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IMPLEMENTATION OF SUSTAINABLE CONSTRUCTION FOR SUSTAINABLE DEVELOPMENT: AN EMPIRICAL ANALYSIS

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ABSTRACT

The construction industry plays a crucial role in achieving sustainable development goals, as it significantly impacts the environment, economy, and social well-being. This research paper aims to explore the elements of environmental-friendly Green Construction, Sustainable Construction, and government policies related to Sustainable Development as well as the gap between the conceptualization and implementation of these policies in implementation of construction projects. The study proposes a conceptual model to assess the relationship among Green Construction, Sustainable Construction, and the Implementation of Government Policies, and their impact on Sustainable Development. An empirical analysis of the proposed model is undertaken to validate the relationships and provide a framework for the acceptance and implementation of sustainable construction for sustainable development.

A few clusters of techniques for Sustainable Development were identified by the research, including Green Construction, Sustainable Construction, and Sustainable Construction Implementation. Regulations and policies are designed to support the key strategies, which included Sustainable Building Design, Government Interest, Environmental Consideration, and Efficient Construction Management. The most popular and successful method for improving environmental stewardship in construction for sustainable development in India was found to be the implementation of sustainable construction.

Key words:
sustainable construction, green construction, government policies, sustainable development, construction industry

1. INTRODUCTION

Construction industry is although vital for the world economy being a major contributor, it also has a big effect on the environment (1). Within the building industry, sustainable development has become a critical issue, as it can balance human needs with environmental protection and economic growth. Existing literatures suggest that the construction industry can contribute to sustainable development through the adoption of sustainable construction practices (2).

Sustainable construction is a holistic approach that considers the social, economic, and environmental dimensions of building projects. It encompasses the use of environmentally-friendly materials, energy-efficient technologies, and sustainable supply chain management (3). There are large number of empirical researches that have explored the elements affecting the implementation of environmentally friendly building practices, such as government policies, technological capabilities, and employee attitudes (1, 2, 4). These studied have highlighted the importance of alignment of government policies with practical implementation within the building and construction sectors as a must to accomplish sustainable development (1, 2, 3). There have been growth of literatures on sustainable construction, but there is still a knowledge vacuum about how the concept of green construction and sustainable construction is implemented within construction projects and its impact on sustainable development. The conceptual framework for sustainable construction is well-established, there is a need to better understand the relationship among the different factors and their influence on sustainable development outcomes. It creates the need for a comprehensive evaluation of sustainable construction practices and their real-world implementation.

2. LITERATURE REVIEW

2.1 Green Construction

The term "sustainable constructions" refers to methods used by developers and builders to any construction project which is designed to support sustainability, developed, built with materials and resources that is in harmony of the environment, and construction managed efficiently with better quality to lessen harmful environmental consequences and eventually negative impacts to the general population and the planet. Green building also entails developing and applying prototypes that are healthier and more resource-efficient for operations and maintenance, restoration, and for disassembly when the service life of the structures come to end. Thus, environmentally friendly building practices must be promoted globally, with sustainable construction serving as the cornerstone. All infrastructures and buildings built with green construction philosophy is often sustainable and seeks to mitigate the damaging consequences of development on the environment overall.

The five fundamental components of green building design are: resource and material conservation, energy-saving measures, water quality and the environment quality and conservation. Factors showing favorable impact on green construction performance -

H1: Efficient Construction Management (ECM) may have a favorable impact on construction companies' green construction performance (GCP).

H2: Effective Quality Management in Construction (QMC) may have a favorable impact on construction companies' green construction performance (GCP).

H3: Material and Resources Management (MRM) may have a favorable impact on construction companies' green construction performance (GCP).

H4: Sustainable Building Design (SBD) may have a favorable impact on construction companies' green construction performance (GCP).

2.2 Sustainable Construction

Green building aims to focus environment through use of recyclable construction materials, reduced construction waste, minimized both operational energy and embodied energy, efficient construction practices, however, for the sustainability, the environmentally friendly building in addition to the environment, it takes into account all the "three sustainable pillars - Planet/Environment, People/ social as well as Profit/Economy" (British Assessment). The sustainability of people and society, the economy, and the environment are said to be the trinity of environmentally friendly building practices. The primary goal of eco-friendly construction is to produce a wholesome setting by using materials and resources wisely and by designing exceptional, sustainable buildings (5).

Sustainable construction will aim to reduce energy waste for the built structure through innovative design such as high rating of thermal insulation to reduce heat loss for the construction in cold area, orientation and layout of the structure in order to optimize solar heating within the building. Incorporation into the building design basic components such as LED lighting, smart meters, and water usage monitors can be help in conservation of energy and support environment. Similarly, sustainable construction design will take into consideration for the fresh air ventilation and air quality monitoring, appropriate selection of construction materials producing thermal insulation can provide occupants with benefits and improved healthy lifestyle.

Study carried out on Lifecycle Cost Analysis (LCA) suggest construction cost for the conventional construction practices appear cheaper initially compared to the green construction practices as the green construction requires high energy efficient construction and innovative materials, advanced construction equipment and techniques, and skilled workforce. Added construction cost for green construction stems from energy efficient construction, durable construction materials, higher insulation consideration for the cold regions, high efficiency glass in windows, recyclable materials incorporation, energy efficient lighting etc. However, LCA suggest that sustainable construction cost at the conclusion of the project's life is more cost effective compared to the conventional construction. It has benefits for the occupant/owner through cost saving in energy utilization throughout the project life, and it offers better healthy living condition. To conclude, sustainable construction addresses all challenging issues and keeps the balance among - the planet, people, and profit—the three pillars of sustainability!

