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Sustainable Construction Performances: Challenge and Limitation to Successful Adoption in Construction Industry

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Abstract. Project management is very vital in the construction industry and sustainability is concerned with the impact of environmental issues and overwhelming concern over climate change. Nowadays, sustainable construction has become the key demand in the construction industry globally. However, sustainable construction in bangladesh still facing impediments, as there is a deficiency of efficient project management framework. This study aims to identify the most influencing barriers to implement the sustainable practices in the construction industry of khulna city area of bangladesh as well as proposing some solutions to overcome the major barriers. Questionary survey and interviews have been conducted among various stakeholders and industry experts in the khulna city area.this study has revealed that lack of knowledge on sustainable construction, client does not agree with the proposal, lack of qualification of construction engineer, lack of qualification of project manager, unfamiliarity with sustainable technologies, lack of sustainable planning, workers' unaware of the correct methods and procedures, unfamiliarity with sustainable technologies, high cost of projects have been the main barriers for implementation of sustainable construction in khulna city of bangladesh. Knowing the most influencing barriers are must for the attainment of sustainability in construction sector. So, this study will help the stakeholders for the implementation of sustainable construction practice.

Keywords: Sustainable Construction, Sustainability, Barriers, Stakeholders, Khulna City

1. Introduction

Sustainable improvement refers to take care and minimize the potential negative

environmental impacts. The concept of sustainable development has been open to a wide range of interpretations. Sustainable construction aims to meet present day needs without compromising the ability of future generations to meet their own needs in times to come. It incorporates the best use of resources.

Sustainable construction involves issues such as the design and management of buildings; materials performance; construction technology and processes; energy and resource efficiency in building, operation and maintenance; robust products and technologies; long-term monitoring; adherence to ethical standards; socially-viable environments; stakeholder participation; occupational health and safety and working conditions; innovative financing models; improvement to existing contextual conditions; interdependencies of landscape, infrastructure, urban fabric and architecture; flexibility in building use, function and change; and the dissemination of knowledge in related academic, technical and social contexts.

The building construction industry is considered as one of the fastest and biggest sector in Bangladesh. It has a significant role within the overall infra-structural improvement of the Bangladesh and its economic system. In terms of employment, it has been growing at 7.3 percent during 1991-2006 periods. The growth price in terms of GDP has been 6.7 percent during 1995-96 to 2008-2009 (record via WCC). In 2008-2009, total employment has stood at 2.024 million. Even on the modern-day boom rate, the whole employment within the construction sector will growth to 2.88 million through 2014 and 3.32 million through 2020 (document with the aid of WCC). Even though production industry is developing in every town of Bangladesh, the exquisite increase has started from the capital town Dhaka. However, constructing production era has not evolved to the quantity as that determined in advanced nations (Ahmed, Siddiquee et al. 2012).

Many research has been conducted around Bangladesh about the safety issue, cause of delay, risk analysis, accident analysis. Despite the similarity in findings of previous studies worldwide, the situation in each country, due to its different and not influenced socio-economic-politic context, requires a particular diagnosis. The intention of this survey-based research is to identify the barriers to sustainable construction practices in Khulna City. It is hoped that the outcomes of this study enrich knowledge about the current state of, drivers of, and barriers to sustainable construction in Khulna City and form a significant base for future SC work within the country.

2. Literature Review

A review of the relevant literature reveals that the status of the industry (in regards to sustainability) in developing countries is not promising, which is apparent from the low level of awareness and the lack of knowledge of its stakeholders. In fact, there is a similar picture in developed countries, as the focus in those countries is mainly on the economic aspects of sustainability (Serpell, Kort et al. 2013) . The review also found that the main factors hindering implementation of sustainability in the construction industry are lack of education and training on sustainable construction (SC), technologies, capacities and, more importantly, policies for the development and successful implementation of sustainability practices. The conventional wisdom is that there is a long way to go to achieve a sustainable construction industry, and this process needs an input from all industry stakeholders; however, it is important to get a clear picture of the current situation as a starting point (Du Plessis 2002, Abidin 2010).

Fernández-Sánchez and Rodríguez-López (2010) have conducted a research based on the risk management standards to identify sustainability indicators in construction project management in Spain. In that paper, a method to identify and selecting an indicator has been established that included every participant involvement in the life cycle of a project, to find a proper balance between all actors.

