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FACTORS AFFECTING DELAY AND SAFETY ON CONSTRUCTION PROJECTS IN BANGLADESH

Tamim Adnan[1], Md. Saeid Ebna Maleque*[2], Md. Shah Jamal[3] and Md. Habibur Rahman Sobuz[4]

[1]Graduate, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: tamimadnan6240@gmail.com
[2]Graduate, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: ebnamaleque.mdsaeid@gmail.com
[3]Graduate, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: hmmannan2013@gmail.com
[4]Assistant Professor, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: habib@becm.kuet.ac.bd

***Corresponding Author**

ABSTRACT

Construction is the process of constructing or executing a building according to plan. In modern building construction, different professionals participate to construct a construction project. A complete construction according to plan is important as it involves money, the value of assets and it impacts stockholders. The important objectives of construction projects are time, cost, quality, and safety. The most common causes of delays on large-scale construction projects are adverse weather, changes of orders, inappropriate scheduling, inaccurate design, lack of experience, unskilled labor, financial issues, and so on. This paper presents the main factor that affects the construction project's delay in completion and safety on the construction site. After a combination of literature review, and open discussion, a questionnaire was prepared with important factors that affect delay on construction projects. 200 questionnaires were sent to professionals where 75 reports returned back and responses were measured five-point rating system. Construction professionals such as Architectural/Engineering firms (A/E), owners, contractors, workers participated in this questionnaire survey from Dhaka and Khulna Regions. The questionnaire survey also includes the awareness of health and safety on personal protective equipment (PPE) where a four-point rating system to measure how they concern about health and safety on PPE. The results are divided into two subcategories: A/E, owner, and Contractor-workers. The results showed that accident (94%), manpower (86%), environment (84%), equipment (82%) are the main reasons for the delay. Nine out of ten sub factors fo delay are indicated above-average rating on satisfaction. However, A/E's and owners consider that environment, scheduling causes more delays in construction whereas contractors and workers consider these subfactors less severe. In the case of materials, it is vice-versa. The reasons for the different opinions of two subcategories might be described as A/E's and owner's works on technical, decision making, and financing, whereas contractors and workers work on the construction site. A Pareto Chart is drawn from the data and it was found that accident, manpower, environment, equipment, materials, government policy are cause more delay, according to the Pareto principle. The results on the importance of health and safety on PPE showed that 87 percent professional believes that PPE is important for safety on construction site. However, safety measurements are not properly followed in the construction industry in Bangladesh. It was also found that workers have less awareness than other categories of professionals as they lack proper training and equipment. Proper managerial measurements including training, modern techniques, scheduling, financing, safety should be taken in order to minimize factors that affect construction projects.

Keywords: *Construction safety, Delay, Construction project, Government policy, Accident.*

1. INTRODUCTION

Safety is a complex phenomenon and the subject of safety attitudes and performance in construction projects is even more so. In general, accidents at work occur either due to lack of knowledge or training, a lack of supervision, or a lack of means to carry out the task safely, or alternatively, due to an error of judgment, carelessness, apathy or downright reckless (Sawacha, Naoum, & Fong, 1999). Various factors significantly influence construction costs from the estimating stage to project completion. Some factors are intrinsically related to construction organizations that are solely responsible for managing them, whereas others are closely related to the socio-cultural, economic, technological and political environments within which such organizations operate. The latter is usually called global risk factors In the construction industry the risk of a fatality is five times more likely than in a manufacturing-based industry, whilst the risk of a major injury is two and a half times higher (Davis & Tomasin, 1990). All the material-factor contains shortage, changes, delivery, damage, manufacturing sub-factors. Moreover, Manpower contains labor shortage, skill, nationality, language. The equipment has shortage, delivery, productivity subfactors (Assaf, Al-Khalil, & Al-Hazmi, 1995). Financing is the contractor main factor. Environment factor contains climate, earthquake, rain, soil, Scheduling, Controlling Techniques, and monitoring are important factors which has management, leadership, quality subfactors. Government policy contains political conflict, change, sate evolution of subfactors. Previously questionnaire surveys done with various delay factors with each questions was measued different sustems such as five-point rating system (Guha & Biswas, 2013). Researchers from the UAE revealed that 50% of the construction projects in UAE encounter delays and are not completed on time. Approval of drawings, inadequate early planning and the slowness of the owner's decision-making process is the top cause of delay in the UAE construction industry (Faridi & El-Sayegh, 2006). This paper discusses the core factors causes delay for a project affecting safety. Factors were identified through an extensive literature review by a questionnaire survey in different under-construction projects. The findings of the questionnaire will form the basis for structured interviews using the report grid techniques to elicit relevant knowledge to develop a knowledge-based decision support system (Baloi & Price, 2003). The most major factors for delay in a construction project are materials, manpower, equipment, financing, environment, scheduling, control techniques, and monitoring, government and political issues, accidents. Accidents occur at work either due to lack of knowledge or training, a lack of supervision or a lack of means to carry out the task safely or due to an error of judgment and carelessness. Personal protective equipment has a pivotal role in construction safety. This paper also provides a catalouge of essentiality of these factors to everyone.