H5: Employees Skills, Training and Attitude (ESTA) may have a favorable influence on the performance of sustainable construction (SCP).

H6: Technological capabilities and Innovation (TCI) may have a favorable influence on the performance of sustainable construction (SCP).

H7: Supply Chain Capabilities (SCC) may have a favorable influence on the performance of sustainable construction (SCP).

H8: Environmental Consideration (ENC) may have a favorable influence on the performance of sustainable construction (SCP).

2.3 Implementation of Sustainable Construction

Meeting and fulfilling the demands of the current generations' development needs without sacrificing the capacity of those for the future generations, is approach to the sustainable construction (6). Because the construction industry is client-driven, clients' adoption of sustainable construction practices and level of awareness are critical for its implementation. With increased awareness of green construction, the key stakeholders in the construction industry are adopting sustainable principles into construction practice (7).

Achieving a harmony among the factors – the society, the economy, and the environment is a success key for the sustainable development that includes providing reasonably priced, secure, and healthy housing (8). Sev, A (16) discovered that the social, environmental, and financial facets of sustainable development—can be used to categorize sustainable construction.

Effective actions and the dedication of all stakeholders as the community as users, government agencies, and service providers must be contributing in construction projects for the successfully implementation of sustainability principles in environmentally friendly building practices. Environmental sustainable development construction requires a holistic thinking and decision making and more innovative solutions that enhance sustainability and result in mutually benefiting outcomes for all stakeholders (14). Government agencies play a significant part in coordination of the construction sector for creating guidelines and procedures around sustainable construction and to be complied by the construction companies for the effective implementation. Eco-friendly and smart buildings are the result of sustainable environment policies in construction sector which is widely responsible for consumption of natural resources and for environment pollution (15). It also demands researches and technological progress in producing more recyclable and innovative construction materials and design for energy efficiency (9); waste handling technique and strategy (10); dedication for sustainable ideas integration into new modes of operations, awareness and education, in order to get better stakeholders' motivation and application of environmentally friendly building techniques (9).

H9: Perception and awareness (PAA) may have a big influence on how sustainable construction is implemented (ISC).

H10: Government Interest, Regulations and Policies (GIRP) may have a big influence on how sustainable construction is implemented (ISC)

H11: Material, Resources and Technologies (MRT) may have a big influence on how sustainable construction is implemented (ISC).

H12: Socio-cultural Belief (SCB) may have a big influence on how sustainable construction is implemented (ISC).

H13: Economic Perspective (ECP) may have a significant impact on Implementation of sustainable construction (ISC).

H14: Green Construction Performance (GCP) has a major effect on Sustainable Development (SD).
H15: Sustainable Construction Performance (SCP) has a significant impact on Sustainable Development (SD).
H16: Implementation of Sustainable Construction (ISC) plays a major role in Sustainable Development (SD).

3. RESEARCH OBJECTIVE

1. To study the sustainable development in general and in the relation to sustainable and environmental friendly green construction
2. To identify the elements of environmental friendly green construction, sustainable construction and government policies in relation with Sustainable development.
3. To study the gap in between how the concept of sustainable construction is set out in government policies and other advisory documents and its implementation within a construction project environment.
4. To put out a conceptual framework evaluating the connection between green construction, sustainable construction and implementation of government policies and their impact on sustainable development
5. To conduct an empirical examination of the suggested framework for determining the correlation between green construction, sustainable construction and implementation of government policies and their impact on sustainable development
6. To propose a validated model for acceptance the application of environmentally friendly building practices for sustainable development.

