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Green Buildings and Sustainable Construction

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Abstract **- The issues of sustainable construction practices have been an emerging phenomenon in India. The increasing concern of harmful effects of construction related activities and need to address the same have regularly appeared in newspaper headlines. In light of the same government of India has already taken proactive measures to promote the concept of green building for better environmental and social protection. Rising concern of deterioration to the environment, developers should also rework on their existing construction practices and should adopt sustainable construction practices in their future projects. However, the speed with which all the associated developers and builders accept this aspect of construction depends upon the level of awareness, knowledge as well an understanding of the consequences of the individual action. Aligned with this objective, survey has been organized in the current study to assess the difference in level of knowledge, awareness and implementation of sustainable practices based on the perceptions of the project developers in India. To improve the acceptance and momentum of sustainable practice in the industry, appropriate actions are recommended towards improving this knowledge at all levels of developers.**

1. INTRODUCTION

Construction industry in any part of the world has significant positive and negative environmental, economic and social impacts on the society. Besides providing the required number of buildings and facilities to human beings, activities within construction industry provides employment opportunities to large number of people. The negative influences of construction activities include; noise, traffic congestion, dust, fumes, water pollution and waste disposal. With emerging technologies and rising population a need for significant increase in infrastructure was felt. Rising number of buildings are required to accommodate the expanding population – this calls for a need to identify optimal solutions for minimizing the environmental impacts (Conte and Yepes, 2012). According to estimates buildings consume more than 30% of energy utilizing 40% of resources while simultaneously generating 40% of wastes and 35% of harmful green-house gases. Indian Real Estate sector is flourishing at an irresistible speed of 112.2% Compound Annual Growth Rate(CAGR) leading to growing demand for natural and other depleting resources. By the end of fiscal year 2030, India is expected to have a GDP of 4 trillion and population of 1.5 billion (Tathagat&Dod, 2015). Energy and peak shortage of 9.8% and 16.6% respectively makes it imperative for developers in India to indulge into activities concerning sustainability.

The movement of Green building in India began in the year 2001, with the establishment of IGBC by Confederation of Indian Industries (CII) in cooperation with USGBC and Green building council of the world. It was a symbolic movement for the country when the first green building; Sohrabji Godrej Green Business Centre was inaugurated. Indian Green building market is anticipated to be 40 billion USD which is likely to grow further. According to estimates out of the total number of registered projects across the world 37% are registered in India under LEED NC-USA (USGBC, 2007). India with a coverage area of 3.59 billion sq holds a second position in the global green market space. The market size of green buildings in India is anticipated to be 10 billion sq. ft. in 2022. The increasing prominence of the concept in the country is a result of the policies initiated by the government to publicize the movement.

IGBC in India has launched 13 indigenous green building rating systems in congruence with national objectives of the sector. The performance of the building is assessed on the basis of; sustainable site development, energy efficiency, water savings, material selection and indoor environmental quality. GRIHA is yet another national rating system with a set of 34 criteria. Mumbai followed by Pune and Bangalore are states leading the number of green buildings present. Majority of the green certified projects under IGBC are commercial buildings (56%). Corporate executives are progressively switching to green spaces to withstand global market pressure. Apart from this, green spaces help the company in retaining employees, cutting operating costs, satisfying shareholder's demands, differentiating their product and establishing a corporate image in the market.

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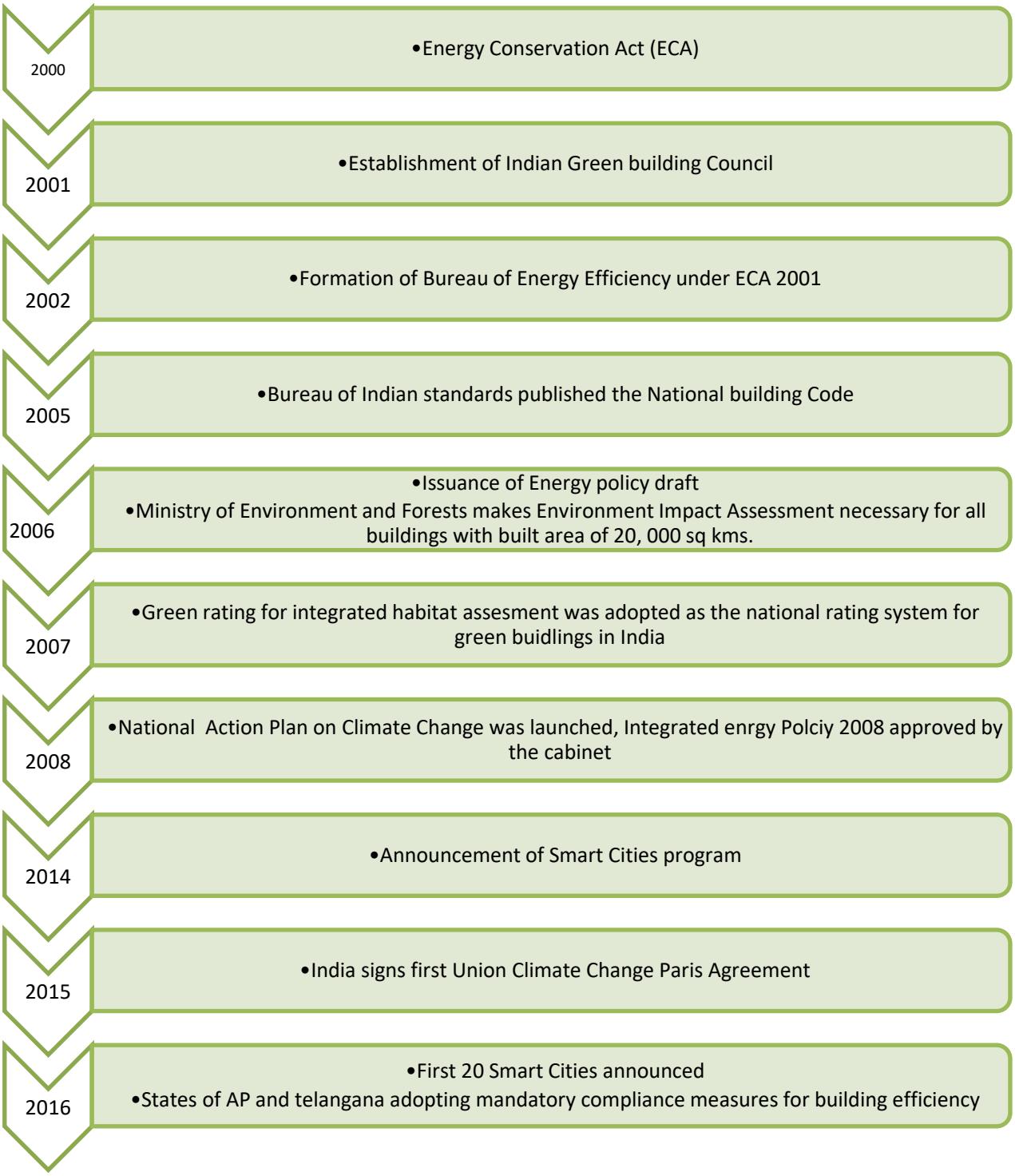
Figure 1 Policy Initiatives for Green building in India



In the absence of structured post construction performance, Green certified residential projects are yet to gain prominence. In the absence of a structured performance metric system buyers are unwilling to buy premium houses. Thus, the state government is providing additional FSI to developers for encouraging their involvement in green projects. Hospitality sector in India are adopting sustainability practices for promoting corporate social responsibility and reducing operating costs (VESTIAN, 2016).

