value	R1, R15, R29, R31, R34,
30	Better relationships with investors	R14, R30, R41, R63, R64
31	Long-term cost reduction	R9, R19, R44, R45, R63
32	Improved health and safety outcomes	R3, R44, R50, R52, R57,
33	Reduced carbon footprint	R33, R3, R37, R48, R59
34	Enhanced corporate governance	R6, R15, R47, R48, R49,
35	Improved Stakeholders relations	R21, R38, R55, R57, R58,
36	Positive impact on public policy and regulation	R33, R34, R35, R50, R60
37	Opportunity for partnerships and collaborations	R4, R57, R58, R59,

R1-Adomako, (2020), **R2**-Afiuc., (2020), R3-Amo-Mensah, (2019), R4-Amo-Mensah, (2021), R5-Amo -Mensah, (2022), R6-Amoako, (2017), R7-Amoatey et al., (2017), R8-RAndrés et al., (2019), R9-Ansu-mensah et al., (2021), R10-Ayangbah, (2017), R11-Baumgartner, (2014), R12-Bhattacharya et al., (2020), R13-Boachie and Tetteh, (2021), R14-Boubaker et al., (2020), R15-Cezarino et al., (2022), R16-Cheng et al., (2022), R17-Coelho and Ferreira, (2023), R18-Coram et al., (2022), R19-Curado and Mota, (2021), R20-Damoah et al., (2019), R21-Debnath et al., (2023), R22-Devie et al., (2020), R23-Elalfy et al., (2020), R24-Eldin et al., (2019), R25-Fatima and Elbannq, (2023), R26-Frederiksen, (2018), R27-Frynas, (2015), R28-Gao et al., (2023), R29-Gillan et al., (2021), R30-Gomez-valencia et al., (2021), R31-He and Tritto, (2022), R32-Ishaq et al., (2023), R33-Keyvanfar et al., (2018), R34-Kim, (2021), R35-Kolk, (2016),R36 Kong, (2021), R37-Kuo, and Smith, (2018), R38-Landi, et al., (2022), R39-Lenssen et al., (2014), R40-Li et al., (2021), R41-Lu et al., (2022), R42-Lu et al., (2019), R43-Maretno and Laksmane, (2018), R44-Neitzert and Petras, (2022), R45-Nguyen et al., (2020), R46-Oetzel and Miklian, (2017), R47-Olubunmi et al., (2021), R48-Ortiz-martínez et al., (2023), R49-Pérez et al., (2023), R50-Raulinajtys-grzybek et al., (2021), R51-Sachs et al., (2019), R52-Schönherr (2017),R53-Shad et al., (2019), R54-Shayan et al., (2022),R55-Shu et al., (2022), R56-Siddique, (2023), R57-Singh et al., (2022), R58-Torres et al., (2023), R59-Velte, (2022), R60-Wu, (2023),R61-Yang and Jiang, (2023), R62-Zhao et al., (2021), R63-Zhao et al., (2023), R64-Zhuang and Junshan, (2023).

Discussion

The benefits of sustainable CSR

This systematic review focuses on the benefits of sustainable corporate social responsibility in the construction business, which has been a knowledge gap in the past decades (Damoah et al., 2019). There are several key benefits of sustainable corporate social responsibility in the construction business (Damoah et al., 2019). These benefits encompass various aspects of business and extend its impacts beyond the businesses and go on to society, and the environment (Kuo and Smith, 2018). One of the main benefits of Sustainable CSR is business risk mitigation (Kong et al., 2021). It helps businesses mitigate their external risk and also reduces environmental footprint and protects natural resources (Kong et al., 2021). It includes initiatives such as reducing greenhouse gas emissions, conserving water and energy, and adopting sustainable practices in the supply chain (Gomez-Valencia et al., 2021). The review points out some notable risks that Sustainable CSR can mitigate, these risks include social risk, environmental risk, ethical risk, reputational risk, operational risk, political risk, cultural risk, financial risk, and technical risk (Devie *et al.*, 2020). Also, other general benefits help businesses when Sustainable CSR is implemented and practiced effectively, these are: enhanced innovation, attraction retention of talent, improved employee engagement, cost serving, improved risk management, enhanced long-term resilience, created stakeholder relationships, access to new market and customers, enhance brand reputation, strengthen stakeholders relationship, enhance supply chain resilience, positive impact on the community and positive impact on society (Gomez-Valencia et al., 2021).

The Benefits of Sustainable CSR on the Construction Business

Upon the limited studies on the benefits of Sustainable CSR on the construction business, numerous benefits of Sustainable CSR enhance the development of construction businesses especially those operating in developing countries (Damoah et al., 2019 Gomez-Valencia et al., 2021).

Social risk mitigation: This benefit emphasizes the importance of addressing social inequalities and promoting social justice (Cezarino et al., 2022). It involves initiatives that focus on fair labour practices, human rights, diversity and inclusion, and community development. Sustainable CSR practices can help companies mitigate potential risks related to social issues, such as vandalism as a result of human rights infringements and disrespect to traditions, beliefs, and culture. Mitigating social risk in the construction industry can benefit businesses in several ways (Devie *et al.*, 2020). these are some key advantages: Enhanced Public Perception- Mitigating social risk can help construction businesses build a positive public image. By addressing social concerns such as community impact, diversity and inclusion, and ethical labor practices, companies can demonstrate their commitment to being responsible corporate citizens (Gomez-Valencia et al., 2021)... This, in turn, can lead to improved brand reputation and greater acceptance of construction projects within local communities (Devie *et al.*, 2020). Stakeholder Engagement- Proactively managing social risk can facilitate better relationships with various stakeholders, including residents, activist groups, government agencies, and non-profit organizations. Engaging with these groups and addressing their concerns can help mitigate potential conflicts, improve project support, and reduce the likelihood of delays or disruptions stemming from social opposition. Regulatory Compliance- Many social risks in construction are intertwined with legal and regulatory requirements. By effectively managing these risks, companies can ensure compliance with relevant laws and standards, reducing the likelihood of fines, legal disputes, or project delays resulting from non-compliance. Access to Financing and Investment- Investors and financial institutions increasingly consider social and environmental factors when evaluating construction projects. Mitigating social risk can make businesses more attractive to lenders and investors who prioritize sustainability, responsible business practices, and community engagement. This can ultimately result in greater access to funding and investment opportunities (Devie *et al.*, 2020). Attraction and Retention of Talent- A company's social responsibility efforts can significantly impact its ability to attract and retain top talent. Construction businesses that prioritize social risk mitigation and demonstrate a commitment to ethical practices, safety, and community welfare are likely to be more appealing to potential employees, leading to a more skilled and motivated workforce. Effectively addressing social risk can lead to improved project outcomes, fewer conflicts, better relationships with stakeholders, and a more favorable operating environment for construction businesses. It can also contribute to long-term business sustainability and profitability by ensuring projects are carried out in a socially responsible manner.

Environmental risk: Mitigating environmental risks in the construction business has a range of benefits, including protecting the environment, reducing potential financial liabilities, and improving the overall reputation of the construction business. Compliance with regulations- Proactively addressing environmental risks ensures compliance with local, national, and international regulations (Devie *et al.*, 2020). This reduces the likelihood of fines, legal issues, and delays in project approvals, which can ultimately save money and time for the construction business. Cost savings- By implementing environmentally sustainable practices and technologies, construction businesses can reduce waste, energy consumption, and resource usage. This can lead to significant cost savings in the long run, as well as potential eligibility for tax incentives and grants for eco-friendly initiatives. Reputation and brand image- Mitigating environmental risks can enhance the reputation of the construction business. Demonstrating a commitment to sustainability and responsible environmental stewardship can help attract environmentally conscious clients and investors, as well as improve relationships with regulatory agencies and local communities (Neitzert and Petras, 2022). Risk management- Identifying and addressing environmental risks early in the construction process can prevent costly setbacks and unforeseen environmental issues during project execution. This proactive approach to risk management can help ensure project timelines and budgets are adhered to, ultimately benefiting the bottom line of the business. Innovation and competitiveness- Embracing environmentally sustainable practices often drives innovation and can give construction businesses a competitive edge (Devie *et al.*, 2020). Utilizing green building materials, implementing energy-efficient designs, and adopting sustainable construction methods can set a company apart in the market and attract clients seeking environmentally responsible partners. To conclude, mitigating environmental risks in the construction business not only benefits the planet but also has significant financial and reputational advantages for businesses. By fostering a culture of environmental responsibility and incorporating sustainable practices, construction business can protect their bottom line while contributing to environmental conservation efforts (Neitzert and Petras, 2022).

Reputational Risk: Mitigation of reputational risk through sustainable CSR is crucial for the success of a construction business for several key reasons. Trust and credibility- Building and maintaining a positive reputation within the construction industry and among clients, suppliers, and partners is essential for gaining trust and credibility. Mitigating reputational risk helps to establish a solid foundation of trust and credibility, which in turn can lead to more business opportunities and a loyal client base. Competitive advantage- A strong reputation can provide a competitive advantage for a construction business, setting it apart from its competitors. Clients are more likely to choose a company with a solid reputation for quality work and ethical practices, and this can lead to higher conversion rates and increased profitability. Risk management- Mitigating reputational risk is an important aspect of overall risk management for a construction business (Devie *et al.*, 2020). A positive reputation can help buffer the company against potential liabilities and negative publicity, reducing the likelihood of legal and financial repercussions. Employee retention and recruitment- A construction business with a good reputation is more likely to attract and retain top talent in the industry. Employees are often drawn to companies with a strong reputation, as they are seen as more stable and desirable places to work. This can lead to a more skilled and motivated workforce, ultimately benefiting the company's performance and success (Neitzert and Petras, 2022). Long-term success and sustainability positive reputation are critical for the long-term success and sustainability of a construction business. By mitigating reputational risk, companies can position themselves as reliable, ethical, and trustworthy partners, which can lead to ongoing business relationships and repeat clients. To conclude, the mitigation of reputational risk benefits construction businesses by enhancing their credibility, competitiveness, risk management, talent acquisition, and long-term success. By prioritizing their reputation, companies can create a foundation for sustainable growth and profitability in the construction business (Saaka, 2019). It also attracts potential clients and investors who prioritize environmentally conscious businesses, leading to increased business opportunities.

Ethical risk mitigation: Mitigating ethical risks through sustainable CSR benefits construction businesses in several ways. This benefit focuses on the importance of conducting business operations ethically and with integrity (Amo-Mensah, 2022). It includes initiatives such as anti-corruption measures, transparent reporting, and responsible marketing and advertising, this benefit reduces the payment of penalties from litigation as a result of non-ethical compliance (Amo-Mensah, 2019). Positive Reputation operating ethically, a construction business can maintain a positive reputation in the industry. This can lead to increased customer trust and loyalty, as well as improved relationships with stakeholders and the community. Attracting and Retaining Talent-Ethical businesses are often more attractive to top talent, as employees are more likely to want to work for a company that operates with integrity and values. Additionally, a strong ethical culture can help retain employees by fostering a positive work environment. Legal Compliance- Ethical behavior helps construction businesses avoid legal issues and regulatory penalties, which can be costly and damaging to a company's reputation. By adhering to ethical standards, businesses can minimize the risk of facing lawsuits, fines, and other legal consequences. Risk Management- Acting ethically reduces the potential for negative incidents, such as fraud, corruption, and safety violations, which can lead to financial and reputational harm. By following ethical guidelines, construction businesses can better manage and mitigate potential risks (Neitzert and Petras, 2022). Building Trust and Relationships- Ethical conduct fosters trust with clients, suppliers, and partners. This trust can lead to stronger, long-lasting relationships, repeat business, and positive referrals. Competitive Advantage- Ethical behavior can serve as a differentiator in a crowded market (Gomez-Valencia et al., 2021). A construction business that is known for its ethical practices may have a competitive edge over less reputable competitor. Mitigating ethical risks benefits construction businesses by safeguarding their reputation, attracting and retaining talent, ensuring legal compliance, managing risks, building trust and relationships, and gaining a competitive advantage in the construction business (Neitzert and Petras, 2022).