4. CONCEPTUAL FRAMEWORK

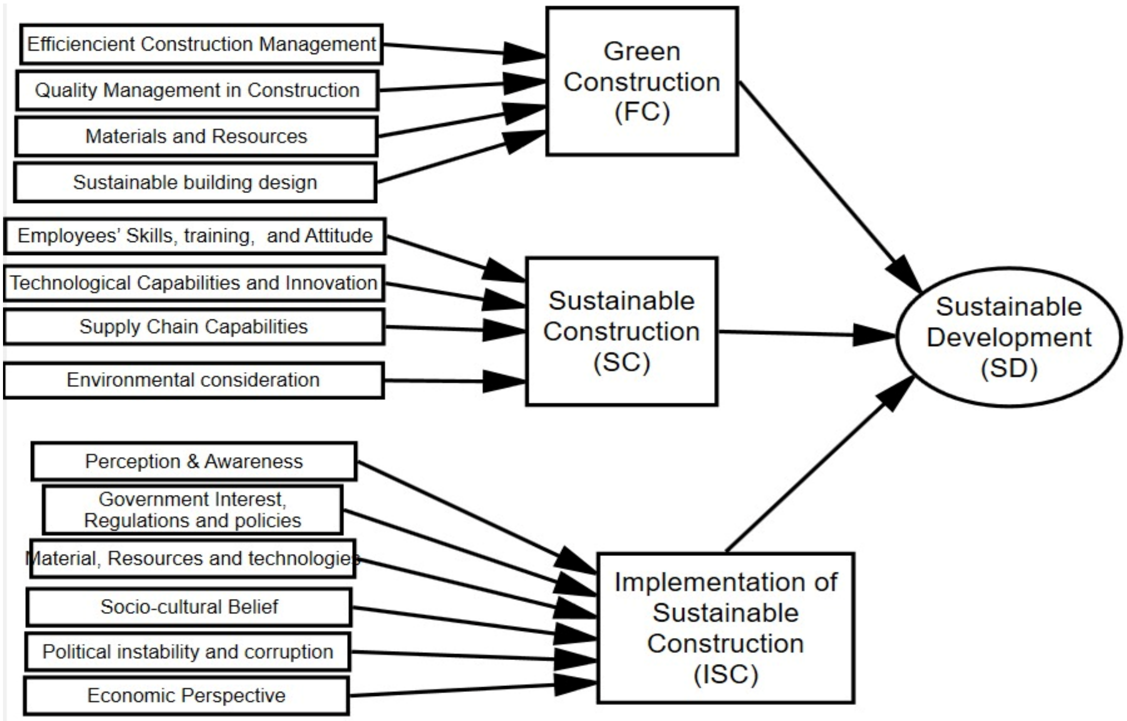

Figure1: Proposed model showing the relationship between influencing and dependent factors

5. RESEARCH METHODOLOGY

5.1 Research Design

The approach used for this study, which shows the factors and influence processes involved in this investigation, is described in Figure 1. The purpose of the literature review stage was to find gaps, breaks, and conflicts of interest with respect to sustainability. To fulfill the objective of this study and to setup a strong theoretical basis, a thorough and critical evaluation of previous literature undertakings becomes important with respect to the green construction and sustainable development in relation to Indian construction sector. It helps in establishing a reference for the associated problems, motivators, benefits, and obstacles in successful implementation of sustainable construction practices. Depending on the characteristics under consideration, relevant questionnaires for data collection were created after these parameters were identified. Variables were identified that can have an impact on "green construction (GC), sustainable construction (SC), Implementation of sustainable construction in India, and overall sustainable development (SD).

5.2 Population and Sample

Questionnaires were distributed to consultants, engineers, managers, contractors, architects, and construction personnel in order to gather data from different construction organizations. In all 451 respondents were sent the questionnaire. The questionnaire was e-mailed to various target respondents in Delhi-NCR. Given the apprehensions of an online survey, adequate measures were taken to ensure the genuineness of the respondent. Filling personal/contact details were made mandatory and were randomly cross verified for almost all of the responses received online. Ultimately, 412 of the 419 surveys that were received were determined to be legitimate for analysis.

5.3 Reliability and Validity

Cronbach's alpha, a reliability coefficient was used to evaluate internal consistency. To validate the constructs, EFA was used, taking into account the specifics of this investigation. Principal Component Analysis (PCA) and Principal Factor Analysis (PFA) are the two fundamental EFA models that are currently in use. The most popular type of factor analysis, principal component analysis (PCA), summarizes the majority of the original data (variance) into the fewest possible factors in order to make predictions. In this study, the EFA was carried out first for conforming constructs using a PCA model.

5.4 Data Analysis

Utilizing information from the questionnaire, EFA and Reliability Analysis were carried out using SPSS 20 software to empirically evaluate the proposed model of construction equipment productivity variables. SPSS is an efficient application for statistical data analysis for many researchers.

6. RESEARCH ANALYSIS AND RESULTS

6.1. Demographic Profile

The survey instruments were disseminated via databases of building industry entities. Several aspects were taken into consideration, including the respondents' prior expertise in construction industry, to ensure the accuracy and consistency of the questionnaire replies. Of the 450 surveys that were distributed, 412 of them (91.56%) were valid because some surveys responses had incomplete answers or inaccurate information. The job experience of the respondents and their positions, however, validated the accuracy and dependability of the data despite the sample size being rather small. The study's a background check was used to choose the volunteers knowledge and expertise. Experts that wish to contribute to the discussion might be chosen based on factors such as gender, experience, and designation. Table-1 provides socio-demographic details about the individuals. Of the 412 respondents, there were significantly more men (351, 85.2%) than women (61, 14.6%); the majority of the men, 176 (42.7%) had been professional contractors and were having experience of more than 11-15 years (153, 37.1%).

Table -1 Descriptive Statistics of Demographic Profile

		Frequency	Valid %
Gender profile	Male	351	85.2
	Female	61	14.6
Designation	Project Managers	50	12.1
	Engineers	114	27.7

	Contractors	176	42.7
	Other	72	17.5
Experience (years)	<5	90	21.8
	5-10	143	34.7
	11-15	153	37.1
	>15	26	6.3

6.2. Exploratory Factor Analysis

For conforming entities, an exploratory factor analysis (EFA) using the PCA approach was done. The EFA technique was used to establish validity. It was determined that factor loadings >0.40 and >0.30, respectively, satisfied the minimal level. A judicious parameter was used to confirm the factor loadings. On the other hand, factor loading values of less than 0.30 were not taken into consideration, but values of 0.50 or more are regarded as highly significant. For this study, a factor loading of at least 0.50 serves as the cutoff point.