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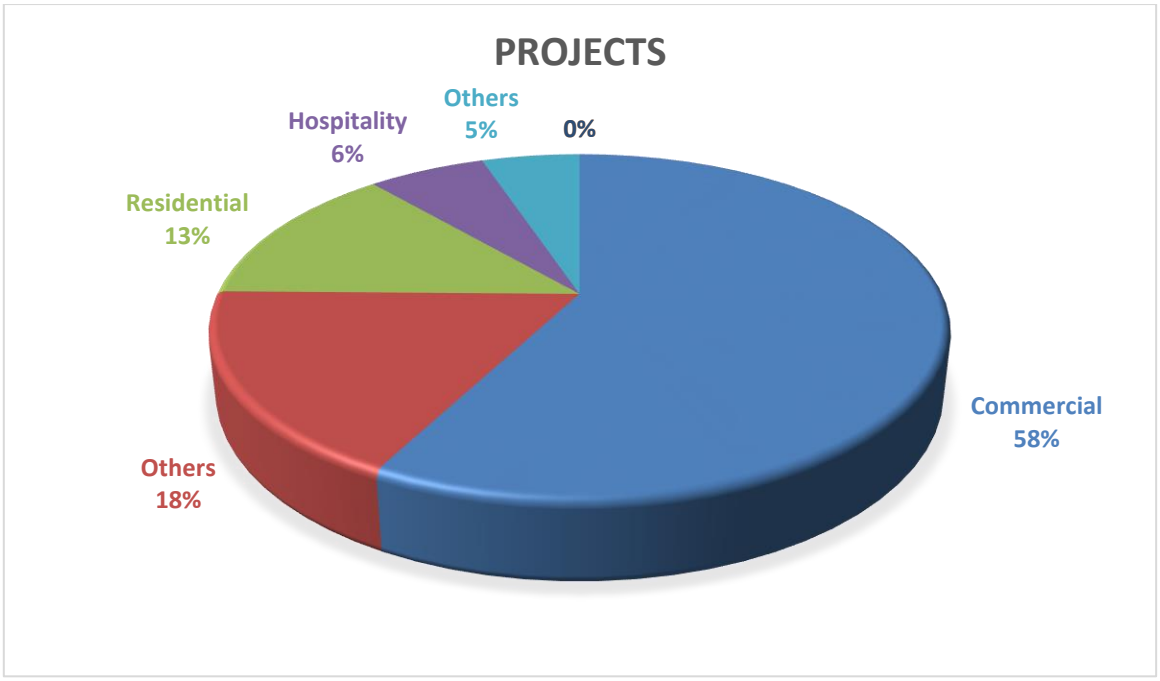

Figure 2 Distribution of IGBC Green certified projects under various uses

Buildings are one of the heaviest consumers of natural resources. With increasing demand for houses it has become critically important for construction industry to come out with alternative for both fulfilling the needs of future generation without disturbing its surrounding environment. Pedini and Ashuri, (2010) argues that green building is not choice but a necessity for environment;owners, developers, government officialsand rest of the stakeholders. Despite the fact that the concept of sustainability has gained momentum, but still there exists a vast community who remain uncertain of the concept and its associated benefits. Actions of few developers in respect of sustainability will not give a fruitful impact to the industry as a whole. Therefore, a consolidated effort of the developers is needed to shift from a conventional way of construction to a more sustainable route. Awareness and knowledge of the developers plays a critical role herein. Larger the number of developers aware of the concept, more are the chances of assimilation. The current study is an attempt to study the level of awareness of the developers towards sustainable construction in India. In addition, the study identifies the triggers driving future construction activities in India and proposes a strong post construction monitoring system for both developers and tenants in order to identify the perceived benefits of the same.

The objectives of the study are as follows:

1. To identify the Sustainable Construction initiatives been organized in India.
2. To assess developers Awareness for Sustainable Construction in India.
3. To assess economic benefits of sustainable construction in terms of cost of construction and sale of products

2. LITERATURE REVIEW

2.1 Green Buildings and Sustainable Construction

The term sustainable development was introduced by Bruntland in 1987. Since, then several progressive actions are taken to promote environmental awareness and agendas of sustainability (ZainulAbidin, 2008). The increased concern for environmental awareness has been promoted by government, businesses, organization and individuals (Ofori et al., 2000). Entire construction industry is shifting its focus towards adoption of measures for reducing the environmental impacts of construction related activities (Roy and Gupta, 2008). Environmental Protection Agency (EPA) of USA defines green building as a building, *which is designed, built operated, maintained or reused with objectives to protect occupant's health, improve employee productivity, use wisely natural resources and reduce the environmental impacts* (Mehta and Porwal, 2013). This is sometimes also referred to as a sustainable or 'high performance' building.

*Benefits of Green Buildings*Three main pillars that direct the concept of sustainable construction include; environmental protection, social well-being and economic prosperity (Udechukwu and Johnson, 2008). Several benefits of green buildings in the literature are explained in the form of energy and water saving, reduced maintenance cost, increased propertyvalue, higher occupant satisfaction, improved productivity, health benefits,and reduced $CO_2$and waste emissions (Zigenfus, 2008; Addis & Talbot, 2001; Lombardi, 2001; Bowman and Wills, 2008). Mohanty et.al., (2010) asserted that green buildings maximize the usage of construction practices and effective building materials, enhances the use of onsite resources, maximizes the usage of renewable sources of energy and provides comfortable as well as hygienic indoor working conditions. Construction practitioners across the world are switching to green

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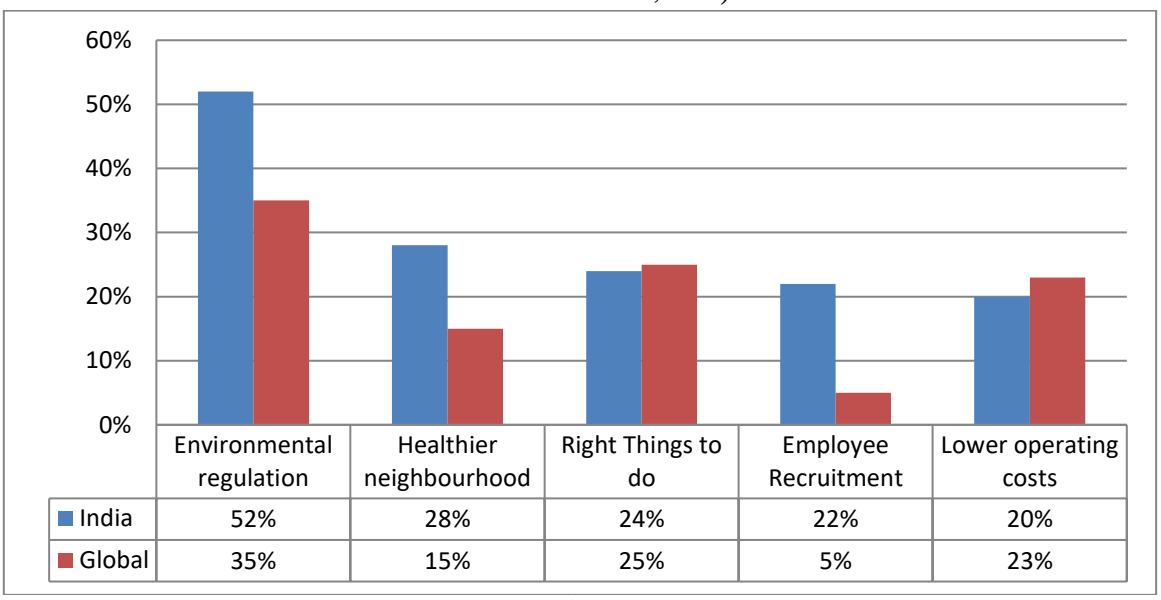
construction activities. Growth of any developing nation can only be sustained with growth in its infrastructural capacity. With increasing global interest on sustainability, there is an emerging need for Indian construction industry to develop awareness for sustainable construction practices to withstand competition.