Operational risk mitigation: Mitigating operational risk through sustainable corporate social responsibility (CSR) practices can benefit construction businesses in several ways (Neitzert and Petras, 2022). To begin with, mitigation of operational risk enhances reputation - Sustainable CSR initiatives, such as implementing eco-friendly construction practices or sourcing materials from ethical suppliers, can bolster a construction company's reputation (Cezarino et al., 2022). This, in turn, can enhance the brand image and appeal to clients who prioritize social and environmental responsibility. A positive reputation can also help in attracting and retaining top talent, as employees are increasingly drawn to companies that are committed to sustainable and ethical practices (Neitzert and Petras, 2022). Also, by reducing regulatory and legal risks by adhering to sustainable practices and meeting environmental regulations, construction businesses can reduce the risk of facing legal issues, fines, or penalties. For instance, reducing carbon emissions and waste can help in compliance with environmental regulations, thus minimizing potential legal repercussions (Neitzert and Petras, 2022). In addition, it improved stakeholder relationships- Adopting sustainable CSR practices can build stronger relationships with stakeholders, including investors, community members, and local authorities (Barnett et al., 2020). Demonstrating a commitment to environmental and social responsibility can foster trust and goodwill, which may result in better business partnerships, easier permitting processes, and increased access to funding (Cezarino et al., 2022). Furthermore, Cost savings- Many sustainable practices, such as energy-efficient construction methods or waste reduction strategies, can lead to cost savings. For example, using recycled materials or reducing energy consumption can result in lower operational expenses over time. These cost savings can contribute to improved financial performance and long-term sustainability of the construction business (Barnett et al., 2020). Resilience to market shifts: Embracing sustainability can future-proof a construction business by ensuring its operations are aligned with changing market demands and consumer preferences. As the construction industry continues to place greater emphasis on sustainability, companies that proactively integrate CSR into their operations will be better positioned to adapt to market shifts and maintain a competitive edge (Cezarino et al., 2022). In conclusion, mitigating operational risk through sustainable CSR practices can benefit construction businesses by enhancing their reputation, reducing legal and regulatory risks, improving stakeholder relationships, generating cost savings, and bolstering resilience to market dynamics. By prioritizing sustainable practices, construction companies can create long-term value while contributing to environmental and social well-being.

Political risk: Mitigating political risk through sustainable corporate social responsibility (CSR) practices can have several benefits for construction businesses. To begin with, it improved stakeholder relations- Engaging in sustainable CSR practices can help construction companies build stronger relationships with government agencies, local communities, and other stakeholders. By demonstrating a commitment to social and environmental responsibility, construction businesses can enhance their reputation and minimize the potential for political obstacles or backlash. Regulatory compliance- Many political risks in the construction industry stem from changes in regulations and policies (Barnett et al., 2020). By aligning with sustainable CSR practices, construction companies can proactively adapt to evolving regulatory requirements, reducing the likelihood of non-compliance issues and associated penalties. In addition, its enhanced brand value- Sustainable CSR initiatives can contribute to a positive brand image, which can be a valuable asset when navigating political environments. Well-regarded companies are often better received by government authorities and local communities, potentially lowering the risk of regulatory challenges or opposition to construction projects (Neitzert and Petras, 2022). Also, access to funding and investment- Investors and lenders increasingly prioritize sustainable and socially responsible businesses. By mitigating political risk through sustainable CSR, construction companies may enhance their appeal to financial partners, improving access to funding and investment opportunities (Barnett et al., 2020). Furthermore, reduced project disruptions: Political instabilities, protests, and community resistance can disrupt construction projects (Cezarino et al., 2022). Engaging in sustainable CSR practices, such as environmental protection, community development, and ethical labor practices, can help mitigate these risks by fostering a more positive relationship with local communities and stakeholders. In conclusion, long-term resilience- Building a strong reputation for sustainable CSR can contribute to the long-term resilience of construction businesses. By being seen as responsible and ethical actors in the market, companies can better withstand political challenges and crises, maintaining their operations and market position more effectively (Cezarino et al., 2022). In summary, mitigating political risk through sustainable CSR practices can benefit construction businesses by improving stakeholder relations, ensuring regulatory compliance, enhancing brand value, accessing funding and investment, reducing project disruptions, and building long-term resilience in a complex and dynamic political landscape.

Cultural risk: Mitigating cultural risk through sustainable corporate social responsibility (CSR) practices can bring several benefits to a construction business (Shayan et al., 2022). Here are some ways in which these practices can benefit construction companies (Barnett et al., 2020). To begin with, by respecting and embracing local cultures, traditions, and social values, a construction company can build strong relationships with stakeholders, including local communities, authorities, and clients. In addition, by respecting diverse cultural norms and values, the construction business can minimize the risk of being perceived as insensitive, disrespectful, or harmful to local communities. This can ultimately protect the company's brand and long-term success (Shayan et al., 2022). Also, it brings a Social License to Operate- Demonstrating a commitment to sustainable and culturally sensitive practices can help a construction business secure and maintain a social license to operate (Neitzert and Petras, 2022). This means that the company has the ongoing acceptance and approval of the local community and other stakeholders to conduct its business activities. This can facilitate project approvals, permits, and overall business operations. Furthermore, attracting and Retaining Talent- Construction businesses that prioritize sustainable CSR and cultural risk management are likely to attract and retain top talent. Employees, particularly those from diverse cultural backgrounds, are often drawn to companies that demonstrate a commitment to social and environmental responsibility (Shayan et al., 2022). This can contribute to a more engaged and motivated workforce (Szczepankiewicz, 2021). It further allows access to New Markets and Opportunities- By proactively addressing cultural risk and integrating sustainable CSR practices into their operations, construction businesses may gain access to new markets and business opportunities (Szczepankiewicz, 2021).

Many clients and investors now prioritize working with companies that demonstrate ethical and socially responsible behaviors, opening doors to new projects and partnerships (Szczepankiewicz, 2021). Long-Term Sustainability- Mitigating cultural risk and embracing sustainable CSR practices can contribute to the long-term sustainability of the construction business (Cezarino et al., 2022). By aligning with the values and expectations of the communities in which they operate, companies can build stronger relationships, reduce conflicts, and foster a positive legacy in the industry. In conclusion, mitigating cultural risk through sustainable CSR practices benefits construction businesses by enhancing their reputation, reducing reputational risk, securing a social license to operate, attracting and retaining talent, accessing new markets, and ensuring long-term sustainability (Szczepankiewicz, 2021). Embracing these practices can lead to a more socially responsible and successful construction business (Shayan et al., 2022).

Financial risk: Mitigating financial risk through sustainable corporate social responsibility (CSR) initiatives can benefit construction businesses in numerous ways; to begin with, access to capital investors and financial institutions are increasingly considering a company's CSR practices when making investment decisions (Shayan et al., 2022). By demonstrating a commitment to sustainable CSR, construction businesses can improve their access to capital and potentially attract lower-cost financing (Barnett et al., 2020). Cost efficiencies- Sustainable practices can lead to cost savings in areas such as energy efficiency, waste management, and resource utilization. By integrating sustainable measures into their operations, construction businesses can reduce operating expenses and improve profitability (Neitzert and Petras, 2022). Reputation and brand value-Embracing sustainable CSR initiatives can enhance the construction company's reputation, making it more attractive to clients, partners, and employees (Cezarino et al., 2022). A positive reputation can help differentiate the business in a competitive market and lead to increased customer loyalty and trust (Devie et al., 2019). Risk management- By implementing sustainable practices, construction businesses can reduce the risk of potential fines, penalties, or legal disputes due to non-compliance with environmental regulations (Devie et al., 2019). This proactive approach can also mitigate the likelihood of disruptions to operations and project delays (Shayan et al., 2022). Regulatory compliance: Sustainable CSR practices can ensure that construction businesses are compliant with evolving environmental and social regulations. By staying ahead of regulatory changes, companies can avoid potential legal and financial repercussions (Cezarino et al., 2022). Long-term resilience: Incorporating sustainable CSR measures can help future-proof the construction business against changing market dynamics, climate-related risks, and evolving stakeholder expectations (Neitzert and Petras, 2022). This resilience can contribute to long-term business success and stability. In conclusion, mitigating financial risk through sustainable CSR initiatives can not only improve the overall financial health of construction businesses but also enhance their reputation, drive operational efficiencies, and position them for long-term success in a rapidly changing business environment.

Technical risk: Mitigating technical risk through sustainable corporate social responsibility (CSR) practices can bring several benefits to construction businesses. Here are some key ways in which this can be advantageous: Enhanced brand reputation- Embracing sustainable CSR practices demonstrates a commitment to responsible and ethical business operations. This can contribute to a positive brand image, which is crucial for construction companies that often rely on their reputation to secure contracts and attract clients (Cheng, et al., 2022). By mitigating technical risk through sustainable practices, construction businesses can differentiate themselves as socially responsible and environmentally conscious, which can be a competitive advantage in the industry. Access to new opportunities clients, especially those in the public sector and large corporations, are increasingly prioritizing sustainability and responsible practices in their procurement processes(Gomez-Valencia et al., 2021). By demonstrating a commitment to sustainable CSR, construction businesses may gain access to new opportunities and contracts that require adherence to stringent environmental and social standards. This can expand their market reach and potentially lead to lucrative projects. Stronger stakeholder relationships- Sustainable CSR initiatives can help build stronger relationships with stakeholders, including clients, investors, employees, and local communities (Shayan et al., 2022). By actively engaging in environmentally conscious practices and community initiatives, construction businesses can foster trust and goodwill, which can be beneficial in times of crisis or when seeking support for new projects (Devie et al., 2019).

Reduced regulatory and legal risks - As sustainability and environmental regulations become more stringent, construction businesses that proactively mitigate technical risk through sustainable practices can reduce their exposure to legal and regulatory challenges (Barnett et al., 2020). By aligning with industry standards and preemptively addressing environmental and social concerns, companies can avoid potential liabilities and fines, thereby protecting their bottom line. Cost savings and operational efficiency- Sustainable CSR practices often involve improvements in resource efficiency, waste reduction, and energy conservation (Devie et al., 2019). By investing in sustainable technologies and practices, construction businesses can achieve cost savings through reduced energy consumption, optimized resource utilization, and streamlined operations(Gomez-Valencia et al., 2021). This not only mitigates technical risk but also contributes to long-term financial sustainability. In conclusion, mitigating technical risk through sustainable CSR practices can benefit construction businesses by enhancing their reputation, opening up new opportunities, strengthening stakeholder relationships, reducing regulatory and legal risks, and driving cost savings (Barnett et al., 2020). By integrating sustainability into their core business strategy, construction companies can position themselves for long-term success in an increasingly environmentally conscious market (Devie et al., 2019).