The significance of the KMO factor analysis for the data is shown by values between 0.5 and 1.0. The outcomes of Bartlett's Sphericity test reveal that the components of the variables are correlated. The degree of relevance indicates the test's outcome. A significant correlation between the variables is probably present if the numbers are less than 0.05. If the value is more than or equal to 0.10, factor analysis cannot be carried out on the data. Table -2 is suitable for the information given, taking into account the findings of the factor analysis.

Table- 2 Results of Exploratory Factor Analysis

Variable	Statement	Factor loadings	KMO Measure of Sample Adequacy (>0.5)	Bartlett's Test of Sphericity		Items confirmed	Items dropped	Cum % of loading
				Chi Square	Sig. (<.10)			
Efficient Construction Management (ECM)	ECM-1	0.897	0.750	771.093	0.000	5	0	56.368
	ECM-2	0.750						
	ECM-3	0.684						
	ECM-4	0.531						
	ECM-5	0.837						
Quality Management in Construction (QMC)	QMC-1	0.742	0.717	292.894	0.000	4	1	42.622
	QMC-2	0.784						
	QMC-3	0.073						
	QMC-4	0.726						
	QMC-5	0.659						
Materials and Resources (MRM)	MRM-1	0.182	0.852	1698.163	0.000	4	1	70.042
	MRM-2	0.920						
	MRM-3	0.939						
	MRM-4	0.947						
	MRM-5	0.918						
Sustainable Building Design (SBD)	SBD-1	0.832	0.737	369.485	0.000	4	0	56.270
	SBD-2	0.775						
	SBD-3	0.597						
	SBD-4	0.776						
Employees Skills, Training and Attitude (ESTA)	ESTA-1	0.884	0.819	1245.101	0.000	5	0	68.482
	ESTA-2	0.902						
	ESTA-3	0.872						
	ESTA-4	0.781						
	ESTA-5	0.677						

Technological Capabilities and Innovation (TCI)	TCI-1	0.648	0.665	914.161	0.000	4	0	66.809
	TCI-2	0.847						
	TCI-3	0.931						
	TCI-4	0.818						
Supply Chain Capabilities (SCC)	SCC-1	0.771	0.678	183.035	0.000	4	0	46.754
	SCC-2	0.726						
	SCC-3	0.554						
	SCC-4	0.666						
Environmental Consideration (ENC)	ENC-1	0.823	0.878	936.637	0.000	5	0	66.234
	ENC-2	0.850						
	ENC-3	0.775						
	ENC-4	0.832						
	ENC-5	0.788						
Perception and Awareness (PAA)	PAA-1	0.920	0.732	2680.681	0.000	5	0	85.006
	PAA-2	0.929						
	PAA-3	0.901						
	PAA-4	0.932						
	PAA-5	0.928						
Government Interest, Regulations and Policies (GIRP)	GIRP-1	0.739	0.727	300.274	0.000	4	1	43.146
	GIRP-2	0.757						
	GIRP-3	0.123						
	GIRP-4	0.753						
	GIRP-5	0.675						
Material, Resources and Technologies (MRT)	MRT-1	0.822	0.859	803.946	0.000	5	0	62.864
	MRT-2	0.812						
	MRT-3	0.769						
	MRT-4	0.785						
	MRT-5	0.774						
Socio-Cultural Belief (SCB)	SCB-1	0.836	0.745	372.910	0.000	4	0	56.680
	SCB-2	0.794						
	SCB-3	0.629						
	SCB-4	0.736						
Economic Perspective (ECP)	ECP-1	0.876	0.836	1185.154	0.000	5	0	68.687
	ECP-2	0.885						
	ECP-3	0.869						
	ECP-4	0.800						
	ECP-5	0.700						
Green Construction (GC)	GC-1	0.663	0.720	719.974	0.000	4	0	65.608
	GC-2	0.854						
	GC-3	0.893						
	GC-4	0.811						
Sustainable Construction (SC)	SC-1	0.943	0.717	4736.903	0.000	5	0	88.831
	SC-2	0.936						
	SC-3	0.943						
	SC-4	0.950						
	SC-5	0.941						
Implementation of Sustainable	ISC-1	0.849	0.796	574.441	0.000	4	0	65.333
	ISC-2	0.824						

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Construction (ISC)	ISC-3	0.765						
	ISC-4	0.793						
Sustainable Development (SD)	SD-1	0.823	0.865	832.669	0.000	5	0	63.697
	SD-2	0.815						
	SD-3	0.774						
	SD-4	0.804						
	SD-5	0.773						

6.3. Reliability Analysis

The validity of the study scale and questionnaire can be verified by computing each internal consistency of the factor using the coefficient of Cronbach's Alpha. This study aims to determine whether the concepts being evaluated by observable factors are equivalent. This technique can be used to remove erroneous variables from the research model. The following is the acceptable alpha value, or Cronbach's alpha coefficient scale:

a. An evaluation is considered appropriate if the cut-off score is 0.60 or higher.

b. The range of 0.7 to 0.8 encompasses both usability and internal consistency.

c. Decent: 0.8 to almost 1.

As per Hair et al. (11), the scale's corrected item-total correlation coefficient needs to be 0.3 or above. The study used a value of 0.7 as its Cronbach's alpha cutoff because it was determined to be both greater than the permitted range and inside the cutoff value of 0.70. It is demonstrated by Hoang and Chu (12) that all definitional scales satisfy the dependability level. The validity of the questionnaire as a research tool is demonstrated by the coefficient of Cronbach's alpha in Table 3.