Du Plessis (2007) has addressed sustainable problems in a way that is socially and ecologically responsible. The paper described the meanings of the implementation the suggestions of "Agenda 21 for Sustainable Construction in Developing Countries" at a local level by developing regional and national action plans. However, there are a number of encounters for the starter of sustainable construction technologies and practices to implement a more sustainable path.

Warnock (2007) has conducted a literature review to find out the integrating instruments to achieve sustainable construction and buildings. The purpose of that paper is to seek to contribute to the objective of the sustainable development process. Finally, that article has advised a simple, practical structure and instruments, aiming at facilitating sustainable construction and buildings.

Singh, Murty et al. (2009) has stated that there had been number of initiatives exist on indicators and frameworks for sustainable development. This article is focused on an overview of various sustainability indices to measure sustainable development. And efforts have been adopted to accumulate the information about how the index were formulated using the three central steps viz. –

normalization, weighting, aggregation. If the indices were executed poorly, this will provide misleading results.

Waris, Liew et al. (2014) have conducted a research on on-site sustainable construction equipment selection by using both the qualitative and quantitative research methods. The authors has stated that during the construction phase, selection of right equipment are always a key factor in the success of any sustainable construction project.

Yang and Yang (2015) have conducted a quantitative questionnaire study, a qualitative interview study to establish a hierarchical model that encompasses critical factors affecting the execution of sustainable housing in Australia. 12 critical factors and their interrelationships were identified based on professional views in the Australian housing industry.

Ali and Al Nsairat (2009) have studied on international green building assessment tools such as such as LEED, CASBEE, BREEAM, GBTool, for a better understanding of the concept of green building assessment tool and its role for achieving sustainable development through developing an effective green building rating system for residential units in Jordan. For those purpose multi-dimensional design strategy have been adopted that involved a variety of approaches – quantitative and qualitative. Fieldwork approach (pilot study, survey), questionnaire, interviews are the strategic approaches. In other words the research is based on interaction between archival ethnographic approach and qualitative interviews.

Khodadadzadeh (2016) has presented a review on recent advances dedicated on different state-of-art articles in the area of green building. Author also states that the green building practice extends and supplement the traditional building design perspectives including economy, utility, durability, and comfort. The paper has raised serious concern to take the necessary actions for green building development.

Robichaud and Anantatmula (2010) have conducted a detailed analysis using matrix present specific adjustments to traditional project management practices. The aim of this paper is to propose specific modifications to conventional building practices to optimize the delivery of cost-efficient green building projects. Finally, this paper has offered an overview of research related to the costs and trends of green building and uses of these research findings to make recommendations for greening project management practices for the construction industry.

Shelbourn, Bouchlaghem et al. (2006) have made a research on “managing knowledge in the context of sustainable construction”. This paper shows that

although indicators, checklists and assessment tools for sustainability in construction is readily available, there is still a need for a structured approach for the implementation of sustainability practices and methods within construction projects. This need has determined from interviews conducted within the C-Sand project, analyzed and subsequently translated into a sustainability management tool for construction projects.

Hoffman and Henn (2008) have researched and argued that environmental progress in the building design and construction industry will continue to stall if the significant social and psychological barriers that remain are not addressed. The level of barriers are determined by surveying and they are individual, organizational, and institutional. Finally, the article has concluded with strategies for overcoming them and stated seven specific strategies, are explained, namely, issue framing, targeting the right demographic, education, structural and incentive change, indemnifying risk, green building standard improvements, and tax reform.

Shen, Tam et al. (2010) has introduced a new approach for conducting project feasibility study by embracing the principles of sustainable development practice with reference to the Chinese construction industry. They has conducted a case study research method in this study. The research team collected 87 feasibility study reports from various projects to measure project performance. The paper also includes 18 economic performance attributes, 9 social performance attributes, and 8 environmental performance attributes. Finally, the study explained and suggested that there is a need for shifting the traditional approach of project feasibility study to a new approach that embraces the principles of sustainable development.