2. METHODOLOGY

In this study, a combination of literature review, open discussions, surveys, and interviews were conducted with an aim to get the necessary information about the public and private construction projects in Khulna and Dhaka. The investigation was undertaken in two phases. The first phase included a literature search and interviews. Various related international journals, conference papers, and reports are analyzed to mark the factor regarded with delay in construction projects. A questionnaire was prepared with a view to evaluating the frequency of occurrence and the impacts of selected causes. After carefully consideration, 10 subcategories are selected for analyzing delays in construction projects. The questionnaire was personally handed over to the respondents such as Architect/Engineers (A/E), owners, contractors, workers. The questionnaire was asked and convinced in Bangla to the labor in order to have the answers more accurately. The response to each attitudinal question was measured on a five-point rating under the categories of ‘strongly agree’, ‘agree’, ‘neither agree nor disagree’, ‘disagree’, ‘strongly disagree’, where each subfactors numerical values are represented as 5,4,3,2,1 respectively. Another questionnaire surveying was runned*s about awareness of personal protective equipment items such as safety helmets, gloves, eye protection, high-visibility clothing, safety footwear and safety harnesses, which protects the worker against health or safety risks at work. In this questionnaire, the attitude of the questions is measured as ‘Very Important=4’, ‘Important=3’, ‘Less Important=2’, ‘Not Important=1’. In total, 200 questionnaires were sent to individuals of which 75 returned, after evaluating 66 reports found valid for use. The operatives who

completed the questionnaire varied in their trade and they were selected randomly under construction site in Khulna and Dhaka.

3. DATA ANALYSIS AND RESULTS

The result of questionnaire survey of delay analysis summarised in Table 1, where results are divided into two categories: first groups are A/E's and owners of construction projects who are responsible for technical, supervision, and financial matters; the second groups are contractors and workers, who execute projects on the construction site. After analyzing data from Table 1 and Figure 1, two groups have a slightly different opinion on delay in construction. While two groups have a more or less similar opinion on manpower, accident, government policy, financing, their opinion varies on materials, environment, scheduling (more than 0.5). A/E's and owners consider that environment, scheduling causes more delays in construction whereas contractors and workers consider these sub-factors less severe. In the case of materials contractors and workers claims that materials cause delay on-site as it is impossible to work without materials. Numbers on the ranking section in Table 1, illustrates chronological order in which sub factors cause more delay.

Table 1: Summary of sub-factors that causes delay on construction

Type of incident	A/E's and Owners	Contractors and Workers	Average Rate	Average Percentile	Ranking
Materials	3.6	4.2	3.9	78	5
Manpower	4.2	4.4	4.3	86	2
Equipment	3.9	4.3	4.1	82	4
Financing	3.4	3.5	3.4	68	8
Environment	4.7	3.7	4.2	84	3
Scheduling	3.9	3.1	3.5	70	7
Control Technique	3.0	2.6	2.8	56	10
Monitoring	3.2	2.8	3.0	60	9
Government Policy	3.7	3.9	3.8	76	6
Accident	4.6	4.8	4.7	94	1