Table-3 Results of Reliability Analysis

Variable	**Cronbach alpha**	**Variable**	**Cronbach alpha**
Efficient Construction Management (ECM)	0.797	Government Interest, Regulations and Policies (GIRP)	0.712
Quality Management in Construction (QMC)	0.706	Material, Resources and Technologies (MRT)	0.852
Materials and Resources (MRM)	0.950	Socio-Cultural Belief (SCB)	0.737
Sustainable Building Design (SBD)	0.727	Economic Perspective (ECP)	0.885
Employees Skills, Training and Attitude (ESTA)	0.884	Green Construction (GC)	0.825
Technological Capabilities and Innovation (TCI)	0.833	Sustainable Construction (SC)	0.968
Supply Chain Capabilities (SCC)	0.610	Implementation of Sustainable Construction (ISC)	0.823
Environmental Consideration (ENC)	0.872	Sustainable Development (SD)	0.857
Perception and Awareness (PAA)	0.956	**Overall Reliability Analysis**	**0.989**

6.4. Correlation Analysis

Following EFA and reliability analysis, the controlled variables are coded for correlation analysis and the mean value is suitably scaled. The Pearson's correlation coefficient (r), which examines the linear connection between components, is used to examine the link between quantitative data. Since every connection between the dependent and the independent variables demonstrates the existence of statistical significance, a multitude of statistics can be utilized to examine the relationship between the variables. Further evidence against the presence of the multi-collinearity problem comes from the

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correlation coefficient levels. An analysis of linear regression can be performed on the variables if the independent and dependent variables have a substantial link with one another. r's magnitude can be used to determine the degree of rigidity in a linear connection by looking at its absolute value. r is closer to 1 the stronger the link between the two variables, and vice versa.

	Efficient Construction Management (ECM)	Quality Management in Construction (QMC)	Materials and Resources (MRM)	Sustainable Building Design (SBD)	Employees Skills, Training and Attitude (ESTA)	Technological Capabilities and Innovation (TCI)	Supply Chain Capabilities (SCC)	Environmental Consideration (ENC)	Perception and Awareness (PAA)	Government Interest, Regulations and Policies (GIRP)	Material, Resources and Technologies (MRT)	Socio-Cultural Belief (SCB)	Economic Perspective (ECP)	Green Construction (GC)	Sustainable Construction (SC)	Implementation of Sustainable Construction (ISC)	Sustainable Development (SD)
ECM	1																
QMC	.631**	1															
MRM	.902**	.731**	1														
SBD	.820**	.749**	.895**	1													
ESTA	.840**	.684**	.923**	.833**	1												
TCI	.859**	.661**	.911**	.853**	.879**	1											
SCC	.786**	.712**	.855**	.956**	.793**	.817**	1										
ENC	.808**	.672**	.894**	.853**	.928**	.860**	.811**	1									
PAA	.787**	.640**	.854**	.789**	.873**	.820**	.743**	.843**	1								
GIRP	.596**	.936**	.685**	.709**	.628**	.618**	.670**	.624**	.679**	1							
MRT	.747**	.660**	.837**	.818**	.857**	.803**	.774**	.930**	.898**	.703**	1						

SCB	.775**	.715**	.844**	.949**	.777**	.806**	.905**	.797**	.826**	.766**	.862**	1					
ECP	.768**	.653**	.847**	.783**	.902**	.807**	.740**	.844**	.929**	.714**	.914**	.847**	1				
GC	.799**	.644**	.848**	.813**	.809**	.929**	.772**	.795**	.878**	.694**	.854**	.859**	.868**	1			
SC	.846**	.651**	.911**	.823**	.942**	.878**	.781**	.903**	.934**	.601**	.839**	.770**	.856**	.810**	1		
ISC	.697**	.636**	.789**	.768**	.808**	.747**	.715**	.873**	.887**	.700**	.949**	.827**	.903**	.814**	.810**	1	
SD	.749**	.659**	.838**	.815**	.861**	.803**	.772**	.933**	.901**	.701**	.997**	.859**	.917**	.854**	.842**	.952**	1

Table -4: Results for Correlation Analysis (N=412)

Table 4 shows that, out of all the parameters considered, there was a significant correlation found between the variables. The variables pertaining to Sustainable Development (SD) and Material, Resources and Technology (MRT) exhibited the strongest correlation (0.997), followed by the relationship between Implementation of Sustainable Construction (ISC) and Material, Resources and Technologies (MRT) (0.949), while the variables pertaining to Government Interest, Regulation and Policies (GIRP) and Technological Capabilities and Innovation (TCI) demonstrated the least significant correlation (0.618)

6.5. Regression Analysis

Using a significant multivariate regression analysis with a five percent enter method level, the investigator tests hypotheses, demonstrates the statistical validity of the prototype assumption, and ascertains the impact of external stimuli on internal characteristics. The questionnaire items and results were computed using analyses of the standard deviation and mean values for every variable. The predictor-criterion, the independent and dependent variables' relationship was found using stepwise regression analysis. This research uses linear regression as opposed to nonlinear regression. Researchers use F-test, adjusted coefficient R2, and t-test to assess whether the model is suitable, scalable, and able to reject the premise that the null hypothesis total regression coefficient is equal to zero.