The integration of sustainable Corporate Social Responsibility (CSR) practices into a construction business serves as construction risk mitigation, mitigate risk through sustainable CSR can bring about numerous benefits that contribute to its overall success and resilience, these lead to Stakeholder relationship: This benefit emphasizes the need for businesses to engage with their stakeholders and incorporate their opinions and concerns into decision-making processes (Gomez-Valencia et al., 2021). It involves initiatives that promote transparency, accountability, and dialogue with stakeholders such as employees, customers, suppliers, and local communities that enhance the reputation of the organization's continued development and growth (Pérez, et al., 2023). Improved stakeholder relations- Sustainable CSR practices help build strong relationships with stakeholders, including local communities, governments, and NGOs (Barnett et al., 2020). Engaging with these stakeholders on sustainability-related issues can foster trust and cooperation, improving project outcomes and reducing conflicts (Li et al., 2021). Five, Compliance with regulations- Many countries have strict environmental regulations in place, especially in the construction industry (Keyvanfar et al., 2018; Olubunmi et al., 2021). Implementing sustainable CSR practices helps ensure compliance with these regulations, reducing the risk of penalties, legal issues, and reputational damage (Landi et al., 2022).

Enhancing Innovation- By adopting sustainable CSR practices, construction businesses are encouraged to explore more innovative and environmentally friendly approaches to their processes and products. This can lead to improved efficiency, reduced waste, and the development of new, sustainable construction techniques and materials. Innovation and competitiveness enhance, sustainability initiatives often drive innovation within the construction business. Companies that prioritize sustainable practices are more likely to adopt new technologies and methods, making them more competitive in the market and potentially leading to cost savings and efficiency gains (Amoako, 2017). Innovation and product differentiation, this benefit highlights the role of innovation and technology in addressing sustainability challenges (Zhao et al., 2023). It involves initiatives that promote research and development of sustainable solutions, as well as the adoption of innovative technologies to drive environmental and social progress (Zhao et al., 2023). These benefits represent the key areas where sustainability and CSR give organizations a market advantage over competitors (Debnath et al., 2023). By addressing these, businesses can contribute to a more sustainable and responsible future by considering the environmental, social, and economic impacts of their operations and engaging with stakeholders to make informed decisions (Wu, 2023). Major policies by Construction companies to get these benefits in the construction business will minimize construction business external risk (Szczepankiewicz, 2021).

Attracting and Retaining Talent- Employees today are often seeking employers with strong CSR initiatives. By demonstrating a commitment to sustainability, a construction business may attract top talent who are passionate about environmental and social causes. Additionally, a strong CSR program can also improve employee retention by fostering a sense of pride and purpose among the workforce. Improved Employee Engagement- Sustainable CSR initiatives can empower employees, leading to increased engagement and motivation. When employees feel, they are contributing to meaningful and socially responsible projects, their overall job satisfaction and productivity tend to improve. Employee satisfaction and retention- Employees often take pride in working for a company that values sustainability (Afiuc et al., 2020). Implementing sustainable CSR practices can create a positive work environment, leading to increased job satisfaction and higher employee retention rates (Cheng, et al., 2022). Cost Savings- Sustainable practices can often lead to cost savings in the long run. For example, adopting energy-efficient building materials and processes can reduce operational expenses and contribute to significant cost savings over time. Cost-serving and economic growth, benefit highlights the need for sustainable economic growth and development (Singh, 2022). It involves initiatives that aim to create economic value while considering the long-term positive impacts on society and the environment (Lu et al., 2019). This can include initiatives such as job creation, responsible sourcing, and investing in local communities (Maretno et al., 2018)

Improved Risk Management and Resilience- By integrating sustainable practices, construction businesses can mitigate environmental, regulatory, and reputational risks. This builds resilience against potential disruptions and volatile market conditions, thus safeguarding the business's long-term stability. Stakeholder Relationships- Sustainable CSR practices can strengthen relationships with various stakeholders, including investors, regulators, and local communities. This can lead to enhanced trust and collaboration, which may facilitate smoother project approvals, funding opportunities, and overall business growth. (Devie et al., 2019). Access to New Markets and Customers- Embracing sustainability can open doors to new markets and clients who prioritize environmentally responsible contractors. Many governments and organizations prefer to work with construction firms that align with their sustainability goals, thus offering access to new business opportunities. Enhanced Brand Reputation being associated with sustainable practices, a construction business can build a positive brand reputation, which is increasingly valuable in today's socially conscious consumer and business landscape.

Supply Chain Resilience- Sustainability efforts often involve assessing and improving the entire supply chain, leading to greater resilience and a reduced risk of disruptions. Positive Impact on the Community and Society-Sustainable CSR initiatives can result in positive impacts on the local community and society at large. This can include job creation, infrastructure improvements, and the promotion of sustainable living, contributing to the overall welfare of society. In conclusion, the integration of sustainable CSR practices into a construction business has the potential to bring about numerous benefits, positively impacting not only the construction business but also its environment, society, economy, culture and tradition, and ethical practice in the wider community (Barnett et al., 2020). Long-term resource availability- Sustainable CSR practices encourage the efficient use of resources such as energy, water, and materials (Zhao et al., 2021). This can lead to cost savings, reduce waste generation, and minimize the environmental impact of construction projects (Debnath et al., 2023).

Finally, Long-term viability- Sustainable CSR practices can help construction companies adapt to changing societal expectations and regulatory frameworks (Raulinajtys-grzybek, 2021). By integrating sustainability and CSR into their business models, companies can ensure long-term viability and remain competitive in an evolving market (Devie et al., 2019). Embracing sustainable CSR practices in the construction business not only benefits the environment but also offers numerous advantages, including cost savings, managing and mitigating risk, creating better stakeholder relations, Mitigating construction external risk, enhancing innovation, and creating a positive impact on communities and increased competitiveness (Chatterjee et al., 2018). There are numerous benefits to implementing sustainable corporate social responsibility (CSR) practices within a company, including:

Conclusion

Sustainable CSR practices offer several benefits for the construction business. Sustainable CSR practices can significantly contribute to risk mitigation in the construction business. By integrating sustainability CSR into the construction business, construction companies can minimize legal, financial, reputational, technical, and operational risks and enhance their overall risk management efforts. Effective implementation led to enhanced innovation, attracting retention of talent, improved employee engagement, cost serving, improved risk management, enhanced long-term resilience, created stakeholders' relationships, gave access to new markets and customers, enhanced brand reputation, strengthened stakeholders' relationships, enhance supply chain resilience, positive impact on the community and positive impact on society. This systematic review called for future empirical studies, and case studies that demonstrate the practical implementation and effectiveness of Sustainable CSR in construction business risk mitigation. The uniqueness of this review is that it has synthesized the major benefits of Sustainability corporate social responsibility under one umbrella to guide construction companies as to how to mitigate some business risks with a focus on construction business external risks such as Environmental risks, social risks, Economic risks, Ethical risk, political risk, cultural risks, and Reputational risk. Overall, this paper provides insight into the potential benefits of sustainable corporate social responsibility as a business strategy for construction external risk mitigation.

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Community Mining: The Evolving Paradigm in the Ghanaian Small-Scale Mining Sector – The Case of Tokwae Community Mining Scheme in the Ashanti Region of Ghana

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Abstract

Globally, Ghana is one of the major mining jurisdictions that has rolled out community mining schemes in response to curbing illegal small-scale mining. However, knowledge about the emerging paradigm in terms of their capacity, operations, and contribution (COC) is very opaque. Little is also known about the strengths, weaknesses, opportunities and challenges (SWOT) of scheme. Again, not much is known of the scheme's efforts towards inclusiveness, responsible and sustainable mining (IRS) in the quest of bringing to an end the long-standing problem of illegal small-scale mining. The scheme according to the Ministry of Lands and Natural Resources are intended to provide livelihoods for members in the mining communities, promote sustainable and responsible mining and bring to an end the problem of illegal mining. As a result, the paper sought to present the COC-IRS-SWOT analysis of the scheme as a basis for scaling-up of the scheme within mining communities in Ghana which will further form grounds and country study for replication within other mining jurisdictions in Africa. The study made use of the case study research approach in zeroing on the Tokwae community mining scheme. The study made use of content analysis, recursive abstraction, deductive reasoning, and triangulation of information to arrive at conclusion. The generally found that community mining schemes have the potential of employing several thousands of small-scale illegal miners in the country with improved working conditions, and contribution to reducing environmental degradation towards the achievement of the SDGs. The paper recommends that the scheme offers a good model for replication in other mining jurisdiction in Africa towards reducing the problem of illegal small-scale mining, environmental degradation and the sustainable development in Africa through the SDGs.

Keywords: Community mining, Capacity, Operation, Responsible, Sustainable, SWOT

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Introduction

One major problem in the Ghanaian mining sector is illegal small-scale mining (Bach & Sundst, 2014; Obeng et al., 2015; Kuffour, Tiimub & Agyapong, 2018). The problem though has a long-standing history, it became intense in the last few decades due to the proliferation of Chinese and foreign nationals into the country (Armah et al., 2013; Antwi, 2014), a surge in the need for mechanization in the mining process (Hilson and Garforth, 2013) and the customary nature and disposition of most Ghanaian lands (Schoneveld, 2010). The implications these trends leave on the environment is getting a growing momentum in empirical literature and its effects are tangible and long-term.

Some studies have also shown that the main environmental problems associated with gold mining activities are mercury pollution (UNIDO, 2000; Babut et al., 2003; Nartey et al., 2011) from gold processing, ecosystems destruction and environmental degradation (Hilson, 2002; Hilson and Pardie, 2006; Asante et al., 2007; Hilson et al., 2007; Yeboah 2008) primarily from the small-scale mining. It is generally known that activities of small-scale mining (SSM) in Ghana often go side-by-side with subsistence farming (Hilson and Garforth, 2013). The mercury pollution could lead to the contamination of crops on or near polluted sites (Odai, 2008; Teschner et al., (2019) posing health implications to communities (Spiegel and Veiga, 2009; Richard et al., 2014; Hilson et al., 2007; UNEP, 2012) and food production and consumption (Donkor, 2015).

In recent times, there's been widespread awareness of political interference in small-scale mining in Ghana. This knowledge stems from various sources such as investigative journalism, documentaries, national audit reports, and positions taken by traditional councils. There have even been reports of farmers willing to offer their cocoa farms for mining in exchange for cash. The issue of illegal mining and its environmental impact has become a significant concern for the Ghanaian government. Despite numerous attempts to address the problem, including task forces, drone surveillance, Operation Vanguard, and nationwide bans, the problem persists. It's been challenging to distinguish between legal and illegal miners, leading to a national ban in 2017 to sort out registered and unregistered operators.