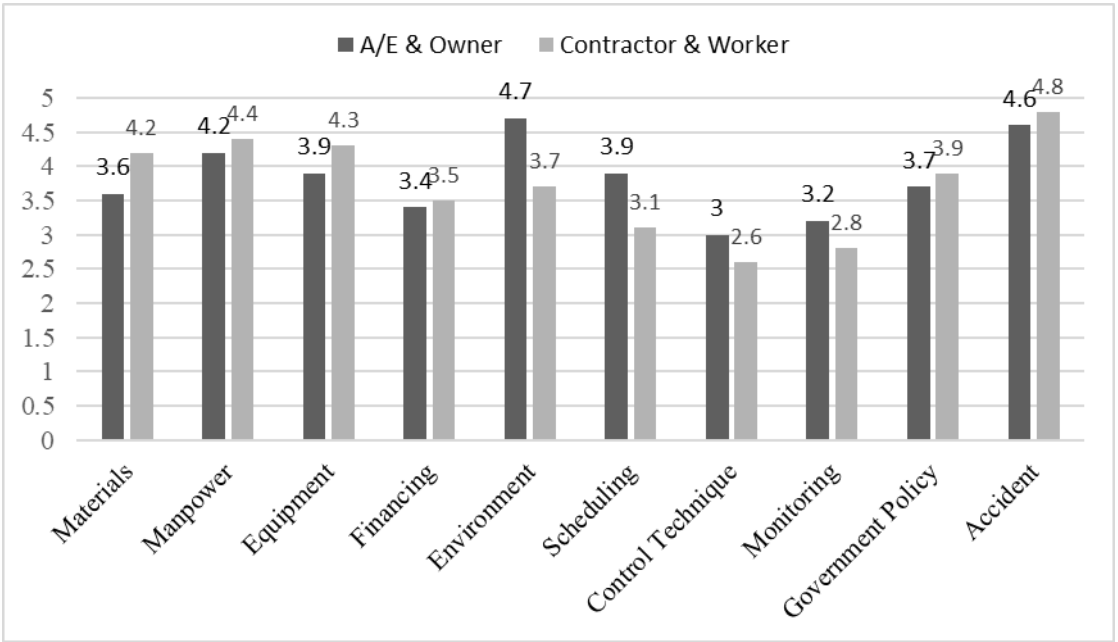


Figure 1: Comparative representation of effecting delay factors through Bar Diagram

Figure 2 represents the Pareto Chart, where the average rate of sub factories is shown in descending order with a cumulative percentile on a secondary axis as a percentile of the total. According to 'Pareto Principle', accident, manpower, environment, environment, materials, government policy considered 'Vital Few' as they stand above 80 percentile, where authority should focus more and target immediately in order to minimize delay on construction while scheduling, financing, monitoring, control technique known as 'Trivial Many', which could be given less importance. The unusual pattern of 'Pareto Line' is because of the uniformity of values of the average rate.