6.5.1. Green construction as dependent variable

The regression result shows that Green Construction (GC) is significantly predicted by all four independent factors: Sustainable Building Design (SBD), Materials and Resources Management (MRM), Quality Management in Construction (QMC), and Efficient Construction Management (ECM). According to Table 5a's R square value of 0.739, the factors could be responsible for roughly 73.90% of the influence on Green Construction. ANOVA findings for the regression model at a 95% confidence level are displayed in Table 5b. The coefficient summary in Table 5c indicates that the factor's beta values are 0.465 and 0.256, which are generally indicative of the effect on Green Construction.

Table 5a: Regression Model summary for GC as Dependent Variable

Model	Predictors	Dependent variable	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	SBD, QMC, ECM, MRM	GC	0.860	0.739	0.737	0.433

Table 5b: Regression ANOVA table for GC as Dependent Variable

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Model	Predictors	Dependent variable		Sum of Squares	df	Mean Square	F	Sig.
1	SBD, QMC, ECM, MRM	GC	Regression Residual Total	216.617 76.461 293.077	4 407 411	54.154 0.188	288.263	0.000

Table 5c: Regression coefficients table for GC as Dependent Variable

Model		Dependent variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
			B	Std. Error	Beta		
1	Constant ECM QMC MRM SBD	GC	0.264 0.184 0.012 0.416 0.279	0.120 0.067 0.054 0.070 0.066	 0.164 0.009 0.465 0.256	2.204 2.771 0.230 5.981 4.255	0.028 0.006 0.818 0.000 0.000

6.5.2. Sustainable construction as dependent variable

All the four independent factors, Employees Skills, Training and Attitude (ESTA), Technological Capabilities and Innovation (TCI), Supply Chain Capabilities (SCC) and Environmental Consideration (ENC) are significant predictors of Sustainable Construction (SC) by enter regression analysis. Based on the maximum R square value of 0.901 found in Table 6a, the variables may account for approximately 90.10% of the influence on Sustainable Construction. Regression model validation at a 95% confidence level is shown by Table 6b's ANOVA results. The factor's beta values are 0.637 and 0.191, which are largely typical of the effect on Sustainable Construction, as per Coefficient summary in Table 6c.

Table 6a: Regression Model summary for SC as dependent variable

Model	Predictors	Dependent variable	R	R Square	Adjusted R Square	Std. Error of the Estimate
2	ENC, SCC, TCI, ESTA	SC	0.949	0.901	0.900	0.30272

Table 6b: Regression ANOVA table for SC as dependent variable

Model	Predictors	Dependent variable		Sum of Squares	df	Mean Square	F	Sig.
2	ENC, SCC, TCI, ESTA	SC	Regression Residual Total	339.435 37.297 376.732	4 407 411	84.859 0.092	926.014	0.000

Table 6c: Regression coefficients table for SC as dependent variable

Model		Dependent variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
			B	Std. Error	Beta		

2	Constant	SC	-0.278	0.060		-4.633	0.000
	ESTA		0.729	0.053	0.637	13.790	0.000
	TCI		0.220	0.042	0.191	5.283	0.000
	SCC		0.002	0.039	0.001	0.042	0.966
	ENC		0.178	0.054	0.146	3.280	0.001

5.7.3. Implementation of sustainable construction as dependent variable

Regression analysis shows that the three independent factors—Perception and Awareness (PAA), Government Interest, Regulations and Policies (GIRP), Material, Resources and Technologies (MRT), Socio-Cultural Belief (SCB), and Economic Perspective (EP)—are all significant predictors of the implementation of sustainable construction (ISC). Based on Table 7a's highest R square values of 0.910, it is possible that 91% of the influence on the implementation of sustainable construction can be attributed to the variables. ANOVA findings for the regression model at a 95% confidence level are displayed in Table 7b. The coefficient summary in Table 7c indicates that the factor's beta values are 0.735 and 0.147, which are generally indicative of the impact on Implementation of Sustainable Construction. Socio-Cultural Belief (SCB) has a negative value, which suggests that they are not handled well enough to take advantage of sustainable construction.

Table 7a: Regression model summary for *ISC as dependent variable*

Model	Predictors	Dependent variable	R	R Square	Adjusted R Square	Std. Error of the Estimate
3	ECP,GIRP, PAA, SCB, MRT	ISC	0.954	0.910	0.909	0.237

Table 7b: Regression ANOVA table for *ISC as dependent variable*

Model	Predictors	Dependent variable		Sum of Squares	df	Mean Square	F	Sig.
3	ECP,GIRP, PAA, SCB, MRT	ISC	Regression	231.683	5	46.337	823.929	0.000
			Residual	22.833	406	0.056		
			Total	254.516	411			

Table 7c: Regression coefficients table for *ISC as dependent variable*

Model		Dependent variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
			B	Std. Error	Beta		
3	Constant	ISC	0.074	0.056		1.331	0.184
	PAA		0.079	0.035	0.096	2.257	0.025
	GIRP		0.065	0.029	0.052	2.215	0.027
	MRT		0.728	0.041	0.735	17.611	0.000
	SCB		-0.050	0.033	-0.050	-1.494	0.136
	ECP		0.134	0.043	0.147	3.098	0.002

5.7.4. Sustainable development as dependent variable

Based on enter regression analysis, the three independent factors—Green Construction (GC), Sustainable Construction (SC), and Implementation of Sustainable Construction (ISC)—are significant predictors of Sustainable Development (SD). The variables may account for almost 93% of the influence on Sustainable Development, according to Table 8a's maximum R square values of 0.930. Table 8b displays the ANOVA findings for regression model validation at a 95% confidence level. As

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can be seen from the coefficient summary in Table 8c, the factor's beta values are 0.177, 0.126, and 0.706, which are generally indicative of the impact on Sustainable Development.