The Deputy Minister of Lands and Natural Resources for instance notes that 'Government is sanitizing the extractive industry with the introduction of the community mining scheme which will pave the way for the commencement of regulated, responsible, and sustainable community mining aimed at helping to get rid of illegal mining. The scheme is being operationalized in '*galamsey'* endemic areas of the country in Western, Ashanti and Eastern Regions of Ghana. The move is also expected to create 10,300 direct jobs and 21,000 indirect jobs' (Ministers' Press Briefing, Ministry of Information, 2021) and further expected to provide 'over 1,400 small-scale concessions capable of generating approximately 500,000 direct jobs' (Ministry of Lands and Natural Resources ((MoLNR), 2022: p.10).

The only country to have had a study published on community mining is Indonesia as can be seen in the work of Narendra et al., (2021) though, [mere] mentions are made of the subject by Verbrugge (2014) of Philippines and other scholars like Cuddy and Seangly (2015) and Spiegel (2016) of Cambodia. That said, little is therefore known about the subject and its dynamics within the mining interface. The subject thus become a new line of research. Ghana, one of the major mining jurisdictions in the globe has rolled out a community mining scheme in recent times but knowledge about the emerging paradigm in the Ghanaian small-scale mining sector in terms of their capacity, operations, and contribution (COC) is very opaque. Little is further known about the strengths, weaknesses, opportunities and challenges (SWOT) of Ghana's emerging Community Mining Scheme. Again, not much is known about their efforts towards inclusiveness, responsible and sustainable mining (IRS) in the quest of bringing to an end the long-standing problem of illegal mining. The schemes according to the Ministry of Lands and Natural Resources 'are intended to provide livelihoods for members in the mining communities, promote sustainable and responsible mining and bring to an end the problem of illegal mining'. As a result, the paper sought to establish whether the combined capacity, operation, and contribution (COC) analysis of the Tokwae community mining scheme in a mining district of the Ashanti region of Ghana amounts to or goes beyond small-scale mining and satisfy some minimum best practices. The paper also presents a SWOT analysis of this new paradigm in the SSM sector within the Ghanaian context. In addition, the paper presents an IRS analysis of this emerging mining cohort against the backdrop of responsible and sustainable mining as embedded in the Small Scale and Community Mining operational manual, 2021. This paper thus adds to the huge deficit of knowledge in literature on the subject of community mining.

Literature

Community mining – Definitions, Concepts and Scope

Community mining, as defined by the Minerals Commission of Ghana (2021), involves the collaboration of multiple small-scale mining groups within a community. It encompasses both permanent and seasonal artisanal and small-scale mining (ASM) activities carried out by local residents who rely on mineral resources for their livelihoods. There are two main types of community mining transitions: rush-type and shock-push mining (Hruschka & Echavarría, 2011). Rush-type mining occurs when people migrate to newly discovered mining areas in pursuit of higher earnings, often leading to the formation of new communities. Shock-push mining arises from poverty, triggered by factors like job losses, conflicts, or natural disasters. It involves individuals with limited education who turn to mining as a last resort due to lack of other opportunities, perpetuating a cycle of poverty.

The definition of community mining lacks clarity, leading to improper implementation of regulations and contributing to illegal mining and environmental degradation (Narendra et al., 2021). In Indonesia, community mining licenses are granted either to individual local residents, with a maximum area of five hectares, or to cooperatives whose members are local residents, with a maximum area of ten hectares. The duration of these permits is initially ten years, with the possibility of two extensions, each lasting five years (Narendra et al., 2021). Conversely, in Ghana the scope of the concession of community mining is limited to 25.2 acres for five years and renewable after a satisfactory performance during the first term (Minerals Commission of Ghana, 2021).

Community mining - The Evolving Paradigm in the Ghanaian Small-Scale Mining Interface

From the legal perspective, small-scale mining includes ‘mining by any method not involving substantial expenditure by an individual or group of persons not exceeding nine in number or by a cooperative society made up of ten or more persons’ (PNDC Law 218, 1989). The Mineral and Mining Act 2006 (Act 703), permits small-scale miners to mine in areas that do not exceed 25 acres of land for a period of three to four years (Hinde, 2010). The legislative has therefore birthed two streams of the small-scale mining i.e. namely legal and illegal small-scale miners. The illegal small-scale mining has come to be known as ‘galamsey’.

The legal small-scale miners comprised those who have acquired mining licenses from the Minerals Commission of Ghana to operate on their concessions. This mining cohort undertakes operations carried out with a valid legal permit, in which operators are entitled to their concessions and sometimes, mine within with the permission of large-scale mining companies (Aryee et al. 2003; Ofori & Ofori, 2018). The illegal ones or *galamseyers* are those who engage in unlawful gold mining activities without the involvement of mining companies. They manually dig small excavations such as pits, tunnels, and sluices. It's important to note that the depth and size of these excavations are generally limited and smaller compared to those of authorized mining companies. They operate without the necessary mining license and often conduct their activities on the concessions of other companies. According to the current laws in Ghana, *galamseyers* are prohibited from mining on land that has been granted as concessions or licenses to mining companies (Amankwah & Anim-Sackey, 2003). On the other hand, legal small-scale miners are individuals who possess mining licenses obtained from the Minerals Commission of Ghana, allowing them to operate on specific concessions.

Interest in SSM for gold has been on the rise in Ghana due to the increase in gold price and demand, the dwindling livelihood choices in the country coupled with the general perception that mining is lucrative than farming (Minerals Commission of Ghana, 2021). That said, the sector is confronted with many environmental problems including illegal mining, land degradation, water pollution, heavy metal contamination, all cumulatively impacting the health of people in hosting communities. In response, different governments have attempted to address these problems but with ineffective outcomes. As a result, the Community Mining Scheme (CMS) was set out to be the basket for all these problems in the sector such that community members could have the opportunity to engage in SSM under certain defined code of practice and operational standards. This is a new paradigm in the Ghanaian mining interface which is intended to limit the environmental degradation associated with small-scale miners (Minerals Commission of Ghana, 2021). As at July 2023, a total of 21 community mining schemes were commissioned in Ghana but this increased to 23 as at March 2024 due to the commissioning of two more CMS in Manso Nkwanta and Moseaso in the Amansie West District of the Ashanti region (Ministry of Lands and Natural Resources, 2023). The Schee has the potential of employing between 1000-3000 SSM-illegal miners directly and at least 2000 people indirectly.

Community Mining in Ghana – The Policy and Institutional Frameworks

The Community Mining Scheme (CMS) is a government policy introduced in 2021 to address the problem of illegal mining by promoting responsible, viable, and sustainable small-scale mining activities among local residents in mining communities. The aim is to encourage adherence to the provisions of the Minerals and Mining Acts, 2006 (Act 703). The implementation of the CMS is driven by the recognition that previous efforts to curb illegal small-scale mining, commonly known as "galamsey," have not yielded significant success. The CMS seeks to provide an alternative and more effective approach to tackling this issue. (Minerals Commission of Ghana, 2021).

The objective of the Scheme is to promote meaningful involvement of local communities in small-scale mining (SSM) activities. By doing so, it aims to stimulate job creation and enhance the quality of life within the communities where mining takes place. Additionally, the Scheme seeks to enhance working conditions for miners and mitigate the environmental degradation often associated with SSM operations (Minerals Commission of Ghana, 2021).

Key Features Of The Scheme

According to the Operational Manual of Ghana's Community Mining Scheme (2021), the scheme;

- Must be community-based and operate as small-scale mining in line with sections 81-99 of the Minerals and Mining Act, 2006 (Act 703)
- Be governed by a Code of Practice as stated in Regulations 475 and 515 of the Minerals and Mining Regulation and shall be signed by operators of the Minerals Commission
- Can also be operated by Large Scale Mining Leases in line with the Tributer System

- Shall be supervised by a Community Mining Oversight Committee and other relevant state institutions as also proposed by Lahiri-dutt (2023).

Community Mining in other Jurisdictions

In countries such as the Philippines (Verbrugge 2014a), Indonesia (Spiegel 2012), and Cambodia (Cuddy and Seangly 2015; Spiegel 2016), there has been some level of policy backing for the issuance of community mining licenses and permits (Lahiri-dutt, 2023). In the Asia-Pacific region, Mongolia has been recognized as a leading country in the formalization of small-scale and community mining. This has been achieved through the implementation of specific measures, such as the issuance of licenses that allow individuals and communities to engage in mining activities (Purevjav 2011). In the midst of these few countries, Indonesia appears to be the only country which had had a study documented on community mining though mentions were made of other countries.

In Mongolia for instance, the provision of small-scale and community mining licenses is seen as a step towards formalizing and regulating of the sector. These licenses enable small-scale miners and local communities to legally conduct mining operations within designated areas. By offering these licenses, Mongolia aims to bring informal mining activities into the formal economy. This approach has several potential benefits, including improved oversight and regulation of mining practices, increased revenue generation, and the promotion of sustainable development in the mining sector. Community mining in the Philippines has been a topic of discussion and research due to its impact on local communities and the environment. It is important to note that community mining practices can vary greatly in different regions and circumstances, and reviews or assessments of these practices can offer various perspectives.

Indonesia is one of the countries endowed with many mineral and metal mining natural resources, including building material mining and easily exploited by the public starting from using simple technology to sophisticated technology (Hendrakusumah & Sukmayaningrum, 2020). Community mining has been a prominent sector, particularly in gold mining in Indonesia. It has been associated with various social and environmental challenges, such as inadequate regulations, land conflicts, unsafe working conditions, and environmental degradation. As a result, formalised community mining licence arrangements required significant paperwork, while local authorities applied extremely high surcharges for the permits. Limited to 25 hectares, community mining licensing also limit mobility and flexibility in developing new mine sites, and thus would seem more readily suitable to fixed hard-rock deposits, rather than for more mobile and ephemeral alluvial gold-mining (Lahiri-dutt, 2023). Miners therefore avoid formalization due to these reasons as similar to the case of illegal mining (*galamsey*) in Ghana.

Recently, the Indonesian government has promised 1,500 community mining licences as a step towards greater formalization of the sector. However, the current permitting process for community mining areas and licences in Central Kalimantan is complex, costly and poorly organized, the procedures are not adhered to and formal permits are only used by a few dozen miners. Under Indonesian Law No. 3/2020, the Minister is authorized to issue Community Mining Permits as a measure to address the widespread issue of illegal artisanal and small-scale mining. These permits are granted either to individual local residents, with a maximum area of five hectares, or to cooperatives whose members are local residents, with a maximum area of ten hectares. The duration of these permits is initially ten years, with the possibility of two extensions, each lasting five years (Narendra et al., 2021). The regulation regime of Indonesia is focused on the management of mineral and coal mining activities including guidelines for reclamation and community mining (Nugroho & Yassir, 2017).

Nevertheless, the lack of a clear definition for community mining led to misinterpretation and improper implementation of these regulations. This situation, in turn, gave rise to illegal mining practices and neglected the important process of post-mining reclamation. The presence of weak legal sanctions, particularly against community miners, has resulted in numerous violations where proper reclamation measures were not carried out, resulting in significant damage to the land (Putra, Sulistijorini, & Aryanti, 2017). In Cambodia, community mining has also been a topic of interest, particularly in relation to gemstone and mineral extraction. Reviews or assessments of community mining in Cambodia might explore issues such as resource governance, legal frameworks, social dynamics, and environmental concerns. It is worth noting that the mining sector in Cambodia has undergone significant changes in recent years, and reviews may provide insights into evolving policies and practices (Lahiri-dutt, 2023).