2.2 Drivers of sustainable design and construction

Studies have revealed numerous drivers that are responsible for intensifying the green building movement. The rapid penetration of LEED green building rating system, supportive legislative policies, executive orders, rules, regulations and policy interventions of the government, advancement in green building technology, environmental impact followed by demand of the tenant, financial benefits, corporate social responsibility, land use regulations and urban planning policies, resource depletion and degradation, re-engineering the design process, product innovation are some of the major drivers behind of sustainability construction (Abidin, 2010; Augenbroe and Pearce, 2009;Vanegas and Pearce, 2000). Thus, green building projects are either driven by need for environmental sustainability or by the need to reduce the cost of building operations. Awareness and knowledge plays a critical role in intensifying the sustainability movement. Increasing consciousness of masses towards harmful impacts of construction related activities are supporting the indulgence into green building practices.

Du Plessis (2007) argues that behavioral change is impossible without personal commitment. To solicit support of all the associated stakeholders, their personal values must be satisfied. Commercial viability of the project is the sole value of the developers. Studies have confirmed the economic feasibility of green buildings (Hydes& Creech, 2000; Pettifer, 2004; Yates, 2001). To encourage acceptance of any emerging concept it is important to examine the awareness level of the developers because developers are the ones who have a fundamental influence on the entire lifecycle of a sustainable construction. The future of buildings not only depend upon the innovation of technology but also on the promotion done by the builders.This, study critically examines the awareness level of key stakeholders in green building processes.(Ashley et al., 2003).



	Environmental regulation	Healthier neighbourhood	Right Things to do	Employee Recruitment	Lower operating costs
India	52%	28%	24%	22%	20%
Global	35%	15%	25%	5%	23%

Figure 3 Top triggers driving future building activities in India

2.3 Developments in India

Each and every step in life cycle of a green building from planning to its demolition should be governed by the principles of green construction industry. These principles are; reduce, reuse, recycle, protect nature, eliminate toxins, life-cycle costing and quality (Kibert, 2016). Additionally, the resources required to undertake construction activities like land, water, energy, materials should also be aligned with the principles of construction industry. The Confederation of Indian Industry (CII) is a body that is working to develop and expand the Indian construction industry without compromising with the environmental well-being of the society. It is a non-profit organization that plays a critical role in development of Indian construction industry.

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Green buildings have several tangible and non-tangible benefits as follows:

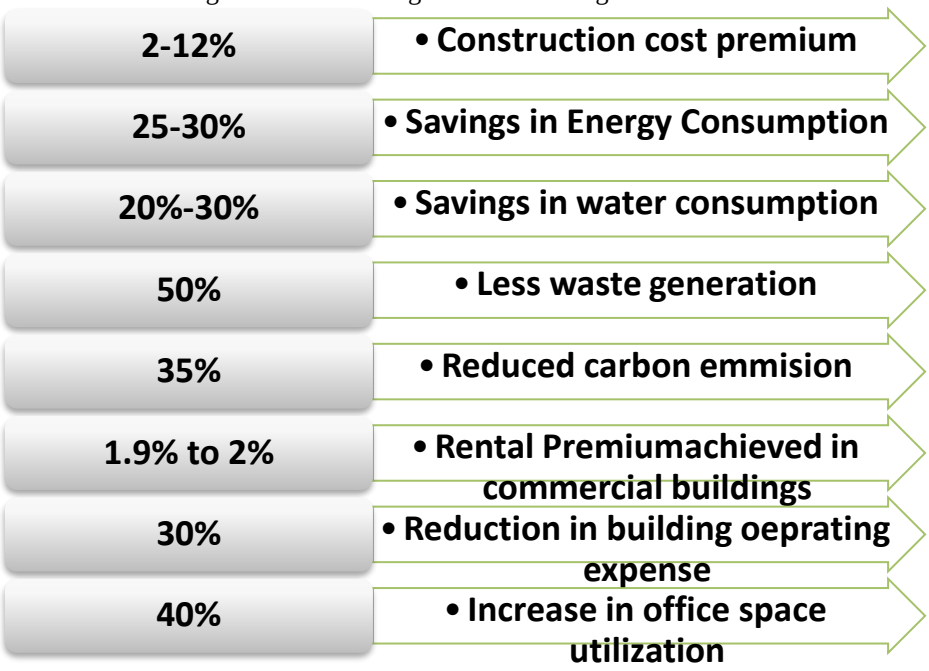

Figure 4 Cost-benefit analyses

(VESTIAN, Sustainable construction Practices in India website 2016)

CII Sohrabji Godrej Green Business Centre a division of CII offers advisory services to the industry on various aspects and issues relating to green buildings viz., Energy Efficiency, Water Management, Renewable Energy, Green Business Incubation and Climate Change activities.Association for Development and Research of Sustainable Habitats(ADaRSH) was a society founded by The Energy and Resource Institute (TERI) to promote administrative that arises while building sustainable habitat. Green Rating for Integrated Habitat Assessment (GRIHA) was developedto establish standards for measuring buildings performance. Green Building Congress was formulated to create awareness on green building concepts and to expose the participants to the latest global trends (CII, 2017).

Since developers are recognized as the key players in realizing the vision of sustainable construction several seminars, professional talks and conferences have been held under the theme of sustainable construction to raise their awareness and know-how. Increasing number of developers are joining the green group with an aim of drawing economic benefits by fulfilling the demands of the green consumers. So keeping this in mind objective of the study was to draw out level of awareness about green buildings, its features and cost benefits.