Powmya and Abidin (2014) has conducted a survey among construction practitioners in Oman focusing on the current progress and barriers of implementation of green construction. The author has identified a total of 12 barriers of implementation for green construction. The lack of demand for green construction and lack of pressure by government were the top two. Finally, the authors has suggested that many more efforts have been necessary to push green construction to the forefront and the government has to play a player's role in this development.

Chan, Darko et al. (2016) have researched with an aim to examine the criticality of various barriers preventing the wider adoption of Green Building technologies. The authors have piloted a questionnaire survey from different countries and with diverse backgrounds. From 104 questionnaire survey responses from GB experts around the world are presented. The results

validated the criticality of 19 of the 26 barriers used for the survey. Resistance of stakeholders to change and higher cost are identified as the most critical barriers to implementing Green Building technologies. The factor analysis showed that the barriers to GB technologies adoption could be grouped into five main interrelated components, which suggest the need for holistic and integrated strategies to overcome the barriers.

Darko and Chan (2017) presented a systematic review of literature on barriers to GB adoption published in academic journals. It has been found that lack of information, cost, lack of incentives, lack of interest and demand, and lack of GB codes and regulations are the most reported barriers in the literature. Recommendations are offered to overcome the barriers to facilitate the adoption of GB. This review provides a valuable reference for both industry practitioners and policy makers to implement GB.

Hwang, Zhu et al. (2017) made a study and questionnaire survey with 40 experts in Singapore and post-survey interviews to: (1) investigate and assess the barriers hindering the adoption of GBPs; (2) assess the impact of the barriers on project management goals; and (3) propose feasible solutions for overcoming current barriers and thus promoting the adoption of GBPs. To achieve the objectives, 15 barriers and 21 solutions were identified from a comprehensive literature review. Through, the results first revealed that the top three barriers were “perceived higher initial capital costs”, “uncertain tradeoff between environmental and financial benefits” and “lack of government support”.

Durdyev, Zavadskas et al. (2018) has been used an empirical questionnaire survey targeting local construction professionals, respondents were invited to rate their level of awareness, knowledge and understanding of SC, as well as to rate the level of importance of 31 drivers and 10 barriers identified from the seminal literature. This paper investigates industry stakeholders’ awareness of the current state of, factors driving, and barriers hindering the adoption of sustainable construction (SC) in Cambodia. The data set was subjected to the relative importance index method. The results suggest that the industry-wide adoption of SC practices is poor, which is believed to be due to a lack of awareness and knowledge, and reluctance to adopt new sustainable technologies.

Ding (2008) has researched to examine the development, role and limitations of current environmental building assessment methods in ascertaining building sustainability. They also discuss about the concept of developing a sustainability model that will allow alternatives to be ranked is discussed in detail in the paper. However, little or no concern has been given to the importance of selecting more environmentally friendly designs during the project appraisal stage; the

stage when environmental matters are best incorporated.

Bourdeau (1999) has represented an international study to present and to take account of the specific city and orientations of various countries. The study investigates the relationship and defined links between the principles of sustainable development and the construction sector. Drawing on information from 14 countries, the study identified main issues, constraints and current policies, predicted changes and adaptations for the construction sectors in each country.

3. Methodology

Sustainability is very vital issue now-a-days. The methodology applied in this research is a questionnaire survey and direct interviews. The flow diagram of this research has been styled in figure-1 Firstly, Sustainability study has been performed. Then the literature review on sustainable construction has been accomplished and the sustainable factors has been selected. Then the questionnaire format was developed according to some criteria. In figure-2, questionnaire design parameter's has been classified. Finally, it has been analysed in SPSS.