Capacity, Operation and Contribution (COC) of Community Mining Schemes

The Scheme according to the Community Mining Operational Manual (2021) is reserved for Ghanaians only and shall be organized under corporate body arrangements, cooperatives or partnerships and sole proprietors based in the community. The group must demonstrate the capacity to invest at least a capital of GHc 100,000 and must provide basic structures and relevant amenities under the following; General Office, Clinic, Mechanical shop, other facilities and Ore processing area. Valid company registration documents, SSNIT certificate and insurance cover for staff shall be mandatory including the requisite licenses and permits from relevant authorities.

Ghana's Community Mining Scheme is governed by a Code of Practice as stated in Regulations 475 and 515 of the Minerals and Mining Regulation and shall be signed by operators of the Minerals Commission, who serve as the primary implementers of the Scheme supported by a Community Mining Oversight Committee, Environmental Protection Agency, Water Resources Commission, Forestry Commission, Ghana Geological Survey Authority, Metropolitan Municipal District Chief Executives (MMDCEs), and Security Services.

Community and small-scale mining have made enormous contributions to the economy of host countries worldwide by contributing significantly to national revenues and foreign exchange earnings, but pose great issues with safety and the environment that negatively affect people's quality of life (World Bank, 2013; Wilson et al., 2015; Amankwah et al., 2015; Marin et al., 2016; Hilson & McQuilken, 2014). For instance, SSM at Osiri mining village in Migori County, Kenya injects USD 1.9 million per year into the local economy. While at the Migori district level, ASM gold mining generates USD 37 million per year and at the national level USD 225 million per year. Gemstone mining in Taita Taveta generates a production value of USD 120 million per year, of which roughly USD 50 million per year is spent locally. It is estimated that SSM gold and gemstone mining nationwide together generate a foreign exchange influx into the country in the range of USD 500 million per year. In Rwanda it was estimated that small-scale miners contributed approximately USD 39.5 million in the form of expenditures to the local economies in 2015. Similarly, in Uganda in one of its poorest regions, Karamoja, small scale gold mining provides 22,500 miners with an annual income that is significantly above the Gross National Income (GNI). Gold production in Karamoja is conservatively estimated at 845 kg per year, representing a London Bullion Market Association (LBMA) market value of USD 36 million. In Ghana, the growth and significance of the small-scale mining sector cannot be under-emphasized. The sector's contribution to wealth creation, employment and the economy makes it one of the nation's most important livelihood activities, employing an estimated one million people and supporting approximately 4.5 million more. It accounted for 35 per cent of Ghana's total gold production in 2014, contributing almost 1.5 million ounces of gold (McQuilken & Hilson, 2016).

Besides, many SSM workings are said to be deficient in implementation of mine safety requirements, access to better mining equipment, recognition of the hazards inherent in mining as well as the safety regulations (Hilson et al., 2017). The most common methods of mining are therefore; underground mining and surface mining (Gibowicz & Kijko, 2013). The SSM work often takes place underground. Underground mining involves mining of hard rock from usually those containing metals. It places workers at risk of workplace accidents due to rock falls from roofs and side walls, lack of ventilation, entrapment, drowning, gas or dust explosions, gas and fuel fires, workers stumbling/slipping/falling and heavy manual work (Kurnia et al., 2014; Elgstrand et al., 2017; Bansah et al., 2016).

Despite these security concerns, community and small-scale mining are crucial activity in developing countries, especially in regions where economic alternatives are insufficient as evidenced by the situation in China, India, Indonesia, Brazil, Peru, Papua New Guinea, Bolivia, Ecuador, Congo (DRC), Mali, and Ghana, where a sizable population is employed in the SSM sector (Hilson et al., 2014; Steckling et al., 2017). In Indonesia for instance, mining products contribute up to 17% per year of Indonesia's total export value, with coal mining contributing a value of 87.27% (Adriani et al., 2020). This is because the Indonesian coal industry is one of the world's largest coal producers and exporters, while the production of other minerals is developing more slowly (Kramadibrata, 2013; Narendra et al., 2021). Mining contributes around five percent to Indonesia's total GDP (Devi & Prayogo, 2013).

The Inclusiveness, Responsible and Sustainable (IRS) Mining of the Scheme

From the point of theory and in practice, inclusiveness has everything to do with broad involvement of certain subjects/ individuals/ samples in a process or system. Bring this conventional perspective into the subject of community mining which involves different people in its value chain, one cannot under-emphasise the identification of all or most stakeholders within and outside the community encompassing such individuals from the national, regional, district, local and the community. According Innes (2004), the 'realistic set of principles intended to identify, and facilitate agreement between, all possible stakeholders in a project' describes what is termed inclusive planning methods (Dennis, 2011, pp. 2-3; Innes, 2004). Although many governments now mandate some form of consultation with local communities, there is often a lack of clear guidelines regarding the quality and depth of these processes, as well as the qualifications of the personnel responsible for facilitating communication (Weber-Fahr et al., 2001). Inclusiveness requires that individual differences are not only tolerated but also handled with recognition and reverence (Fainstein, 2005).

The concept and the practice of responsible and sustainable mining appear to be closely related. In other words, mining cannot be sustainable if it is not responsibly done in the first place. Thus, responsible mining is a precursor to sustainable mining. The concept of 'responsible mining' refers to the practices adopted by mining companies to mitigate the adverse social and environmental effects of their operations while maximizing economic benefits. This involves measures to minimize pollution, reduce waste, and ensure that local communities derive positive outcomes from the presence of the mine (Narendra et al., 2021; Encore, 2022). Responsible mining is characterized by a recognition of the negative impacts associated with mining and a commitment to addressing these impacts (Responsible Mining Foundation (RMF), 2018).

Various standards have been developed to promote responsible mining practices, such as the International Council on Mining and Metals' (ICMM), the Principles of Sustainable Development, the United Nations' Sustainable Development Goals (SDGs), and the Global Reporting Initiative's (GRI) Standards. These frameworks provide guidelines and benchmarks for mining companies to follow in order to uphold responsible practices in their operations. The Australian Centre for Sustainable Mining Practices (ACSMP) (Laurence, 2011) and the Responsible Mining Foundation (RMF) have also contributed to the development of responsible mining practices and indices which all call for planning (Langefeld & Binder, 2018; Knoche et al., 2019).

By combining the above institutional indices, responsible mining can therefore be achieved through the combination of these factors with other country specific or site-specific practices (Wenig et al., 2005);

- To become more responsible, companies should adopt cleaner production technologies, invest in renewable energy sources, and implement post-mining land reclamation plans (Knoche et al., 2019) to mitigate their ecological footprint (Encore, 2022). Rehabilitation of mines can contribute to the restoration and improvement of riparian areas and vegetation, ultimately leading to healthier hydrological systems (Cane et al., 2015; Knoche et al., 2019).

The concept of sustainable mining actually takes inspiration from the concept of sustainable development. Embracing the principles of sustainable development, responsible mining strives to make a positive impact, create value, and preserve opportunities for future generations, ensuring a range of possibilities without compromising their ability to meet future needs (Langefeld & Binder, 2018). Sustainable mining thus entails minimizing the adverse environmental, social, and governance effects associated with mining activities while ensuring the viability of mining for future generations (Chugh et al., 2023).

Sustainable mining therefore requires planning and conscious efforts (Knoche et al., 2019). Langefeld and Binder (2018) therefore believe that mining industry has a crucial role to play in assuming sustainability in the conduct of mining. Recent studies (Chugh, Schladweiler & Skilbred, 2023; Narendra et al., 2021) also show that sustainable mining can be achieved through; Ensuring communities thrive beyond the life of mine; Restoring the land to its natural state; Combatting illegal mining and its impact and communities and the environment; Lowering CO2 emissions by transitioning to renewable energy; Water conservation; and Reusing mine waste for other purposes (Chugh et al., 2023). By integrating these elements, the mining sector can contribute to a more sustainable and responsible approach that safeguards the welfare of communities and the environment (Woźniak, & Pactwa, 2018; Chugh et al., 2023).

SWOT of the Scheme

SWOT Analysis is a widely used and straightforward framework for assessing the strengths, weaknesses, opportunities, and threats associated with a specific project, business, firm, or industry (Teece, 2018). SWOT Analysis is a strategic planning framework utilized to evaluate an organization, plan, project, or business activity (Teece, 2018; Benzaghta et al., 2021). It is a 'simple but powerful tool for sizing up an organization's resource capabilities and deficiencies, its market opportunities, and the external threats to its future' (Thompson et al., 2007: 97; Afifah & Sopiany, 2017). It serves as a valuable tool for conducting a situation analysis and helps managers identify both internal and external factors affecting the organization (Gürel, 2017). The internal dimension of SWOT Analysis focuses on the strengths and weaknesses of the organization, while the external dimension encompasses the environmental factors, commonly known as opportunities and threats (Rozmi et al., 2018; Wu, 2020).

By employing SWOT analysis, organizations can identify the factors that contribute to achieving their objectives and recognize the challenges and barriers that need to be addressed or minimized to attain desired outcomes (Singh, 2010; Ommani, 2011). Nevertheless, within the context of this study, SWOT analysis will be employed in assessing the strengths, weaknesses, opportunities and threats of the community mining scheme.

Theoretical foundation of the study

The theoretical foundation of the present study is hinged on community development theories. Community development is a collaborative process in which agencies assist community members in identifying and addressing issues that hold significance to them. It aims to empower individuals within the community, fostering a sense of strength and interconnectedness, thereby building more resilient and closely-knit communities (Australian Institute of Family Studies, 2017).

The concept of community development inherently involves a deliberate and purposeful process of bringing about change. The ultimate goal is to enable communities to develop economic, ecological, and social independence and capabilities (Meirinawati, Prabawati & Pradana, 2018; Supriyanto & Subejo, 2004). These understandings in line with community mining thus leads us to the Asset Based Community Development (ABCD) theory which is an approach to community development that focuses on identifying and mobilizing the existing strengths and assets within a community. It emphasizes recognizing and leveraging the skills, knowledge, capacities, and resources that individuals and community organizations possess (McKnight, 2017; Foot & Hopkins, 2009).

Based on these expositions, the Community-Based Development (CBD) Theory and Participatory Planning (PP) Theory have been adopted for the study. Community-based development theory has gained significant attention in various fields, including the mining sector. One fundamental aspect of community-based development theory is the recognition of the importance of community participation in decision-making processes. Very close to the CBD theory is the PP theory. Participatory planning theory is a widely recognized approach to development that involves the active and comprehensive engagement of development agents in making decisions about development processes or projects that impact people's living conditions (Smith, 1973; Maričić, Cvetinović & Jean-Claude, 2018). It provides a conceptual framework for addressing complex planning scenarios involving multiple stakeholders, with the goal of finding mutually beneficial solutions (Yang, Yang, & Ma, 2022).

Linking the theories to the present study, it can be seen that CBD theory emphasizes the importance of involving local communities in decision-making processes and empowering them to actively participate in community mining activities. In addition, the link between participatory planning theory and community mining lies in their shared principles of community engagement, empowerment, and sustainable development. Participatory planning theory advocates for the inclusion of community members in decision-making processes, enabling them to have a voice in shaping development initiatives. Similarly, in community mining, the involvement of local communities is crucial for achieving sustainable outcomes and addressing social, economic, and environmental concerns. This is because collaborative planning with affected stakeholders can help companies to ensure sustainable futures and positive legacies not only when their mining operations cease (Chugh et al., 2023) but when it is even ongoing (Cane et al., 2015; RMF, 2018).