3. RESEARCH METHODOLOGY

To assess the awareness level of the developers towards green building concept, a descriptive research was carried out in Delhi-National Capital Region(NCR) region. For the purpose of the study 50 Civil Engineers and 50 Real estate Marketing agents associated with Green buildings projects were randomly selected from data found from civil works registration department. Semi-structured interviews were organized to assess the drivers and economic benefits of green buildings as perceived by the developers. Thus, this research is both qualitative and quantitative in nature. An awareness scale (5 point- LikertScale-Strongly Agree–Strongly Disagree) was constructed,authorized and used to collect the requiredinformation. The items included in the questionnaire were designed to gain understanding on developer's knowledge on the subject matter and whether they have incorporated this aspect into their current and past projects. Extent of awareness on concepts of sustainable construction was gauged in terms of; economic, social and environmental benefits of going green. Also, level of awareness and willingness to Take Action by Incorporating Necessary Changes to Implement Green Building Practices was estimated. Additional, role of government in promotion of green building construction practices is assessed. The data gathered was analyzed quantitatively as well as qualitatively.Also, a structured and an unstructured video interview was conducted. Finally, on the basis of current attitude and awareness appropriate recommendations are made.

4.ANALYSIS AND FINDINGS

4.1 Respondent's Profile

The questionnaire survey was distributed to civil engineers and market agents associated with Green buildings projects. Table 1 summarizes the respondent profile. Majority of the respondents (37%) belong to age interval of 41 to 50 years. Results revealed that majority of the respondents who participated in the survey belonged to male category (89%). Only (11%) of females made an insignificant contribution to the survey. The largest number of participants have completed their graduation (60%) followed by (40%) of respondents who have completed their post-graduation. Of

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the respondents surveyed, 52% had experience between 1 to 3 years, 20% had experience of less than 1 year and 3% had experience of more than 20 years. The results reveal that the majority of participants (91%) belonged to the private sector, whereas (9%) of the participants belonged to the government sector. The largest number of respondents (50%) belonged to sales department followed by (24%) project management and (20%) operations management. Majority of the participants (49%) fall to the income category of Rs. 20,001-30,000 followed by (25%) who earn more than Rs. 30,000. When enquired about the driving forces behind the green construction, (64%) of the respondents feel that educational programs are important driving forces behind green building construction. Set rules and legislations and Green design guidelines and construction standards are also significant drivers of green building construction for (81%) and (82%) of the respondents. An economic incentive is the driving force for only (54%) of the participants.

Table 1 Respondent's Profile

	Categories	Number	Percentage
Age	Under 21 years	0	0.00%
	21-30 years	25	25.00%
	31 to 40 years	21	21.00%
	41 to 50 years	37	37.00%
	51 to 60 years	17	17.00%
	61 to 65 years	0	0.00%
	Over 65 years	0	0.00%
Gender	Male	89	89.00%
	Female	11	11.00%
Qualification	Matriculation	0	0.00%
	Intermediate	0	0.00%
	Graduation	60	60.00%
	Master	40	40.00%
	M.Phil./PhD	0	0.00%
Organizational Tenure/Length of Service	Less than 1 year	20	20.00%
	1 to 3 years	52	52.00%
	4 to 10 years	16	16.00%
	11 to 20 years	9	9.00%
	More than 20 years	3	3.00%
Department	Estimating	1	1.00%
	Administrating/Accounting	1	1.00%
	Drafting	1	1.00%
	Sales	50	50.00%
	Project Management	24	24.00%
	Operations Management	20	20.00%
	Other (Please specify)	3	3.00%
Income	Less than Rs. 10,000	11	11.00%
	Rs. 10,001-20000	15	15.00%
	Rs. 20,001-30,000	49	49.00%
	Above Rs. 30,000	25	25.00%
Type of Organization	Government sector	9	9.00%
	Private sector	91	91.00%

4.2 Descriptive

As per the data displayed in Table 2 majority of the respondents show a better understanding and awareness of environmental, economic and social benefits of sustainable construction. However, when it comes to implementation, it seems that respondents are not sure or not have considered whether they have implemented sustainable elements into housing or not

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Table 2Descriptive Statistics

		Mean	Standard Deviation
Environmental	Understanding	3.989090909	0.232683
	Implementation	2.490909091	0.348155312
Economical	Understanding	3.9725	0.38088
	Implementation	2.5225	0.492488
Social	Understanding	3.992222222	0.251324
	Implementation	2.53	0.376003

Figure 5 and 6 shows difference in understanding and implementation of developers associated with sustainable construction industry on account of perceived environmental benefits of the same. As per the results in the figure below respondents agreed that Development effects on ecology, Efficiency waste management, Water conservation, Energy efficiency and Building materials selection are some of the important factors that contribute to environment stability.

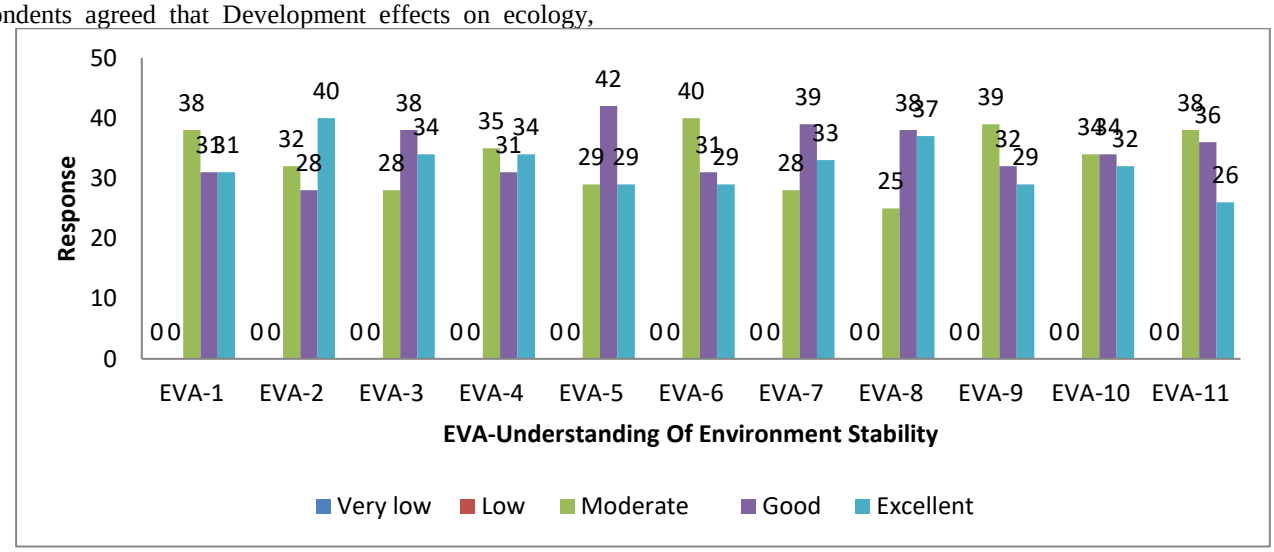

Figure 5Developers Awareness of Environment stability from sustainable construction in India

However, as per the results displayed in the figure below when it comes to implementation, most of the respondents were undecided or unaware of the effects of sustainable construction on water conservation, Guidelines and certifications to adopt green practices, ISO 9000 in construction activities, Quality of end products, building material selection, energy efficiency.