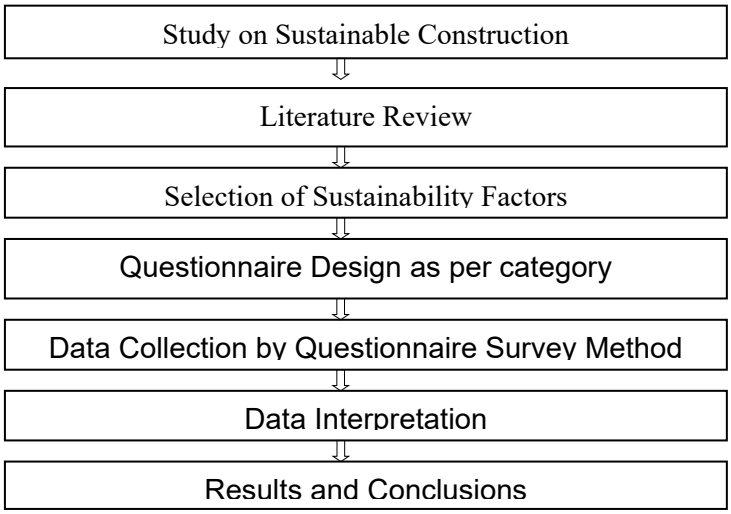

Fig.1. Flow Diagram of Methodology

Data preparation is of crucial importance before starting the data analysis stage. This study adopted a Likert scale rating of influence level from 1 to 5 where 1 stands for "Very less" and 5 for "Very high" influence of the drivers and barriers collected via the face to face questionnaire survey. Once the data

were prepared in a suitable form for the statistical package used, the next step of the research process adopted in this study was the analysis of the data.

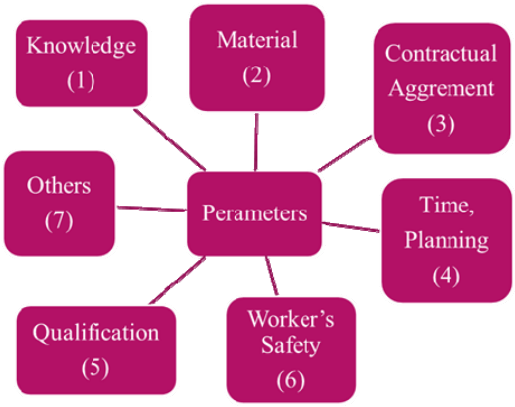

Fig.2. Selection criteria of sustainability factors

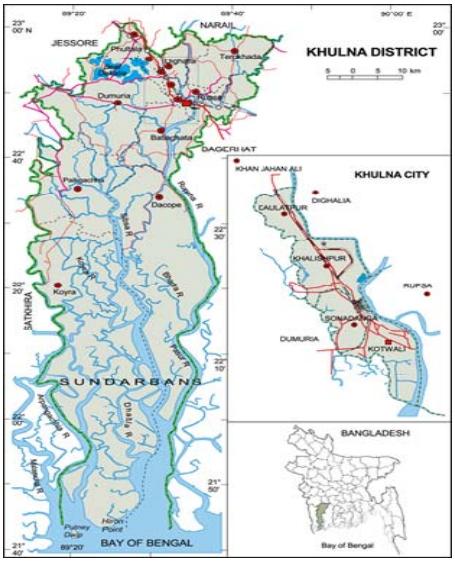

Fig.3. Survey locations in Khulna city

This study aimed to prioritize the identified drivers and barriers of Sustainable Construction in Khulna according to their importance, using the RII method. For each driver and barrier, the RII was calculated using equation-1:

$$RII = (\sum W) / (N \times A) \quad (1)$$

In Eq. (1),

W= weighting of each driver or barrier given by respondents;

A = highest weight, which is 5 for this study;

N = total number of respondents.

The study adopted questionnaire survey as a method to identify the underlying factors affecting the implementation of sustainable construction in construction projects. Surveys through questionnaires were found effective because of the relative case of obtaining standard data appropriate for achieving the objectives of this study. Based on the literature cited various factors were selected. The study was conducted by developing a questionnaire and collecting the responses from 34 individuals (20 workers, 8 Contractors, 6 Engineers) from construction sites around residential area in Khulna City. The survey area has been cited in figure-3.

4. Data RELIABILITY & Analysis

The required data for this study was collected from stakeholders of construction industry. So it is necessarily essential to analysis to check the reliability and validity of the independently collected data. The Cronbach's Alpha test is conducted by the software of Statistical Package for the Social Science (SPSS). Table 1 and 2 represent the Cronbach's Alpha test result of this research.

Table 1. Case processing summary

		N	%
Cases	Valid	50	100.0
	Excluded	0	.0
	Total	50	100.0

Table 2. Reliability statistics

Cronbach's Alpha	Cronbanch's Alpha Based on Standardized items	N of Items
0.825	≥0.7	50

Table 3, 4, 5 represents the result of responses on respect to worker,

contractor and engineer respectively. The data has been collected through questionnaire survey. The data were analyzed by SPSS software. Mean, Standard Deviation, Variance were determined from that data. Finally, the Relevant of Importance Index (RII) was determined according to equation-1.