Conceptual Framework of the study

The conceptual foundation (CF) of the present study is presented in Figure 1. It is based on the huge deficit of knowledge in literature on community mining culminating into various knowledge gaps on the subject. These knowledge gaps are premised on three areas of the emerging mining paradigm in Ghana focusing on the Tokwae CMS within the Ashanti region. These include the capacity, operation, and contribution (COC) dimension of the CM, the Inclusiveness, Responsible and Sustainable (IRS) of CM and the Strengths, Weaknesses, Opportunities and Threats (SWOT) of CM.

The framework sought to establish whether the combined capacity, operation, and contribution (COC) of the Tokwae community mining scheme in a mining district of the Ashanti region of Ghana amounts to or goes beyond small-scale mining and satisfy some minimum best practices. The capacity dimension sought to unravel the human resource, technical, financial and natural resource (concession) options of the Tokwae CMS. How these capacities inform the operation of the Scheme in Tokwae becomes important for this study. The type of mining, License regime, Administration, Concessions, Technicians, Safety & Health care provision, Food supply for workers, working durations and days, and Production thus constitute the operational aspect of the Scheme that are empirically worth investigating.

What the CF further sought to unravel is the contribution of the Tokwae CMS towards economic development in relation to Job creation, Household income, Job security, and Job Satisfaction. The contribution of the Scheme to social development in terms of Reduction in social vices, Reduction in hunger, Reduction in child labour and Community Development become important. What the CF also sought to bring to light in this new line of research and knowledge is the extent of the Inclusiveness, Responsibility, and Sustainability (IRS) of the Tokwae CMS. In order for the Scheme to be Inclusive, it ought to have certain level of reception and consideration for Gender, Age, Political affiliation Community participation, Engagement of people outside the community, Involvement of state/government institutions, Involvement of community leaders, and Benefit sharing among relevant stakeholders.

What is further paramount in this present research is the conduct of mining operation by the Scheme within the ambit of responsibleness and Sustainability. As early defined and expatiated in literature, responsible mining involves the awareness of the negative impacts of mining operation and the commitment towards bringing under a certain minimum control such potential impacts in the course of mining operations. On this score, the following parameters were investigated; Mercury pollution, Underground water acidity, Surface water contamination, Waste water discharge, Destruction to farms, Destruction to water bodies, Land degradation, Mining confined to only concession, Provision of personal protective equipment, and Safety of the miners.

How the Tokwae CMS honours sustainable mining practices thus constitute the empirical evidence upon which such conclusions are drawn. This dimension of the conceptualization is founded on the tenets that for the Scheme to be operationally sustainable, it ought to have conscious consideration for the following parameters; Land reclamation, Water reclamation, Waste water discharge, Water acidity, Destruction to farms, and Surface water destruction. That the presence of these parameters, where applicable thus renders the Scheme operational sustainable within the boundary of sustainable mining literature.

What is further significant in the CF is its position of the SWOT assessment of the Scheme, which is measured for the following parameters and indices; **Strength** (Employment and Livelihood, Better income, better working condition); **Weakness** (Partisan politics and exclusion); Opportunities (Could limit illegal mining, National Acceptance), and **Threats** (Surface mining, Land degradations, Change in government & policy). These pieces of empirical evidence cumulatively present the conceptual position of this study towards the contribution to knowledge in this emerging line of research.

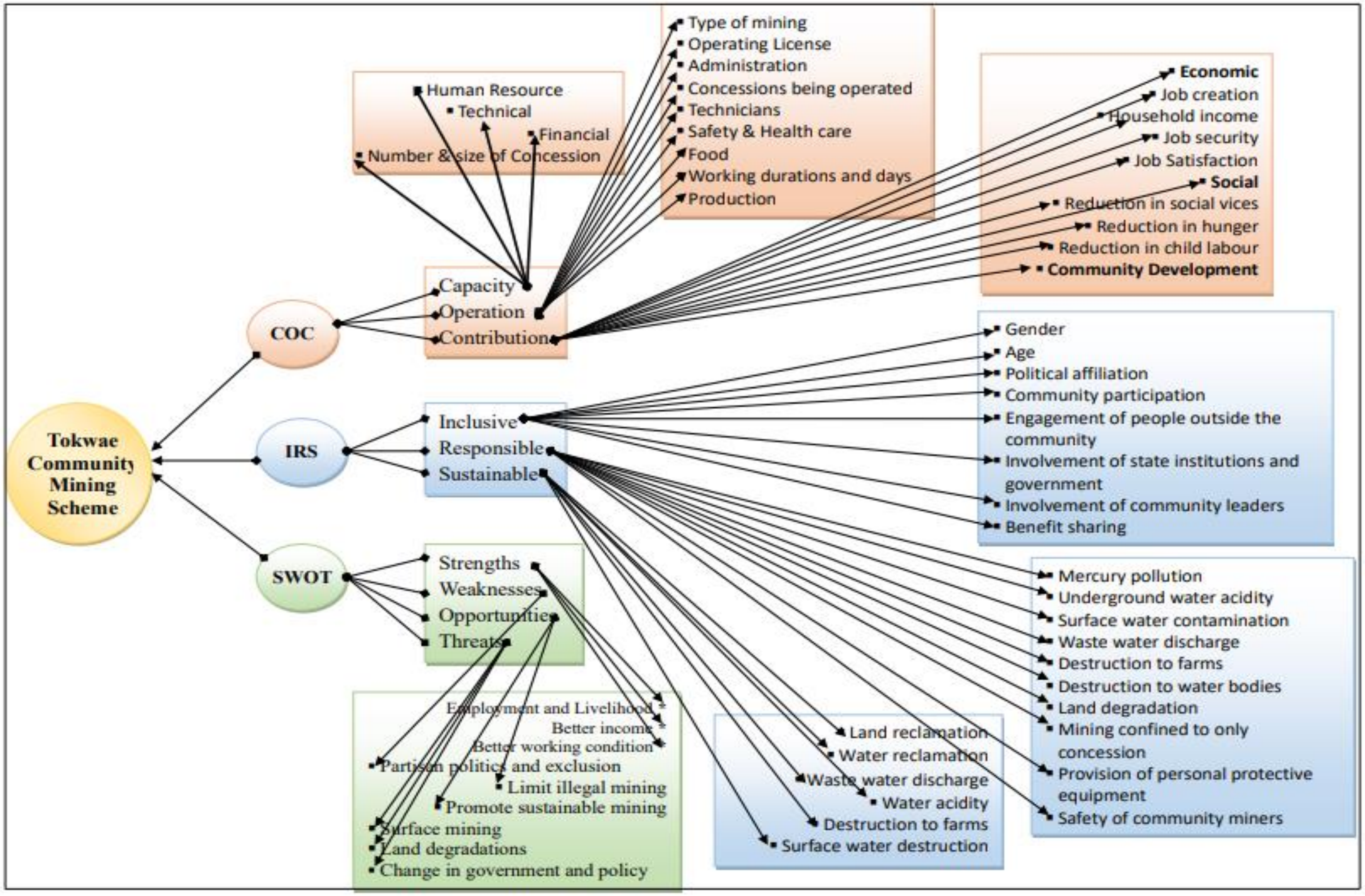

Figure 1: The Conceptualization of the Study
LEGEND: All Arrows and lines are direct connections showing linkages between constructs, proxies and the variables
Source: Authors' Construct, 2024

Study Site Description

The study was conducted in the Asante Akyim South District (Figure 2). The district is situated in the eastern part of the region and is the 'gateway to Ashanti region' from the Eastern and Greater Accra Regions. It covers a total surface area of about 1,153.3 square which form about five percent (5%) of the total area of the Ashanti Region, and 0.5 percent of the total area of the country (Annual Performance Report, 2012). It shares boundaries with the Asante Akim Central Municipal in the North, Asante Akim North District in the Northwest and the Bosome-Freho District in the southwest, all in Ashanti Region. Its neighbours on the eastern border that coincides with the boundary between the Ashanti and Eastern Regions. The district is predominantly made up of farmers in both food and cash crops mainly, cocoa. The land is suitable for food and cash crops like maize, cassava, plantain, cocoa, coffee, oil palm and vegetables. Economic deposits of gold and diamonds have been reported at Banka, Tokwai, Ofoase, Morso, Kurofa, Asankare and the Pra River basin. These mineral deposits are not exploited on large scale however there is the existence of pockets of illegal mining operations in the district. Besides, granite rocks extend from Yawkwei through Juaso, Obogu, and Banso. Currently, two companies are extracting granite chippings for the construction of roads throughout the country (Ghana Statistical Service, 2014).