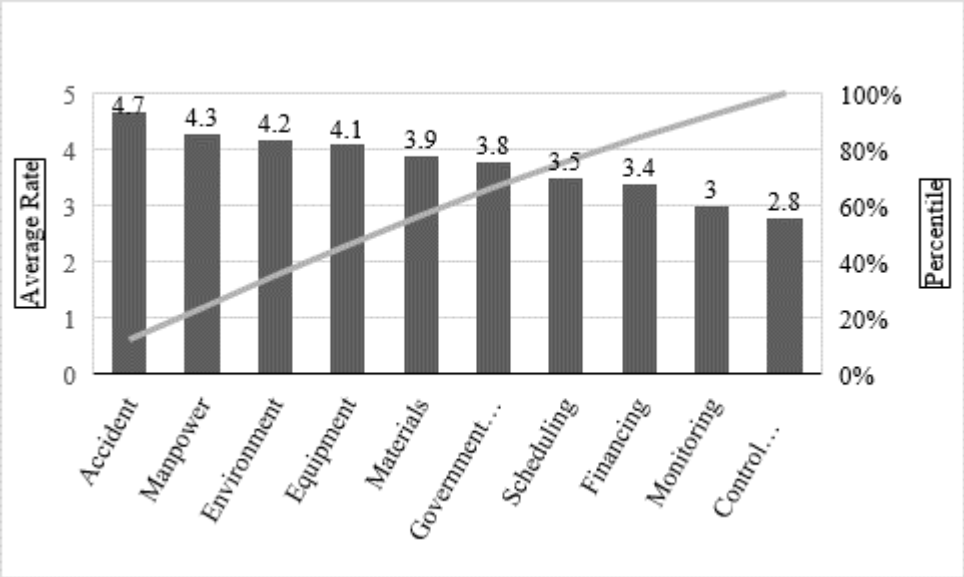
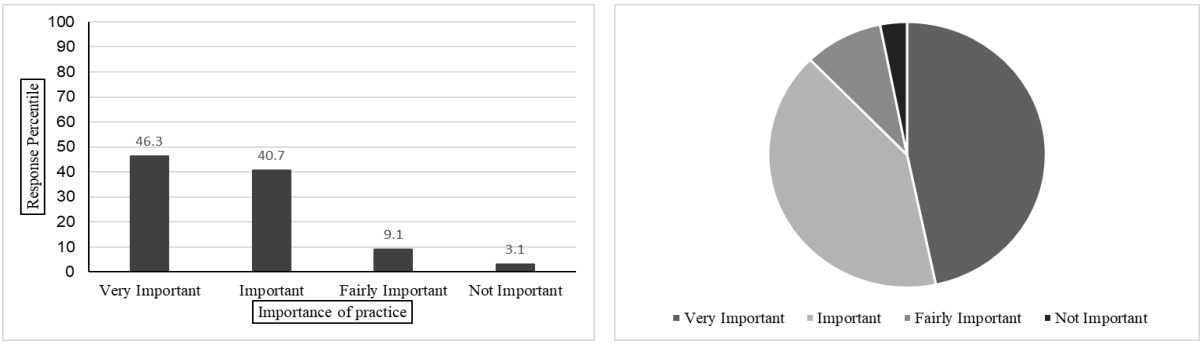


Figure 2: Analysis of delay factors with Pareto Chart

Table 2 represents the summary of uses of personal protective equipment, where 87 percentile believes that personal protective equipment is important for health and safety on the construction site. Figure 3 (a) and Figure 3 (b) is the graphical representation of uses rate of using personal protective equipment. However, personal protective equipment is not used in Bangladesh. In some cases, proper training is not provided to the worker about the significance of Personal protective equipment and sometimes, for lack of knowledge, the workers do not take it seriously. After analyzing data, Dhaka city's construction professionals and workers practice higher rate personal protective equipment than in Khulna city. Sometimes, the health and safety of workers fail because of no inspection from local government authorities like RAJUK, KDA, etc.

Table 2: Summary of uses of personal protective equipment

Importance of safety and health	Rating	Response (%)
Very Important	1	46.3
Important	2	40.7
Fairly Important	3	9.1
Not Important	4	3.1
Total		100



(a) (b)

Figure 3: Representation importance of personal protective equipment through (a) bar diagram; (b) Pie

4. CONCLUSIONS

This study represents the factors affecting construction projects especially in the delay of works on site and the importance of safety and health in construction on Bangladesh, mainly on Dhaka and Khulna. A literature review was conducted and most vital factors were noted and questioned about causes delay on construction site. A field questionnaire was done involving A/E's, owners, contractors, and workers, who are professionals in this sector. The result was presented in two categories; first, the A/E's and owners and second, contractors and workers. The resulted showed that nine out of ten sub-factors of delay on-site are above the average rate. Accident (94%), manpower (86%), environment (84%), equipment (82%) are the main reasons for the delay, hence, these affect the construction site physically and financially. In two categories of professionals, opinion varies widely between two sub-factors that affect delay. Another survey result showed that more than 85 percent of professional believes PPE is important for safety. However, contractors and workers are less concern about personal protective equipment as they have minimal training, awareness, equipment, and budgets on health and safety.

RECOMMENDATIONS

To ensure safety, governmental intervention is a crucial need where the bureaucratic auditors have an enormous role to play for arranging seminars and training on health and security in an ongoing construction project. These campaigns are supposed to focus on scaffolding, electrician's sensibilities, along with head and fall protection to prevent the accidents. New techniques such as Building Information Modeling (BIM) should be implemented for proper scheduling and finance. Before starting a construction project, proper managemental measurement should be taken in order to prevent any hazardous situation that could happen on the construction site.