Table 3. Survey Response Result According to Worker with RII

Sustainability Factors	Worker's perspective		
	Mean	RII	Rank
High Cost of Projects	3.889	0.029	5th
Lack of Knowledge on Sustainable Construction	4.722	0.035	1st
Is familiar with the word sustainability?	3.556	0.026	8th
Lack of Government Support	3.944	0.029	5th
Due to Different Contract Forms of Project Delivery	3.778	0.028	6th
Lengthy approval process for new sustainable technologies	4.333	0.032	3rd
Unfamiliarity with sustainable technologies	4.056	0.030	4th
Lack of communication and interest required amongst project team members	4.111	0.030	4th
More time required to implement sustainable construction practices on site	3.889	0.029	5th
Client does not agree with the proposal	4.444	0.033	2nd
Lack of sustainable Planning	3.889	0.029	5th
Labor related challenges	3.611	0.027	7th
Lack of sustainable materials	3.778	0.028	6th
Lack of Qualification of project manager	4.389	0.033	2nd
Lack of Qualification of construction engineer	4.444	0.033	2nd
Weather Condition of Khulna	3.222	0.024	10th
Lack of qualified consultants	4.333	0.032	3rd
Lack of Political Stability	3.389	0.025	9th

Workers' unaware of the correct methods and procedures	4.278	0.032	3rd
Conflict with the architect over the type of material to be used	1.944	0.014	11th

Table 4. Survey Response Result According to Contractor with RII

Sustainability Factors	Contractor's perspective		
	Mean	RII	Rank
High Cost of Projects	4.000	0.030	3rd
Lack of knowledge on sustainable construction	4.333	0.032	2nd
Is familiar with the word sustainability?	2.667	0.020	9th
Lack of Government Support	3.833	0.028	4th
Due to different contract forms of project delivery	3.500	0.026	6th
Lengthy approval process for new sustainable technologies	2.333	0.017	10th
Unfamiliarity with sustainable technologies	4.500	0.033	1st
Lack of communication and interest required amongst project team members	3.500	0.026	6th
More time required to implement sustainable construction practices on site	3.500	0.026	6th
Client does not agree with the proposal	3.667	0.027	5th
Lack of sustainable Planning	4.500	0.033	1st
Labor related challenges	2.833	0.021	8th
Lack of sustainable materials	3.667	0.027	5th
Lack of Qualification of project manager	4.333	0.032	2nd
Lack of Qualification of construction engineer	4.333	0.032	2nd
Weather Condition of Khulna	2.667	0.020	9th
Lack of qualified consultants	4.333	0.032	2nd

Lack of Political Stability	3.000	0.022	7th
Workers' unaware of the correct methods and procedures	4.500	0.033	1st
Conflict with the architect over the type of material to be used	2.000	0.015	11th

Table-5: Survey Response Result According to Engineer with RII

Sustainability Factors	Engineer's perspective		
	Mean	RII	Rank
High Cost of Projects	4.333	0.032	2nd
Lack of knowledge on sustainable construction	4.000	0.030	3rd
Is familiar with the word sustainability?	3.333	0.025	5th
Lack of Government Support	3.667	0.027	4th
Due to different contract forms of project delivery	4.000	0.030	3rd
Lengthy approval process for new sustainable technologies	3.333	0.025	5th
Unfamiliarity with sustainable technologies	4.667	0.035	1st
Lack of communication and interest required amongst project team members	3.667	0.027	4th
More time required to implement sustainable construction practices on site	4.000	0.030	3rd
Client does not agree with the proposal	3.000	0.022	6th
Lack of sustainable Planning	4.000	0.030	3rd
Labor related challenges	4.000	0.030	3rd
Lack of sustainable materials	3.667	0.027	4th
Lack of Qualification of project manager	4.000	0.030	3rd
Lack of Qualification of construction engineer	3.667	0.027	4th
Weather Condition of Khulna	2.667	0.020	7th
Lack of qualified consultants	4.000	0.030	3rd