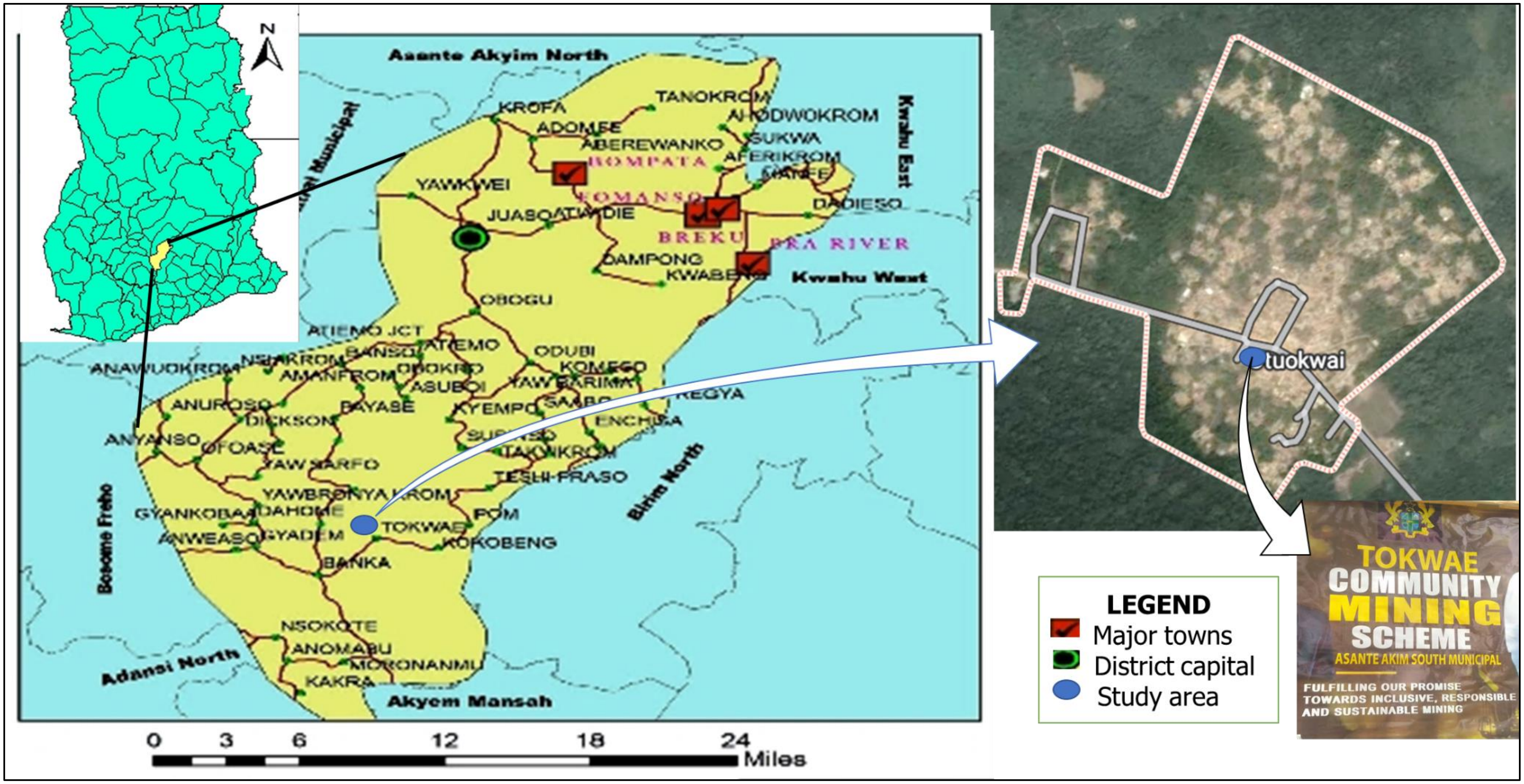

Figure 2: Map of Asante Akyim North showing study site

Source: Authors' Construct, 2024

Methodology

Design

The study made use of the case study research approach and the cross-sectional research design in studying in detail the Tokwae community mining scheme. The case study approach was adopted due to its flexibility with multiple data collection methods, in-depth data exploration and analysis techniques (Creswell, 2007; Bhattacherjee, 2012), empirical nature in investigating a contemporary phenomenon within real-life context (Yin, 2006) thereby providing researchers with opportunities to triangulate data in order to strengthen the research findings and conclusions. As a result, the Tokwae community mining scheme was selected for the present study to understand the COC, IRS and SWOT dimensions of the emerging paradigm in the SSM sector. cross-sectional design was utilized primarily because data for the study were collected from a

Methods

Participants

Given the case study nature of this research, participants that were available on site were interviewed. At the time of data collection, 48 permanent workers and two supervisors of the Tokwae community mining scheme (TCMS) on-site were interviewed as also found in previous studies (Ritchie et al. 2003; Yin, 2006; and Kruger et al. 2008), where between 30–50 respondents were seen to have been ideal for an in-depth analysis or case studies. Five focus groups of ten members (with one group totalling 8 members) were held on the COC, IRS and SWOT aspects of the research. Each interview session lasted about an hour. The two supervisors of the workers were also isolated and interviewed on all aspects of the research for triangulation purposes. Creswell (1998) have also okayed 25 participants to be adequate for phenological studies in arriving at reliable conclusions. The present study therefore purposively selected 50 participants who were all males and permanent staff of the TCMS based on their provision of "relevant and valuable data" (Kelly, 2010: 317). More specifically, expert sampling was operationalized in selecting the 50 participants who were experts with different skills (Patton, 2002; Palinkas et al., 2015) in the mining sector for instance.

Materials

Participatory research tools such as key informant interviews (KIIs), Focus Group Discussion (FDG) and open-ended questions were used to solicit data from the respondents.

Analysis

The study made use of content analysis (Hsieh & Shannon, 2005), recursive abstraction (Polkinghorne & Taylor, 2022), deductive reasoning (Johnson-Laird, 2010), and triangulation (Honorene, 2017) of information to arrive at a solid conclusion. The qualitative data gathered was analyzed using the Dey's three-tier analytical approach of transcription, categorization and interconnection (Dey 1993). Important quotes and themes were developed from the transcripts as evidences to buttress points made by beneficiaries. COC, IRS and SWOT analyses were also performed to understand the CMS within the Tokwae community as illustrated in Fig 1 and detailed in Table 1.

COC ⇨ IRS ⇨ SWOT

COC Measurement and Analysis

Within the COC analysis, four indices/ proxies were developed to measure the **Capacity** of the CMS (i.e. directors, managers, permanent staff and temporal staff) whilst nine indices and proxies were developed to measure the **Operation** of the CMS (i.e. Number of CM schemes in the district, License regime, Administration, Type of mining, Concessions, Technicians, Safety &Health care, Food, and Working days). Seven indices and proxies were also developed to measure the **Contribution** of the CMS namely, Job creation, Household income, Job security, Job Satisfaction, Graded Road, Reduction in Social vices, Reduction in hunger.

IRS Measurement and Analysis

In addition, five indices and proxies were developed to measure the **Inclusiveness** variable namely; Gender, Age, Political affiliation, Community participation, and Engagement of people outside the community. This was followed by eight indices and proxies used to measure the **Responsible mining** variable namely; Mercury pollution, Underground water acidity, Surface water contamination, Waste water discharge, Destruction to farms, Destruction to water bodies, Limited land degradation, and Mining Confined to concession. Besides, six indices and proxies were developed to measure the **Sustainable mining** variable of the CMS namely; Land reclamation, Water reclamation, Waste water discharge, Water acidity, Destruction to farms, and Destruction to surface water.

SWOT Measurement and Analysis

SWOT (Strengths, Weaknesses, Opportunities and Threats) measurement was done during and after the field interviews and data collections. The SWOT analysis was done using recursive abstraction from the data collected and field notes.

Table 1: Parameters, Proxies and Measurement

COC INDICES/ PROXIES			
No.	**Capacity**	**Operation**	**Contribution**
1	Directors	Number of CM schemes in the district	Job creation
2	Managers	License regime	Household income
3	Permanent staff	Administration	Job security
4	Casual staff	Type of mining	Job Satisfaction
5		Concessions	Graded road
6		Technicians	Social vices
7		Safety &Health care	Reduction in hunger
8		Food	
9		Working days	
IRS MINING INDICES/ PROXIES			
No.	**Inclusiveness**	**Responsible mining**	**Sustainable Mining**
1	Gender	Mercury pollution	Land reclamation
2	Age	Underground water acidity	Water reclamation
3	Political affiliation	Surface water contamination	Waste water discharge

4	Community participation	Waste water discharge		Water acidity
5	Engagement of people outside the community	Destruction to farms		Destruction to farms
6		Destruction to water bodies		Destruction to surface water
7		Limited land degradation		
8		Mining Confined to concession		
SWOT INDICES/ PROXIES				
No.	**Strengths**	**Weaknesses**	**Opportunities**	**Threats**
	▪ Able to absorb several hundreds of illegal SSM miners at the community level.	▪ The scheme is being politicized. ▪ Lack of land reclamation though embedded in their operational manual	▪ Has the potential of reducing the spreading effect of SSM illegal mining ▪ Has the potential of reducing environmental destructions, deforestations, farm losses, et al.,	▪ Lack of access to land for concession. ▪ Land litigation in some communities. ▪ Rejection of the scheme in some communities

Source: Authors' Construct, 2024

Results

The COC Analysis of Tokwai Community Mining Scheme

Capacity

- Human resource
  The Scheme has 50 permanent staff (all men), and 2000 (majority being men) temporal workers during peak explorations.

- Technical
  The scheme has one Director, one Deputy Director, two Supervisors, a Public Relations Officer, Engineers in charge of Mining, Electricals, and Maintenance. The scheme has a clinic for free treatment for all workers. It has a rest room for staff, kitchen where two chefs cook for all the permanent staff daily. The food is sent to the site by the Chef when ready. The scheme has extended a step-down electricity from the mains to the yard and to the main site for their operations. Two moveable mercury-free plants are available in addition to the one moveable Compressor for drilling holes for blasting purposes. Plates 1 and 2 depict the mercury free processing machines/plants used for mining operations at TCMS and the buildings consisting of workers' clinic, kitchen and rest rooms in an open yard for the Scheme. /

Plate 1: Mercury free rock processing plant Plate 2: Clinic, kitchen, office yard

- Financial
  The permanent staff are on payment plans such that at least GHc 3000 is what one receives at minimum. That minimum amount worked out by the number of permanent staff alone amounts to GHc 150,000 per month which is equivalent to USD 1154 per month. This amount plus the operational expenses on food, health care, utilities, fuel and others, point to the financial capacity of the Community Mining Schemes – in this case, the Tokwai CMS.

- Concession and regulatory compliance
  The Scheme has two concessions each totalling 25 acres, put together, amounting to 50 acres. This however appears to be in contravention with the concession benchmark value set out in the Operational Manual of the Scheme. That said, prospecting works are ongoing on these concessions including blasting activities.

Operations

Table 2: Operational parameters of the Tokwai CMS

Indices/ proxies	Results
Number of CM schemes in the district	One, Tokwai
Type of mining for the Scheme	Underground with prospecting for surface explorations subject to full surface operations based on prospecting outcomes.
Operational License	Prospecting in wait for main mining license before end of 2023
Administration and structure	Government, State institutions (FC, LC, EPA, MC, WRC), Directors, Supervisors, Public Relations Officers (PROs)
Concessions	Two concessions totaling 50 acres, each being 25 acres
Technicians	Maintenance, Electrical, Mining, Explosives, Blasters
Safety & Health care	Working gears (boots, head lamps, electricity, ventilators, water pumps, and free clinic
Food	Two male Chefs who cook for the permanent workers daily

Source: Fieldwork, August 2023

Plate 3: One of the underground mining pits at the site

Plate 4: A section of the permanent staff

Source: Fieldwork, 2023

Contributions

Table 3: Contribution parameters of the Tokwai CMS

Proxies	**Results**	
Economic	Job creation	There are a total of 50 permanent staff and about 2000 temporal workers of the Scheme. This amount to job creation for the youth in and around Tokwai community
	Household income	The job creation thus translates into access to household income for the workers
	Job security	There seem to be production prospects of the Tokwai CMS which thus amounts to job security
	Job Satisfaction	All the respondents were satisfied with their employment at the TCMS.
	Local economy Development	The overall effect on the community is seen in terms of developing housing infrastructure and improved housing conditions, availability of food, and children of school going age going to school.
Social	Reduction in social vices	Reduction in community vices in the form of theft, and gambling have been mentioned.
	Reduction in hunger	Hunger at the household level used to be a common phenomenon at the minor cocoa season but has been reduced due to the TCMS
	Reduction in child labour	Previously, children are allowed to take part in *galamsey* and artisanal mining but community mining scheme excludes children

Source: Fieldwork, August 2023

The IRS Analysis of Tokwai Community Mining Scheme

Table 4: Inclusiveness parameters of the Tokwai CMS

Proxies	**Inclusiveness**
Gender	All participants were men. The Scheme excludes women's engagement.
Age	Age bracket of workers fall between 20-50 years. Individuals below this range (teenagers and minors) and above (adults or elderly) are excluded.
Political affiliation	Members of other political parties are part of the scheme.
Community participation and recognition of indigenous rights	Community participation is above average as majority of the temporal workers are indigenes of Tokwai.
Involvement of community leaders	Community leaders were involved at the initial stages of the launching of the Scheme at Tokwai during community consultation.
Engagement of people outside the community	Most the of the permanent staff were from other communities outside Tokwai.
Involvement of state institutions	The following government agencies are deeply involved in the activities of the Scheme; LC, FC, WRC, MC and EPA
Indices/ proxies	**Responsible Mining**
Mercury pollution	Not seen due to the use of mercury free plants
Surface water contamination	Negligible