Table 8a: Regression model summary for SD as dependent variables

Model	Predictors	Dependent variable	R	R Square	Adjusted R Square	Std. Error of the Estimate
4	GC, SC, ISC	SD	0.964	0.930	0.930	0.211

Table 8b: Regression ANOVA table for SD as dependent variables

Model	Predictors	Dependent variable		Sum of Squares	df	Mean Square	F	Sig.
4	GC, SC, ISC	SD	Regression Residual Total	242.558 18.243 260.801	3 408 411	80.853 0.045	1808.245	0.000

Table 8c: Regression coefficients table for SD as dependent variables

Model		Dependent variable	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
			B	Std. Error	Beta		
4	Constant	SD	0.051	0.038		1.347	0.179
	GC		0.167	0.024	0.177	7.065	0.000
	SC		0.105	0.021	0.126	5.076	0.000
	ISC		0.714	0.025	0.706	28.049	0.000

5.8 DISCUSSION ON HYPOTHESES TESTING

5.8.1 Discussion on Hypotheses Testing of Green Construction (GC)

The significance of all four factors when strategizing for sustainability outcomes in the construction sector is indicated by an analysis of the results of hypothesis testing of the aggregate values of the independent variables, Quality Management in Construction (QMC), Materials and Resources Management (MRM), Sustainable Building Design (SBD) and Efficient Construction Management (ECM), on the dependent variable, Green Construction (GC), as previously explained. Three of the four hypotheses pertaining to these four variables have been confirmed, while one has been ruled out. The most important significant predictor of Green Construction (GC) in India is thought to be Materials and Resources Management (MRM), which is followed by Sustainable Building Design (SBD) and Efficient Construction Management (ECM), both of which are thought to be significant predictors of sustainability in the construction industry. The respondents rejected the fourth independent variable, Quality Management in Construction (QMC), even though it did not have a substantial impact on Green Construction (GC). Instead, they felt that the influence was not that great. The established correlation between the four research variables, as shown in table 9.

Table 9: Summary of Hypotheses Testing of Green Construction

S. No:	Dependent Variable	Independent Variable	Hypotheses Code	Beta Coefficient	t-value	Sig Value	Status of Hypotheses
1	Green Construction (GC)	Efficient Construction Management (ECM)	H1	0.164	2.771	0.006	Accepted
2		Quality Management in	H2	0.009	0.230	0.818	Rejected

		Construction (QMC)					
3		Materials and Resources (MRM)	H3	0.465	5.981	0.000	Accepted
4		Sustainable Building Design (SBD)	H4	0.256	4.255	0.000	Accepted

5.8.2 Discussion on Hypotheses Testing of Sustainable Construction (SC)

The significance of all four factors when strategizing for sustainability outcomes in the construction sector is indicated by an analysis of the results of hypothesis testing of the aggregate values of the independent variables Employees Skills, Training and Attitude (ESTA), Technological Capabilities and Innovation (TCI), Supply Chain Capabilities (SCC), and Environmental Consideration (ENC) on the dependent variable Sustainable Construction (SC), as previously explained. Three of the four hypotheses pertaining to these four variables have been confirmed, while one has been ruled out. It is believed that the most important and significant predictor of Sustainable Construction (SC) in India is Employees Skills, Training, and Attitude (ESTA). Other important and significant predictors of sustainability in the construction sector are Technological Capabilities and Innovation (TCI) and Environmental Consideration (ENC). The respondents eliminated the fourth independent variable, Supply Chain Capabilities (SCC), even though it did not have a significant impact on Sustainable Construction (SC). This is because they did not believe the influence to be particularly strong. The four research variables and their verified relationships are shown in table 10.

Table 10: Summary of Hypotheses Testing of Sustainable Construction (SC)

S. No:	Dependent Variable	Independent Variable	Hypotheses Code	Beta Coefficient	t-value	Sig Value	Status of Hypotheses
1	Sustainable Construction (SC)	Employees Skills, Training and Attitude (ESTA)	H5	0.637	13.790	0.000	Accepted
2		Technological Capabilities And Innovation (TCI)	H6	0.191	5.283	0.000	Accepted
3		Supply Chain Capabilities (SCC)	H7	0.001	0.042	0.966	Rejected
4		Environmental Consideration (ENC)	H8	0.146	3.280	0.001	Accepted

5.8.3 Discussion on Hypotheses Testing of Implementation of Sustainable Construction

All five of the independent variables—Perception and Awareness (PAA), Government Interest, Regulations and Policies (GIRP), Material, Resources and Technologies (MRT), Socio-Cultural Belief (SCB), and Economic Perspective (ECP)—have a significant impact on the dependent variable, Implementation of Sustainable Construction (ISC), as demonstrated by the analysis of the hypotheses testing results. Each one of the five linking these factors has been deemed credible. Perception and Awareness (PAA), which is also considered to be a significant predictor of sustainability in the construction sector, and Economic Perspective (ECP) are seen as the next most important significant predictors of the implementation of Sustainable Construction (ISC) in India, after Material, Resources, and Technologies (MRT). Even if it has a negative influence, respondents believe that the independent

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variable Socio-Cultural Belief (SCB) has a very substantial impact on the implementation of SCI. Table 11 shows the verified correlation between the five research variables.