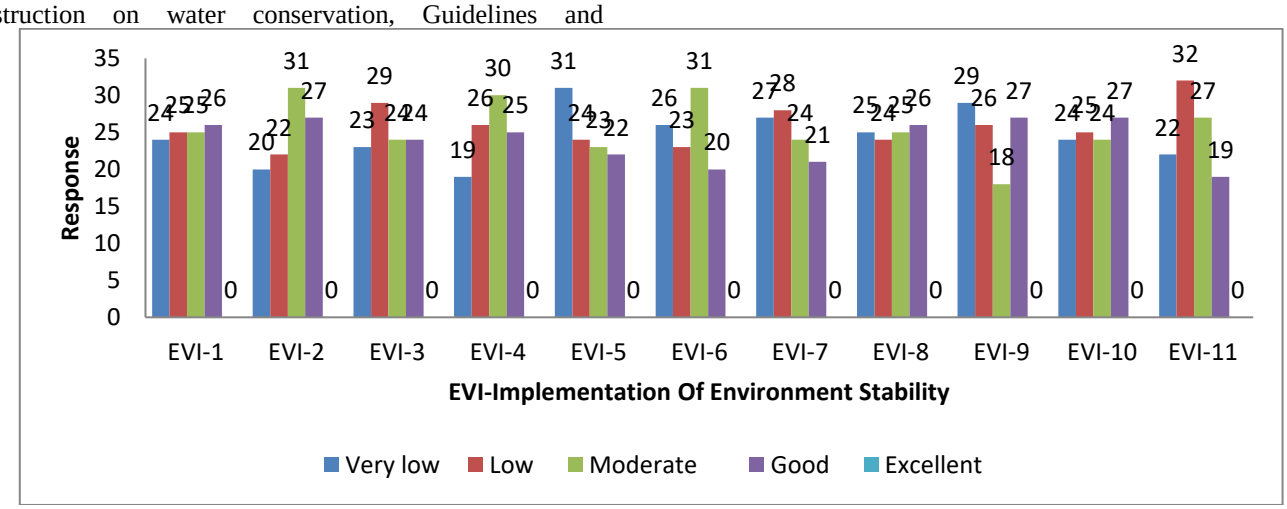

Figure 6Implementation status of sustainable construction in India as per perceived environmental benefits

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Economic sustainability emphasizes on financial issues of housing affordability, life cycle cost, building life span by incorporating building maintenance aspects as well as opportunity to optimize existing infrastructure. As per the results displayed in Figure below, 35% of developers are aware of the economic benefits of optimizing the existing infrastructure as per sustainable standards. 37% of the developers have excellent understanding on how maintenance can contribute to increased life cycle of the sustainable buildings.

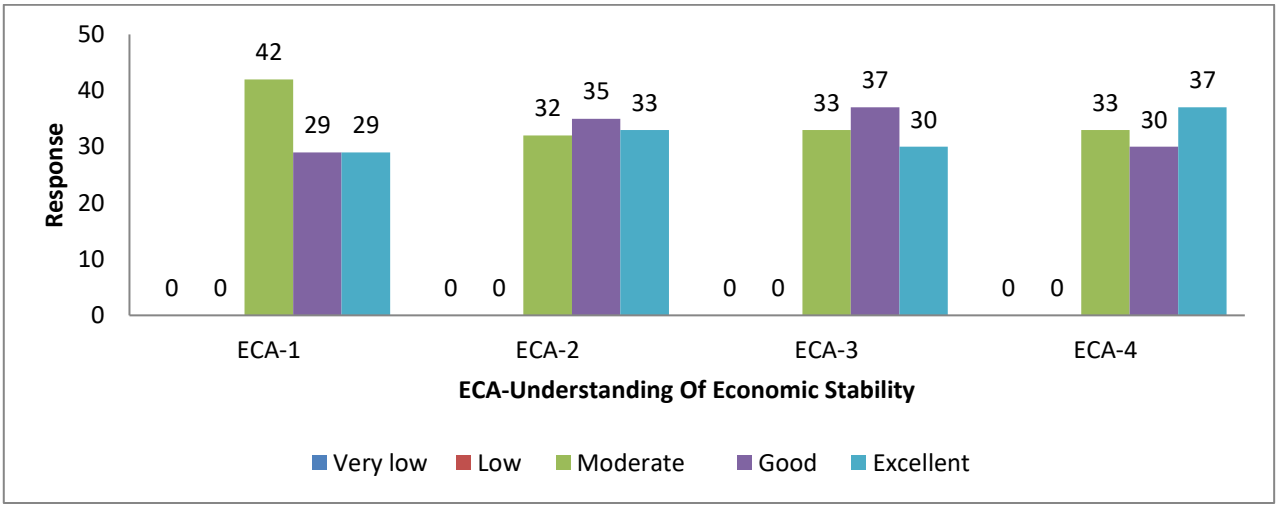

Figure 7Developers Awareness of Economic stability from sustainable construction in India

Figure 8 displays the actual implementation status of sustainable buildings. The developers fully understand the concept of sustainable housing but when it comes to actual implementation 39% of developer's fails to assure that whether they are able to optimize the existing infrastructure. This is followed by 27% of developers who fail to address the reduction in indirect costs associated in the construction of green buildings.

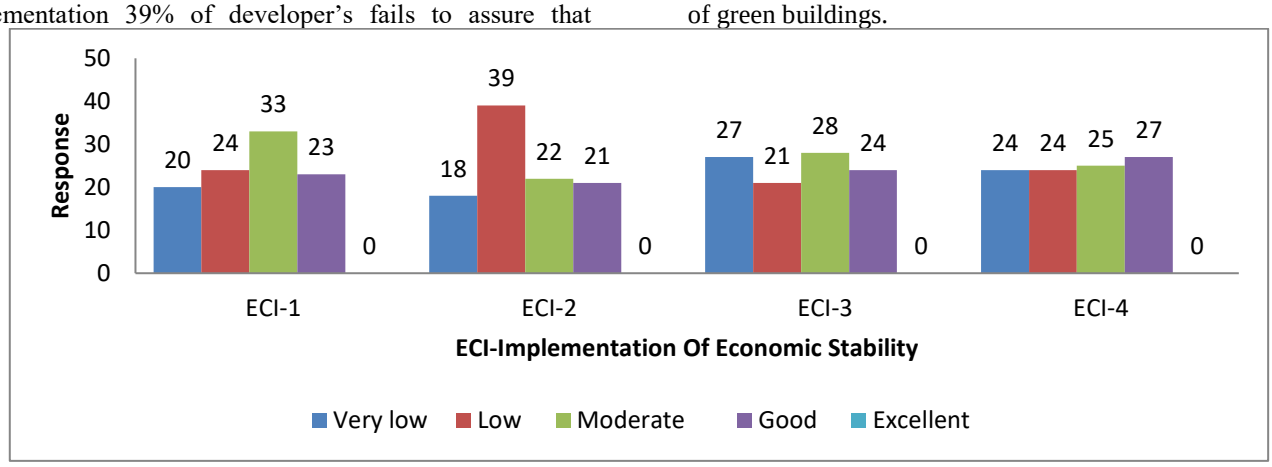

Figure 8 Implementation status of sustainable construction in India as per perceived economic benefits

As for social sustainability, it was found that Accessibility to facilities, Safety/security to occupant/tenure, Tenant participation in design and management, Better quality of housing and living environment, social network and harmony, are all perceived as important.