ACKNOWLEDGMENTS

This paper is made possible through the help of Md. Ikramul Hoque and Md. Hamidul Islam, Assistant Professor of Department of Building Engineering and Construction Management at Khulna University of Engineering & Technology. Additionally, we want to thanks developer companies, building owners, engineers, and workers, who participated, volunteered in this survey.

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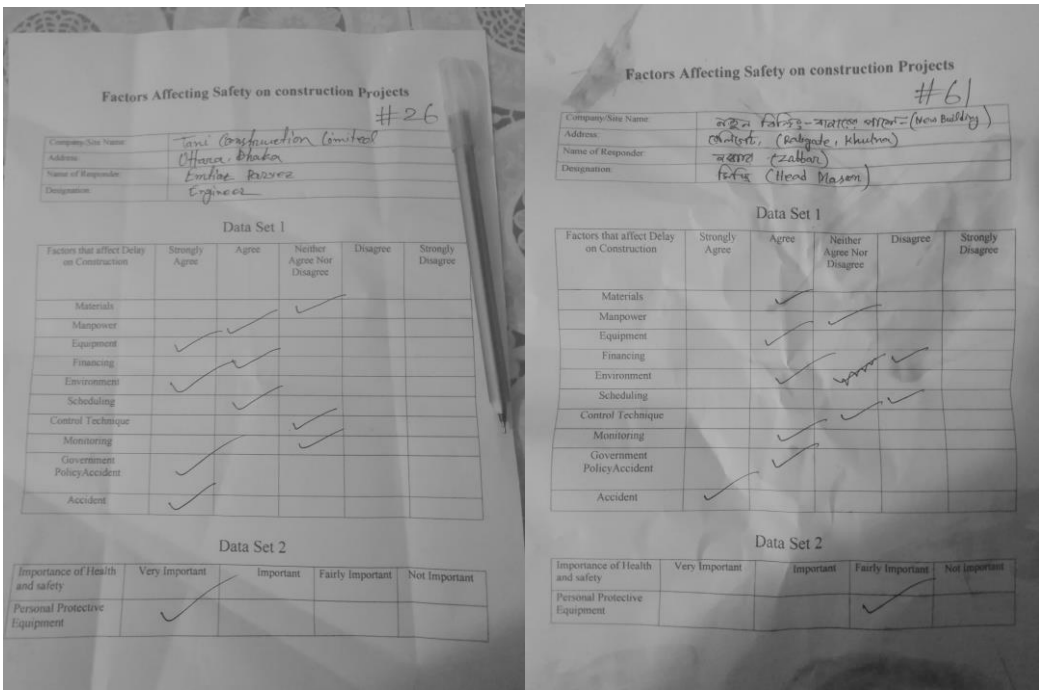
APPENDIX

The following pictures are the sample of questionnaires that were asked.



Factors Affecting Safety on construction Projects

#26

Company/Site Name:	Tani Construction Limited
Address:	Uttara, Dhaka
Name of Responder:	Emtiaz Razzaq
Designation:	Engineer

Data Set 1

Factors that affect Delay on Construction	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Materials			✓		
Manpower		✓			
Equipment	✓				
Financing		✓			
Environment	✓				
Scheduling		✓			
Control Technique			✓		
Monitoring			✓		
Government PolicyAccident	✓				
Accident	✓				

Data Set 2

Importance of Health and safety	Very Important	Important	Fairly Important	Not Important
Personal Protective Equipment	✓			

Factors Affecting Safety on construction Projects

#61

Company/Site Name:	বহুতল বিল্ডিং-নির্মাণাধীন প্রকল্প (New Building)
Address:	মোহাম্মদী, (Mohammadi, Khulna)
Name of Responder:	যাকারিয়া (Zakaria)
Designation:	মিস্ত্রি (Head Mason)

Data Set 1

Factors that affect Delay on Construction	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Materials		✓			
Manpower			✓		
Equipment		✓			
Financing			✓	✓	✓
Environment		✓	✓		
Scheduling			✓	✓	
Control Technique			✓		
Monitoring		✓			
Government PolicyAccident		✓			
Accident	✓				

Data Set 2

Importance of Health and safety	Very Important	Important	Fairly Important	Not Important
Personal Protective Equipment			✓	

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DEVELOPMENT OF SUSTAINABLE AND LOW COST JUTE-POLYESTER COMPOSITE: APPLICABILITY ASSESSMENT IN HOUSING SECTOR