Lack of Political Stability	3.000	0.022	6th
Workers' unaware of the correct methods and procedures	4.000	0.030	3rd
Conflict with the architect over the type of material to be used	3.000	0.022	6th

5. Results

5.1 Worker's Perspective

Figure-4 represented the radar chart of Relevant Important Index (RII) vs Sustainability factor according to worker's perspective. The RII of the sustainability factor has been shown in column table-3.The RII value was used to present the desired graphical representation in radar chart. It was represented on the y-axis and the horizontal axis (radius) is used for the representation of the sustainability factor. The most influencing barrier is situated at the most outer part of the radar chart. Finally, the rank has been displayed in table-3 and it was determined with the help of the figure-4.

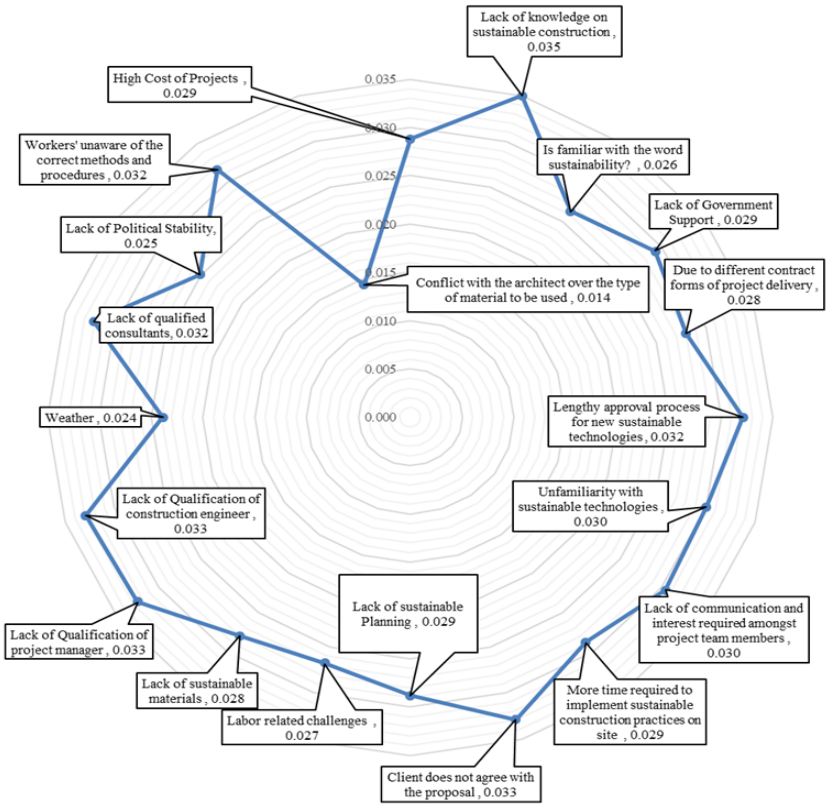

Fig.4. Radar chart: RII vs Sustainability Factor(worker's perspective)

5.2 Contractor's Perspective

According to contractor's perspective figure-5 shows a chart of Relevant Important Index (RII) vs Sustainability factor. In table-4 the RII of the survey result has shown. This value is used to present the desired graphical representation in chart. The RII is represented on the y-axis and the horizontal axis (radius) is used in order to show the sustainability factor. At the most outer part of the chart the barrier which influenced the most was situated. In the end the rank has been displayed in table 4 and it was determined with the help of the figure-5.