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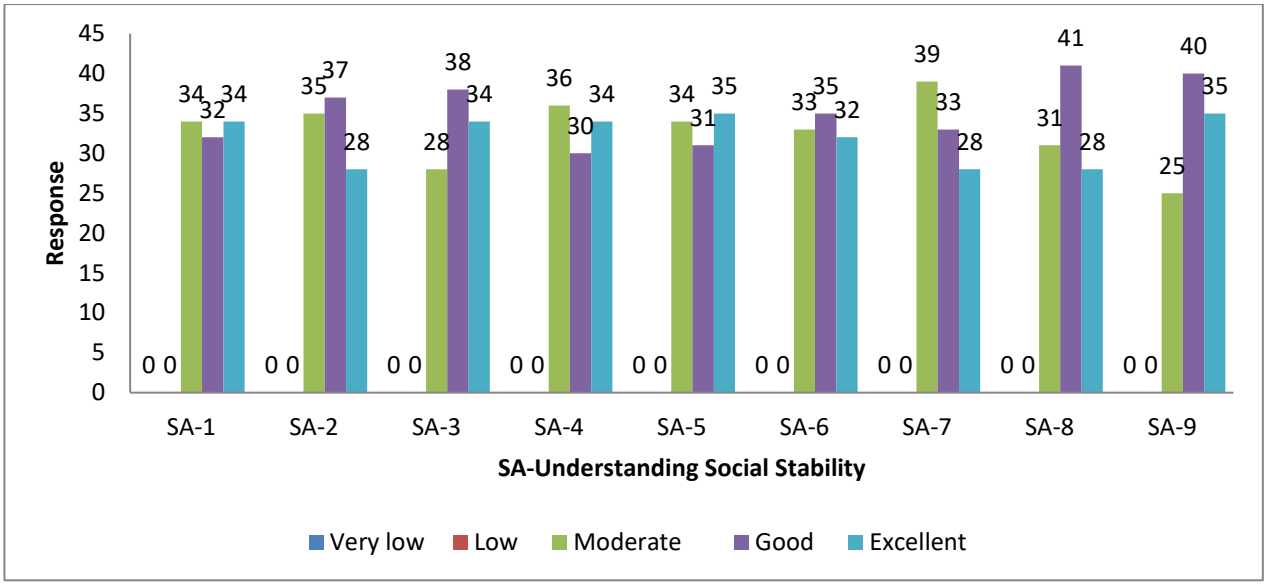

Figure 9Developers Awareness of Social stability from sustainable construction in India

However when it comes to implementation, elements such as; design aims for present and long-term use, better quality of housing and living environment, encouragement of social networks and social solidarity in neighborhood, impact of housing quality on physical and mental health of occupants. This can be inferred from the low responses of the developers when enquired about the implementation status of construction in India as per perceived social benefits.

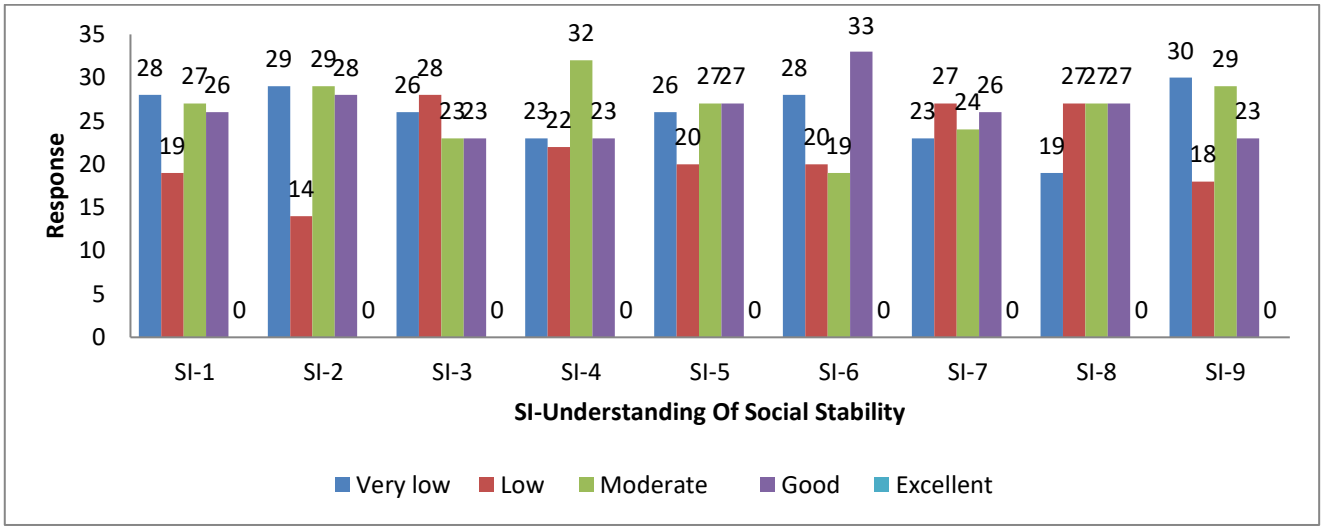

Figure 10 Implementation status of sustainable construction in India as per perceived social benefits

Thus, it is deduced that majority of the respondents understand that sustainable construction practices is about protecting the environment and preserving the social and economic aspects of the construction. The continuous efforts of the government to raise understanding on environmental awareness of sustainable construction has led to the situation where large percentage of participants (31%) are taking efforts to develop knowledge on the concept of green building. Also, (37%) of participants are willing to take action to implement green building practices. Despite this, the level of implementation of sustainable practices is either low or moderate. This might be because of lack of enforcement and existing law and legislation. Government is the only source that can readdress this situation through enforcing legislation, devising new policies, or giving incentives to developers who are willing to pursue sustainability into their projects. In case the demand for the sustainable buildings is increased, the interest on the developer's side towards development of sustainable buildings will also increase. Since, this aspect of construction is not publicized to its full potential; it is neither in the priority list of the purchasers nor is in the interest of the prospective buyers.

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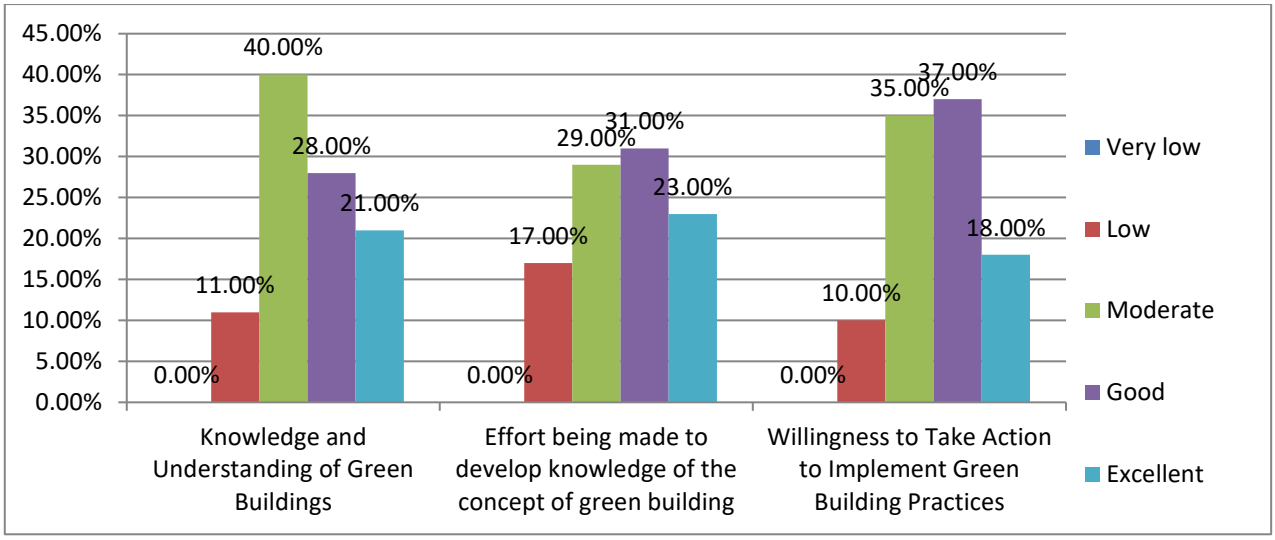