Sharaban Tohora*[1], Subrata Chandra Das[2] and Mubarak Ahmad Khan[3]

*[1]MSc Student,Bangladesh University of Engineering and Technology, Department of Materials and Metallurgical Engineering Dhaka, Bangladesh *, e-mail: stnodi79@gmail.com*
[2]Pabna Textile Engineering College, Pabna-6600, Ministry of Textiles and Jute, Dhaka, Bangladesh
[3]Bangladesh Jute Mills Corporation (BJMC), Ministry of Textiles and Jute, Dhaka, Bangladesh e-mail:makhan.inst@gmail.com

***Corresponding Author**

ABSTRACT

In this study, the applicability of jute–polyester composite as housing material was evaluated. The effect of stacking sequence on mechanical behavior of jute reinforced polyester composite was investigated. Jute fiber was chosen as the reinforcing material because of its availability, low cost and excellent bonding properties. It has high tensile strength, low extensibility, and ensures better breathability of fabrics. Polyester Resin was used as matrix material. Polyester is easy to handle, cheap, stable dimensionally, and has good mechanical and electrical properties with good chemical-resistance. Simple hand layup method was used to fabricate the composite. The jute was cut into desired pieces and then dried inside a heating chamber at 80-90 ◦C approximately for an hour and a half. A wooden mold was used. The polymer solution was applied to the pieces of jute fabric and composites of different stacking sequence were fabricated. The mixture was pressed using available means for better adhesion. It was kept for 48 hours for better curing. Tensile strength (TS), Tensile modulus (TM), Bending strength (BS), Bending modulus (TM), Impact strength (IS) were measured. The TS, TM, BS, BM and IS for specimens with one jute layer (J1) to five jute layers (J5) were measured. In each case J5 showed better mechanical properties. The TS, TM, BS, BM and IS for specimens with five jute layer (J5) was 117.7 MPa, 3.78 GPa, 126.7MPa, 5.192 GPa, 20.97 kJ/m^2. The increase of TS, TM, BS, BM and IS for J5 were found to be 26.5%, 8.7%, 154.4%, 74.8% and 71.5% respectively. Water intake test revealed that the intake rate increased gradually at first but eventually steadied. On average the water intake was not more than 30%. The water intake increased with increased stacking sequence. As this composite is aimed to be used as a housing material, soil degradation properties were tested. In the soil degradation test, after 6 weeks, the mechanical properties such as TS, TM, BS and BM were decreased to 31.2, 24.6, 23.5 and 30.1% respectively. A facile approach to cost analysis was made for J5. The cost was approximately 73tk/ft^2. It was clear that the Jute-Polyester composite has superior mechanical properties than other locally available natural housing materials. Also, the cost was lower than other materials available in market. It is suitable to be made into parts like roof, floor covering, walls, tiles etc. Eco-friendly and hygienic toilets are possible to be made by this composite material.

Keywords: *Jute fiber, Polyester resin, Mechanical properties, Eco friendly, Low cost housing material.*

1. INTRODUCTION

Bangladesh is a country of 142 million people living in 32 million households. Only 2% of this huge population live in concrete houses, 46% live in corrugated-iron (CI) and galvanized-plain (GP) sheet-made households (Population & Housing Census 2011, Bangladesh Bureau of Statistics). The balance population live in houses built of housing materials like tree leaves (31%) and thatch (21%). These materials are not secured and also unstable. This ghastly scenario is a result of poverty of the marginalized people as indicated by the economists from the World Bank (World Bank Report on South Asian Real Estate Sector, October 2010). Because of lack of access to rudimentary housing, the socio-economic pyramid faces multiple consequences like reduced productivity and lack of income, mental trauma owing to the lack of security etc. (Friedman & Danny, 2010).

The intense level of poverty coupled with unaffordable housing materials walk hand in hand for which the housing problem of Bangladesh is far from being solved. A humble effort can be made by making high quality composite material with locally available natural reinforcements.

Synthetic fibres have hazardous effects to the surroundings. Natural fibre has some advantages like high strength and modulus, low extensibility, high abrasion resistance, good thermal stability, insulation against sound & heat, biodegradability, anti-static property, surface morphology, etc.