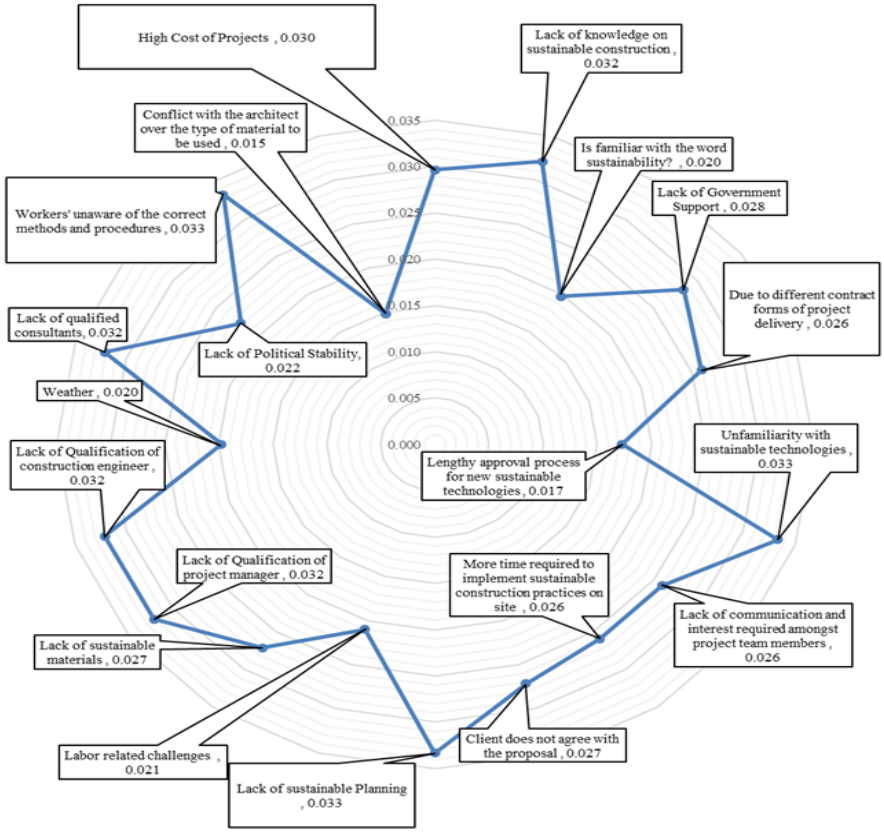

Fig.5. Radar Chart: Sustainability Factors vs RII (contractor's perspective)

5.3 Engineer's Perspective

The radar chart of Relevant Important Index (RII) vs Sustainability factor according to engineer's perspective represented in figure-6. In table-5 the RII of the survey result has been shown. The RII is used to present the desired graphical representation in radar chart. The horizontal axis (radius) is used for the representation of the sustainability factor and the RII is represented on the y-axis. At the most outer part of the radar chart the most influencing barrier was situated. Relevant Importance Index (RII) vs Sustainability Factor as engineer's perspective is a key diagram in the research and it has been shown in figure-6. Last but not the least in table-5 the rank has been displayed and with the help of the figure-6 it was determined.