Figure 11 Developers awareness and knowledge

Another aspect of research survey was to undertake to a structured and an unstructured interview. A firm conclusion was not drawn from the unstructured interview as the information given by the interviewee couldn't be categorized. For structured interview the interviewee showcased lack of knowledge about the subject. Hence results drawn from these interviews are exempted from analysis.

Interviews are concluded are as follows.

1.Unstructured Interview

Part A: Introduction.

Interview of Mr. PrassanaBachuwar was taken who is a civil engineer by profession, working with a private firm in legal and permissions department from last three years.

Part B: Understanding of Environment stability, Economic Stability, Social Stability.

First question asked was what did he understand by environment stability. According to him environment stability meant construction work done for maintaining ecological balance. The second question was understanding of economic stability to which he commented, understanding of economics was restricted to cheap loans and its repayment. Later when enquired about the understanding of developer's social responsibility he answered social responsibility is giving value for money.

Part C: Implementation of Environment stability, Economic Stability, Social stability.

When questioned about implementation of environment stability he mentioned that there was no proper implementation of all the factors pertaining to sustainable environment and mainly focused on green buildings rather than the stability of environment. When asked about implementation economic stability he answered that the firm was flexible in giving benefits to the customer, if there was positive change in construction market. Answer to the question regarding implementation of social responsibility was providing promised services and recreational areas.

Part D: Factors affecting Sustainable Construction.

According to him willingness to take action by incorporating necessary changes to implement green building practices is the most important factor to promote and implement sustainable construction in India.

2.Structured Interview

Part A: Introduction

A structured interview of Mr. NinadSindgi was taken, who is a civil engineer by profession. He is working in a private firm in administration department from last 3 years with an approximate income above Rs30,000 per month. This interview was conducted to get in-depth information about understanding and implementation of construction practices in India.

Part B: Understanding of Environment stability, Economic Stability, Social Stability.

From the interview it was found that understanding of environment stability was low or very low for energy efficiency, disturbance of environment, quality of end products, certification and ISO 9000 construction activities. Whereas, for factors like site selection, waste management, material selection, sanitation was moderate or good.

Overall Understanding of economic stability was moderate. Understanding of social stability varied from good and moderate except tenant participation and impact of construction on health which was low.

Part C: Implementation of Environment stability, Economic Stability, Social stability.

There was not much gap in Understanding and Implementation of environment stability according to the developer's point of view apart from implementation of ecology which had very low implementation in construction activities in India. It was seen that the economic stability was given importance and efforts were taken in implementation than in understanding it, as greater consideration was given to factors which gave economic profit.

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Implementation of social stability and its understanding did not change much. Hence, it was concluded that social responsibility was given due consideration.

Part D: Factors affecting Sustainable Construction.

It was found that the level of knowledge and understanding of green buildings and willingness to take action by incorporating necessary changes to implement green building practices are of greater importance than efforts being made to develop knowledge of the concept of green/sustainable construction.

RESPONSE OF STRUCTURED INTERVIEW

R=Response

	Code	Item	Very low(1)	Low (2)	Moderate (3)	Good (4)	Excellent (5)
Item	Understanding of Environment stability from Developers point of view						
EVA-1	Choice of site selection					R	
EVA-2	Development effects on ecology				R		
EVA-3	Energy efficiency			R			
EVA-4	Efficiency waste management				R		
EVA-5	Water conservation					R	
EVA-6	Proper sanitation					R	
EVA-7	Building materials selection				R		
EVA-8	Minimization of disturbance to environment			R			
EVA-9	Quality of end products			R			
EVA-10	Guidelines and certifications to adopt green practices		R				
EVA-11	ISO 9000 in construction activities			R			
Item	Understanding of Economic stability from Developers point of view						
ECA-1	Financial issue-housing affordability				R		
ECA-2	Opportunity to optimize existing infrastructure			R			
ECA-3	Life cycle cost of housing/indirect costs				R		
ECA-4	Increase building life cycle span by maintaining building				R		
Item	Understanding of Social stability from Developers point of view						
SA-1	Accessibility to facilities					R	
SA-2	Design for present and long term use					R	
SA-3	Safety/security to occupant/tenure				R		
SA-4	Tenant participation in design and management			R			
SA-5	Better quality of housing and living environment					R	
SA-6	Encouraging social network and harmony				R		
SA-7	Impact of housing quality on physical and mental health			R			
SA-8	Larger space					R	
SA-9	More facilities					R	

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PART C: Please tick the appropriate option against the Implementation status of green building practices as perceived by developers

	Code	Item	Very low(1)	Low (2)	Moderate (3)	Good (4)	Excellent (5)
Item	Implementation of Environment stability from Developers point of view						
EVI-1	Choice of site selection				R		
EVI-2	Development effects on ecology		R				
EVI-3	Energy efficiency				R		
EVI-4	Efficiency waste management			R			
EVI-5	Water conservation					R	
EVI-6	Proper sanitation					R	
EVI-7	Building materials selection					R	
EVI-8	Minimization of disturbance to environment			R			
EVI-9	Quality of end products				R		
EVI-10	Guidelines and certifications to adopt green practices			R			
EVI-11	ISO 9000 in construction activities		R				
Item	Implementation of Economic stability from Developers point of view						
ECI-1	Financial issue-housing affordability				R		
ECI-2	Opportunity to optimize existing infrastructure				R		
ECI-3	Life cycle cost of housing/indirect costs					R	
ECI-4	Increase building life cycle span by maintaining building					R	
	Implementation of Social stability from Developers point of view						
SI-1	Accessibility to facilities					R	
SI-2	Design for present and long term use				R		
SI-3	Safety/security to occupant/tenure					R	
SI-4	Tenant participation in design and management			R			
SI-5	Better quality of housing and living environment				R		
SI-6	Encouraging social network and harmony				R		
SI-7	Impact of housing quality on physical and mental health				R		
SI-8	Larger space					R	
SI-9	More facilities					R	

PART D: Please tick the appropriate option against the one that best suits your answer

NO	Code	Item	Very low(1)	Low (2)	Moderate (3)	Good (4)	Excellent (5)
	Developers awareness and knowledge						
1	Level of Knowledge and Understanding of Green Buildings					R	
2	Effort being made to develop knowledge of the concept of green/sustainable construction				R		
3	Willingness to Take Action by Incorporating Necessary Changes to Implement Green Building Practices					R	