Table 11: Summary of Hypotheses Testing of Implementation of Sustainable Construction

S. No:	Dependent Variable	Independent Variable	Hypotheses Code	Beta Coefficient	t-value	Sig Value	Status of Hypotheses
1	Implementation of Sustainable Construction (ISC)	Perception and Awareness (PAA)	H9	0.096	2.257	0.025	Accepted
2		Government Interest, Regulations and Policies (GIRP)	H10	0.052	2.215	0.027	Accepted
3		Material, Resources and Technologies (MRT)	H11	0.735	17.611	0.000	Accepted
4		Socio-Cultural Belief (SCB)	H12	-0.050	-1.494	0.000	Accepted
5		Economic Perspective (ECP)	H13	0.147	3.098	0.002	Accepted

5.8.4 Discussion on Hypotheses Testing of Sustainable Development

The significance of all three variables when strategizing for sustainability outcomes in the construction sector is indicated by an analysis of the results of hypothesis testing of the aggregate values of independent variables Green Construction (GC), Sustainable Construction (SC), and Implementation of Sustainable Construction (ISC) on the dependent variable Sustainable Development (SD) as previously explained. All three of the hypotheses linking these variables have been deemed valid. In India, the most important and significant predictor of sustainable development (SD) is thought to be the implementation of sustainable construction (ISC). This is followed by Green Construction (GC) and Sustainable Construction (SC), which are also thought to be important and significant predictors of sustainability in the construction industry. The verified correlation between three research variables, as shown in table 12.

Table 12: Summary of Hypotheses Testing of Sustainable Development

S. No:	Dependent Variable	Independent Variable	Hypotheses Code	Beta Coefficient	t-value	Sig Value	Status of Hypotheses
1	Sustainable Development (SD)	Green Construction (GC)	H14	0.177	7.065	0.000	Accepted
2		Sustainable Construction (SC)	H15	0.126	5.076	0.000	Accepted
3		Implementation of Sustainable Construction (ISC)	H16	0.706	28.049	0.000	Accepted

8. CONCLUSION

The factors influencing sustainable development through green construction, sustainable construction, and Implementation of sustainable construction practices in relation to Indian construction industry and building projects are identified in this study. Based on this study that focused on previous researches and participant data input, a novel analysis approach was created. Experts from the construction industry participated in research survey and it was used in the model's validation. The study conclusion suggests, among the investigated parameters Green Construction (GC), Sustainable Construction (SC), and Implementation of Sustainable Construction (ISC) practices, ISC as the most significant factor in the model with combined value of 0.706. , followed by GC and then SC to be significant predictors for Sustainable Development.

Material, Resources and Technologies (MRT) identified as the main driver, however, Economic Perspective (ECP), Socio-cultural (SCB) and Perspective and Awareness (PAA) remains important for Implementation of Sustainable Construction (ISC) practices.

For Green Construction (GC), Material and Resource Management (MRM) is primary driver followed by Sustainable Building Design (SBD). And for Sustainable Construction (SC), Employee Skills, Training and Attitude (ESTA) is key driver for sustainable construction. Supply chain capabilities was not seen as any influencing factor for SC.

This study's also throw light different obstacles and challenges coming in way of the sustainable development. It is recommended that a comprehensive revision to the local building codes and standards including the National Building Code to incorporate sustainable construction practices and energy efficiency. Energy efficiency technologies are the key to solving global challenges (13). Environmental Regulations and permit approvals for the construction projects be in line with the applicable environment protection act. Regulatory agencies established by governments at all levels may help implementation of sustainable development policies. Implementation of sustainable policies and compliance to the regulatory environmental requirement through enforcement can be effective. Initial project cost for the sustainable construction tend to be higher than the conventional construction, but the life-cycle cost analysis suggest sustainable construction is more rewarding, therefore the government at all levels can have incentive programs to promote sustainable construction. Secondly, it is needed to promote awareness and technical training to the workforce in the construction industry, including schools and technical schools that produce newer generation workforce for future. Introduction of new technologies, innovative construction materials, adoption of sustainable design practices can be far rewarding for environmental friendly development. This research study brings addition of information that enhances the database for experts, as well as for the benefit for all in the construction sector. Environmental friendly construction and sustainable development is need of today for everyone.

9. LIMITATIONS ANDRECOMMENDATIONS

Despite assurances of secrecy, the present study encountered obstacles in the data gathering procedure, such as participants' unwillingness to talk about how their company uses sustainable building approaches and tools in interviews. Furthermore, it's possible that a framework built on generic construction practices and research bias affected the findings, failing to adequately capture the particular context of the construction industry. In this work, an analysis model was created using survey data gathered from a specific area—India. Since different nations recognize different benefits of productivity when utilizing construction equipment, comparable studies might be carried out in other nations. This study aimed to determine strategies for improving production in various places and to comprehend the structural interactions between these aspects. The findings may have different ramifications depending on the project in question. Large-scale studies may also be used in future study to quantify these interrelationships. The small sample size of this study hindered the ability to quantify the relationships between construction parameters in construction projects. For the evaluation of the model, more study with a bigger sample size is recommended.

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