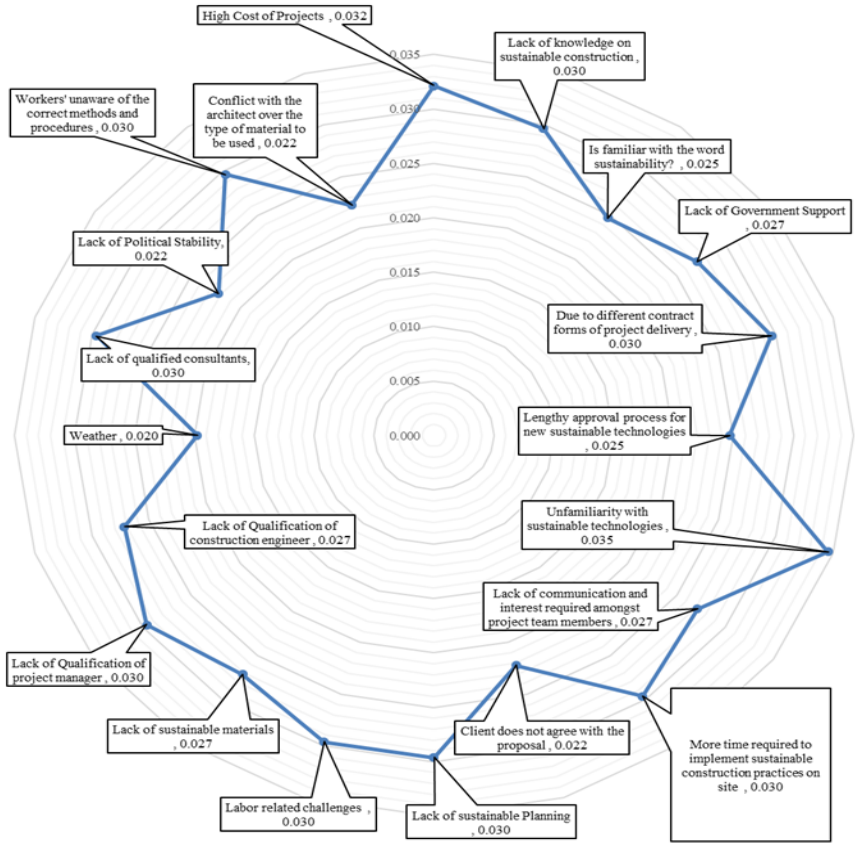

Fig.6. Radar Chart: sustainability factors vs RII(engineer's perspective)

Finally, a summary of top 5 sustainability factor has been tabulated on table 6. The table has formed with the help of table-3,table-4,table-5. These have been the table of rank according to stakeholders e.g. workers, contractors, engineer.

Table 6. Top 5 sustainable factors according to Ran

Rank	Worker's Perspective	Contractor's Perspective	Engineer's Perspective
1st	Lack of knowledge on sustainable construction	Unfamiliarity with sustainable technologies	Unfamiliarity with sustainable technologies
		Lack of sustainable Planning	
		Workers' unaware of the correct methods and procedures	
2nd	Client does not agree	Lack of knowledge on	High Cost of Projects

	with the proposal	sustainable construction	
	Lack of Qualification of construction engineer	Lack of Qualification of project manager	
	Lack of Qualification of project manager	Lack of Qualification of construction engineer	
		Lack of qualified consultants	
3rd	Lengthy approval process for new sustainable technologies	High Cost of Projects	Lack of knowledge on sustainable construction
			Due to different contract forms of project delivery
			More time required to implement sustainable construction practices on site
	Lack of qualified consultants		Lack of sustainable Planning
			Labor related challenges
	Workers' unaware of the correct methods and procedures		Lack of Qualification of project manager
			Lack of qualified consultants
			Workers' unaware of the correct methods and procedures
4th	Lack of communication and interest required amongst project team members	Lack of Government Support	Lack of Government Support
			Lack of communication and interest required amongst project team members
	Unfamiliarity with sustainable technologies		Lack of sustainable materials
			Lack of Qualification of construction engineer
5th	Lack of Government Support	Client does not agree with the proposal	Is familiar with the word sustainability?
	High Cost of Projects		
	More time required to implement sustainable construction practices on site	Lack of sustainable materials	Lengthy approval process for new sustainable technologies
	Lack of sustainable Planning		

6. Conclusions and Recommendations

This study has focused on the obstacles for sustainable construction in Khulna City, Bangladesh. Contractor, Worker, Engineer are the major and driving

stakeholders in this research. The data are collected through questionnaire survey and direct interviews. 20 factors were selected as a barrier or obstacles to sustainable construction. The results have been interpreted on the basis of RII. From the perspective of major parties the results are described. Among the barriers, lack of knowledge on sustainable construction (RII= 0.035) is the most influencing barrier according to worker's perspective. Other impelling barriers are Client does not agree with the proposal; Lack of Qualification of construction engineer; Lack of Qualification of project manager. Weather Condition; Conflict with the architect over the type of material to be used were counted as less persuading barrier according to the worker's outlook. Similarly with the help of the rank according to the contractor's perspective Unfamiliarity with sustainable technologies (RII=0.033) and Lack of sustainable Planning(RII=0.033) are the most influencing barrier. Lengthy approval process for new sustainable technologies; Conflict with the architect over the type of material to be used were counted as less effected barrier from contractor's perception. And, the last stakeholder's viewpoint, who is the major driver of this research, is Unfamiliarity with sustainable technologies are the main obstructions and Conflict with the architect over the type of material to be used and Weather were identified as less influencing barriers. Finally the authors are hopleful that the research will help the stakeholders for the implementation of sustainable construction practice.

7. Recommendations for Future Study

Sustainability is very vast. This study limits within the Khulna City. For, the determination of the sustainable obstacles of whole Bangladesh is very difficult, time consuming and costly. If someone wants to study on whole Bangladesh, that will be an appreciated one. Finally, the knowledge of SPSS is very necessary for the analysis of the data.

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