5. CONCLUSION AND RECOMMENDATION

The initiatives of the government have led to a situation where increasing number of developers have accepted the concept of sustainable construction and are beginning to integrate the concept of sustainability into their forthcoming projects or existing projects. The results of the study are aligned to the drivers discussed in the green building literature that are encouraging industry players to implement sustainability into their projects and attract the potential buyers by publicizing green as an emerging phenomenon (Hydes& Creech, 2000; Pettifer, 2004; Yates, 2001). Yet, the acceptance of this concept has not taken place at a larger scale. Many small and medium developers still rely upon traditional construction practices due to lack of knowledge, capital and experience. Results revealed greater willingness of developers to implement sustainable green building practices in their projects. Yet, the implementation status was found to be low. This might be because of lack of professional training, knowledge, skills, education, associated norms and policies, capital and submissive culture etc. The economic benefits of sustainable construction practices as perceived by the developers is in congruence with the

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tangible and non-tangible benefits of sustainable practices as dictated by CII, (2007). In order to increase the acceptance of sustainable construction practices, following steps should be taken:

1. All associated industries should be encouraged to attend seminars, workshops and other training programs being organized at various eventsto develop and strengthen their knowledge of sustainable development concept.

2. Government should restructure the existing laws and policies of the construction practices to re-enforce the concept of sustainability and ensure its successful implementation.

3. The Government can also encourage participation of developers by giving them indirect incentives in the form of tax rebates. The timeline of the approval process should be minimized to encourage large small and medium size developers in construction of green buildings.

4. The results of the study revealed low implementation status of green buildings. Actions must be initiated by the industries and government to apply sustainable construction practices in future projects. Research should be carried out to assist developers and consultants in integrating sustainable issues at the conceptual and planning stage itself. Guidelines and emerging innovation technologies recommended as a result of the research will be beneficial for the industry players to maintain quality standards similar to the former buildings.

5. Perceived benefits of green buildings should be explained clearly both to the customers for increasing the demand and developers; to ensure effective supply of sustainable houses.

6. All industry agents including developers, marketers, contractors, authorities, manufacturers as well as customers play a critical role in successful implementation of a green building project. Detailed research should be carried out to investigate how each agent contributes to the success of a sustainable project.

7. Government plays a critical role in successful completion of sustainable project. Study on existing legislative policies of construction industry should be carried out to identify the potential areas that need to be changed and altered to ease the problem of 'absence of enforcement'.

8. Sustainable building practices are increasingly understood as practices adopted for combating the harmful effects of construction related activities on its environment. Research needs to be undertaken to publicize amongst developers as profit driven. Potential societal benefits of green buildings should be elaborated to the developers to accept this form of construction.

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APPENDIX-A
QUESTIONNAIRE
PART A: Please choose the appropriate option.

Age	1. Under 21 years 2. 21-30 years 3. 31 to 40 years 4. 41 to 50 years 5. 51 to 60 years 6. 61 to 65 years 7. Over 65 years	
Gender	1. Male 2. Female	
Qualification	1. Matriculation 2. Intermediate 3. Graduation 4. Master 5. M.Phil./PhD	
Organizational Tenure/Length of Service	1. Less than 1 year 2. 1 to 3 years 3. 4 to 10 years 4. 11 to 20 years 5. More than 20 years	
Department	1. Estimating 2. Administrating/Accounting 3. Drafting 4. Sales 5. Project Management 6. Operations Management 7. Other (Please specify)	
Income	1. Less than Rs. 10,000 2. Rs. 10,001-20000 3. Rs. 20,001-30,000 4. Above Rs. 30,000	
Type of Organization	1. Government sector 2. Private sector	
What are the driving factors behind Green building construction?	1. Educational programs 2. Set rules and legislations 3. Green design guidelines and construction standards 4. Economic incentives	

PART B: Please tick the appropriate option against the perceived benefit of Green building.

	Code	Item	Very low(1)	Low (2)	Moderate (3)	Good (4)	Excellent (5)
Item	Understanding of Environment stability from Developers point of view						
EVA-1	Choice of site selection						
EVA-2	Development effects on ecology						
EVA-3	Energy efficiency						
EVA-4	Efficiency waste management						
EVA-5	Water conservation						
EVA-6	Proper sanitation						
EVA-7	Building materials selection						
EVA-8	Minimization of disturbance to environment						
EVA-9	Quality of end products						
EVA-10	Guidelines and certifications to adopt green practices						
EVA-11	ISO 9000 in construction activities						
Item	Understanding of Economic stability from Developers point of view						
ECA-1	Financial issue-housing affordability						
ECA-2	Opportunity to optimize existing infrastructure						
ECA-3	Life cycle cost of housing/indirect costs						
ECA-4	Increase building life cycle span by maintaining building						
Item	Understanding of Social stability from Developers point of view						
SA-1	Accessibility to facilities						
SA-2	Design for present and long term use						
SA-3	Safety/security to occupant/tenure						
SA-4	Tenant participation in design and management						
SA-5	Better quality of housing and living environment						
SA-6	Encouraging social network and harmony						

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SA-7	Impact of housing quality on physical and mental health						
SA-8	Larger space						
SA-9	More facilities						

PART C: Please tick the appropriate option against the Implementation status of green building practices as perceived by developers

	Code	Item	Very low(1)	Low (2)	Moderate (3)	Good (4)	Excellent (5)
Item	Implementation of Environment stability from Developers point of view						
EVI-1	Choice of site selection						
EVI-2	Development effects on ecology						
EVI-3	Energy efficiency						
EVI-4	Efficiency waste management						
EVI-5	Water conservation						
EVI-6	Proper sanitation						
EVI-7	Building materials selection						
EVI-8	Minimization of disturbance to environment						
EVI-9	Quality of end products						
EVI-10	Guidelines and certifications to adopt green practices						
EVI-11	ISO 9000 in construction activities						
Item	Implementation of Economic stability from Developers point of view						
ECI-1	Financial issue-housing affordability						
ECI-2	Opportunity to optimize existing infrastructure						
ECI-3	Life cycle cost of housing/indirect costs						
ECI-4	Increase building life cycle span by maintaining building						
	Implementation of Social stability from Developers point of view						
SI-1	Accessibility to facilities						
SI-2	Design for present and long term use						
SI-3	Safety/security to occupant/tenure						
SI-4	Tenant participation in design and management						
SI-5	Better quality of housing and living environment						
SI-6	Encouraging social network and harmony						
SI-7	Impact of housing quality on physical and mental health						
SI-8	Larger space						
SI-9	More facilities						

PART D: Please tick the appropriate option against the one that best suits your answer

	Code	Item	Very low(1)	Low (2)	Moderate (3)	Good (4)	Excellent (5)
	Developers awareness and knowledge						
	Level of Knowledge and Understanding of Green Buildings						
	Effort being made to develop knowledge of the concept of green/sustainable construction						
	Willingness to Take Action by Incorporating Necessary Changes to Implement Green Building Practices						

Unstructured Interview

Structured Interview