Waste water discharge	Discharged into cocoa farms on site
Destruction to farms	Nil
Destruction to water bodies	Nil
Land degradation	Negligible
Mining confined to only concession	Yes. No incidence of haphazard mining as is the case in *galamsey*
Provision of personal protective equipment	Yes. Head lamps, boots, tools, etc., are provided for the miners
Safety of community miners	This is taken into consideration and aided by the provision of clinic for the workers.
Indices/ proxies	**Sustainable Mining**
Land reclamation	Nil
Waste water discharge	Pumped from the underground pit and discharged into farms nearby
Destruction to farms	Nil
Destruction to surface water	Nil

Source: Fieldwork, August 2023

SWOT Analysis of Tokwai Community Mining Scheme

Table 5: SWOT analysis of the scheme

SWOT Results				
	Strengths	**Weaknesses**	**Opportunities**	**Threats**
1	Independent operational manual and Administration of the Scheme towards smooth implementation	Partisan politics	Could limit SSM illegal mining by absorbing large numbers of illegal miners	Community agitations and rejection of the scheme in certain areas over environmental destruction concerns.
2	Job creation for the youth and able to absorb large labour force and illegal miners	Conflicts with existing mining concessions for mining companies	Could offer solutions for responsible in the SSM sector	The Scheme could face dissolution due to change in national government
3	Household Income for the youth	Lack of available mining lands	Could offer solutions for sustainable SSM	Regulatory conflicts with Minerals Commission due to political interference
4	Combined Technicians	Lack of sustainability plans	Could have national acceptance if best practices are followed	Could face agitation from land owners and custodians on royalty payments.
5	Better Safety & working conditions	Lack of post-mining land reclamation plans	Technological Advancements	Could be seen as another form of illegal mining if best

				mining practices are compromised
6	Provision of mercury free plants		Could serve as a road map and a country-level example for handling illegal mining	Could trespass into forest reserves and restricted lands given political backing
7	Potential to absorb large number of SSM illegal mining cohorts.		Government support and replication in other communities	
8	No pollution to water bodies and destruction of farms		Could limit land degradation.	
9	No haphazard mining approach i.e. mining is controlled and restricted		Could have positive influence on the SDGs	
10	Supports responsible mining		Could limit the mercury pollution in the environment due to the use of mercury-free plants	
11	Promotes sustainable mining and environmental sustainability			

Source: Fieldwork, August 2023

Discussion

The Community Mining Scheme has demonstrated the capacity of employment creation for both men and women within or near mining communities. One major capacity of the Scheme is its ability to engage a few thousands of SSM-illegal miners and offer them better working conditions with improved technologies. These technologies thus limit the health impacts on the workers and the environment. He organised nature of the Scheme offers permanent workers' salaries and regular income. The Scheme has been designed to operate with an industrial set up so as to maximize the work output of workers. This can be seen in terms of the services of Chefs or cooks provided to take care of the meals of the workers. Provision of mining clinics and first aids tool kits to manage accidents and injuries at sites thus makes the operation of the Scheme unique. Trained mining technicians such as welders, mechanics, and electricians for instance, thus make the scheme operationally attractable to SSM-illegal miners and the unemployed youths at the community levels. This therefore explains the large numbers of the illegal miners on the Scheme. What is further promising about the operation of the Scheme is its ability to send electricity from the national grid to the various sites as to facilitate the operations. This is as a result of government support to make the Scheme succeed. Plate 3 and 4 show the use of electricity at one of the community mining sites being used to power the water pumps and charge the cell phones of the workers. These facilities and benefits are not possible with the SSM illegal mining as some of the miners have indicated as follows;

> *"Under the community mining scheme, we are assured of regular income, free medical care, feeding, no buying of fuels, and so on. We are not under pressure and do not fear the police who previously chase us for illegal mining and cease our excavators and machines. There is nothing like taskforces chasing community miners and so it is far better than working as an illegal miner.." [FGD, SSM illegal miners, August 2023]*

The major contributions of the community mining apart from job provision for the youth household income. If one community scheme could employ more than 2000 people, then the replication of the scheme in other mining communities has implication for SDGs. For instance, the haphazard nature typical of illegal mining that has been ranked as the major contributor land degradation, environmental degradation, water pollution, and farms destruction, will thus be reduced as mining is now confined under the Scheme. This will therefore limit the effect on poverty (SGD 1), hunger (SDG 2), good health (SDG 3), clean water and sanitation (SDG 6), good jobs and economic growth (SDG 8), and Life on land (SDG 15). Job security and job satisfaction for workers cannot be underemphasized. These have therefore led to the reduction in social vices the community levels. The Scheme is gender inclusive though men dominate the scheme as conventional in the mining sector. Political diversity is one inclusive aspect of the scheme that goes beyond the polarized partisan nature of doing business with the government in power. Community participation and engagement of individuals outside of the communities on the scheme thus makes it inclusive. That said, no disabled persons have been enrolled on the scheme.

The Scheme's capacity to comply with regulations and some best practices were observed in their discharge of waste water, mercury usage, and safety regulations. There was no evidence of destruction to surface water bodies or discharging waste/contaminated water into downstream. There was no evidence of destruction to farms, and vegetations. This therefore makes the scheme responsible. The scheme subscribes to a code of practice that has provision on land reclamation in its operational manual which makes it sustainable though yet to carry out land reclamation. The TCMS also makes use of underground water without trespassing into surface water as part of its sustainability mechanism.

SWOT results thus show that the strengths of Ghana's community mining scheme outweigh its weaknesses whilst the opportunities also outweigh the threats. These findings show that the scheme as an emerging paradigm has prospects for eradicating Ghana's problem of SSM illegal mining. The analysis also means that the Scheme is a panacea for the country's major problem of land degradation and its associated effects in the environment. The stand-alone operational manual for the scheme serves as the roadmap for the administration of the scheme and a benchmark against which it can assessed. The manual was developed because community is new in Ghana and has to be made to fit into existing mining laws. Because, the scheme was a novel creation of the government of Ghana, it was made to find space within the already existing legal and institutional frameworks but there seemed to be a political drive and the spearheading of the administration of the scheme in conflict with the mandate of the Minerals Commission in some cases. One major strength of the scheme is its ability to engage several thousands of SSM illegal mining cohorts across different communities, particularly those heavily prone to illegal mining. One community mining scheme could employ a few thousands of illegal miners. This thus serves as the assurance for household income. The scheme offers better working conditions under safe and controlled concession with improved technologies such Mercury-free plants, crushers, gold catcher, generators and electricity, security, cooks, et al.

So far, the operation of the scheme has not polluted waterbodies, not destroyed farms, and spilled mercury, washed loads in the rivers as typical of the illegal mining activities in Ghana. This paradigm shift thus makes the scheme environmentally friendly, and responsible. In the midst of these substantial strengths, there are certain core weaknesses that could compromise the sustainability of the scheme in Ghana. These include partisan politics which could trigger the exclusion of illegal miners appearing to have affiliations with non-ruling government. There are also reported cases of conflicts with existing mining concessions belonging to resident mining companies in the communities. A typical case is the community mining scheme in Asuadei within the Amansie South District that faced termination over land litigation with Asanko Gold Mine, a large-scale mining company. That said, availability of lands for community mining concessions (25.2 acres) appears to be lacking in some hotspot mining communities which has resulted in the shifting of the scheme to different communities and their implementation without due process and formalization/ licensing by the Minerals Commission as is the case in the Nsiana community in the Amansie West District in the Ashanti region of Ghana. The implementation of the Scheme is spearheaded by an ad hoc Committee set up by government. Another shortfall of the scheme has to do with the question of sustainability plan and post-mining land reclamation plan (Hamenoo, Baah-Ennuhm & King, forthcoming). The Scheme seemed to have no sustainability and reclamation plans in place. Though, land reclamation is placed in the Scheme's Operational Manual, there is yet to be one pot-mining land reclamation attributable to the Scheme (Hamenoo, Baah-Ennuhm & King, forthcoming).

The opportunities of the Scheme outweigh the Threats it poses to the country. As shown in existing and current literature (Aryee et al., 2013; Obeng et al., 2015; Ghana Chamber of Mines, 2015; Kuffour, Tiimub, & Agyapong, 2018; Ministry of Lands and Natural Resources, 2017; Multilateral Mining Integrated Project, 2017; Frimpong-Boateng, 2021; Hamenoo, Baah-Ennuhm & King, forthcoming). The Scheme has by far demonstrated the capacity of absorbing several thousands of SSM illegal miners within Ghana's hotspot mining areas. This has the potential of attracting other mining communities in the country to follow same in response to curbing the increasing impact on the land, farms, waterbodies and vegetation. The consequence is that responsible and sustainable mining can be better achieved by the Scheme within the Ghanaian SSM interface. The Scheme's provision of improved technologies such the Mercury-free plants and rock crushers for instance are indicative of its potential for continuous use of improved technology. The implication is that more environmentally friendly mining technologies i.e. provision of Mercury-free plants will be imported into the country towards the mining operation of the scheme. This could provide business for individual importers and also make Ghana market for such environmentally-friendly mining equipment. The overall effect is that Mercury spillage in the environment with its associated health hazards and impacts will be mitigated as a result of the Scheme. The corresponding effect these turn-out have on land and environmentally linked SDGs are promising. The scheme is therefore at the heart of the current government of Ghana though could face audit and re-structuring due to change in government.

The Scheme is however faced with community revolt and rejection in some mining areas in Ghana on the grounds that it the Scheme is not different from illegal mining and could lead to the problem of land and environmental degradation confronting the country. This turn-out is also being crusaded by the land owners and chiefs who serve as custodians of the lands in Ghana. What this means is that community leaders are becoming very concerned about the destruction of their lands due to mining and the non-practice of post-mining reclamation. This emerging observation could constrain the replication of the Scheme in other mining areas in the country. The scheme given its political undertone, could be trespass into protected areas and forest reserves when communities fail to offer lands for the Scheme.

Conclusion and Policy Recommendation

Community mining schemes have the capacity of job creation for thousands of Ghanaian youths within mining communities which has the prospects of eradicating illegal mining in the country given its modus operandi and incentives. The scheme thus has the potential of reducing mining-related land degradation in Ghana. The implication this paradigm has on the SDGs, responsible and sustainable mining cannot be underemphasised. The scheme's contribution to environmental management, social governance, and sustainable development in Ghana is getting momentum. The replication of the scheme in other mining communities Ghana therefore needs a scaling-up so as to double the gains so far seen. This paradigm thus serves as case study for other mining jurisdiction in Africa confronted with the problem of illegal small-scale mining. The scheme's evidence of inclusiveness, responsible and sustainable mining practices thus makes it suitable for replication in other mining jurisdictions in Africa towards sustainable development. That said, the strength and opportunities of the scheme far outweigh its weaknesses and threats, making it suitable for replication in other mining jurisdictions.

Recommendation

Given the prospects of the scheme, there is still the need to continuously engage and involve mining communities before rolling it out the scheme as the success of any development agenda require the participation of the primary stakeholders. The scheme needed replication in other mining jurisdiction in Africa towards reducing the problem of illegal small-scale mining, environmental degradation and the regional efforts of achieving the SDGs.

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