Products made of jute-reinforced composites have the additional advantages such as low density, acceptable specific strength, less wear during processing, low cost, renewability and biodegradability. Among all the natural fibres, jute fibre gain particular attention to the scientists due to its many unique properties like durable, biodegradable, renewable, rust proof, saline resistant, unbreakable, maintenance free, fire retardant and water resistant, less costly, heat resistant with low thermal conductivity, Eco-friendly (Khan, Hossain & Ali, 1999).

Bangladesh grows 1,349,000 Tonnes of jute per year (Wikipedia, Jute). The lives of 40 million Bangladeshi people depend on either jute or jute related business (Bangladesh Jute Research Institute [BJRI]. n. d) Jute is being used in this sub-continent since the beginning of the Mughal era. Clothes, ropes, twines etc are common uses of jute. But the use of jute has extended largely. A host of new products with high value addition such as home textiles, floor coverings, shopping /carry bags, soft luggage, brief-cases, footwear/shoes/espadrilles, home decorative, handicrafts, novelties, gift items, fashion accessories, fine and wrap yarn, particle boards, composites, technical textiles, chemical products, pulp and paper, etc. have been possible to be manufactured from jute.

2. METHODOLOGY

Jute fiber is bio-degradable. It can be recycled and so not harmful to the environment. It is a natural fiber with golden and silky shine and it's called The Golden Fiber. It is the cheapest Bast fiber. In terms of usage, global consumption, production, and availability, jute is the second most important plant fiber. It has high tensile strength and low extensibility. Therefore, jute is very suitable in bulk packaging. It helps to make best quality industrial yarn, fabric, net, and sacks. It is one of the most versatile natural fibers that have been used in raw materials for packaging, textiles, non-textile, construction, and agricultural sectors. Having said that, the crease resistance of Jute is very low and the drape Property is not good enough. (Asia Jute, n. d)

Polyester resins are low viscosity liquids based on unsaturated polyesters, which are dissolved in a reactive monomer, such as styrene. (Science Direct, n. d) Polyester is easy to handle, cheap and is stable dimensionally. It has good mechanical and electrical properties with good chemical-resistance. Polyester resins are the most optimum choice amongst all resin options as it is the least expensive with best qualities (Molded Fiber Glass Companies, n. d).

2.1 Materials

For producing the desired composite regular quality jute cloth were collected from available source. Unsaturated polyester resin, peroxide (hardener), anti-bubbling agents were collected from the local market.

2.2 Fabrication

The jute cloth was cut to desired sized pieces and then dried inside a heating compartment approximately for two hours. The heating chamber was made out of clay walls and the temperature inside the chamber was kept 80-90 ◦C. The polymeric solution was prepared by mixing unsaturated polyester resin, hardener, and anti-bubbling agent. The mixture was stirred well to get an even mixture. This mixture was then added to the fiber. Here, a simple hand lay-up method was used.

A wooden mold was used. Releasing agent was applied at the bottom and then the composite mixture was poured and evenly spread. Different stacking sequences were applied and five different compositions were manufactured. The mixture was pressed using available means for better adhesion. It was kept for 48 hours for better curing.

The jute content was kept 25% in all the composites from J1 to J5. This was done because in previous studies (Mohanty & Khan, 2000) it was found that 25% jute fiber in a composite show best mechanical property.

2.3 Testing of Mechanical Properties

2.3.1 Tensile Test

To test the tensile properties of the Jute-Polyester composite, specimen was prepared as the first step. The dimension of the specimen was 120mm×20mm. A Universal Testing Machine (Hounsfield series, model: INSTRON 1011, UK) with a cross-head speed of 10mm/min at a span distance of 50 mm was used and the tests were conducted according to ASTM Designation: D638-03.

2.3.2 Flexural Test

For measuring Flexural properties, the same UTM was used. Specimens had a dimension of 65mm×20mm. The tests were carried out according to ISO14125 methods. The cross-head speed of the UTM was 60mm/sec at a span distance of 25mm.

2.3.3 Impact Test

The Charpy impact test were conducted on composite specimens (un-notched) according to ASTM D 6110-97 using an Impact tester (MT-3016, Pendulum type, Germany).

2.3.4 Water Intake Test

Firstly, the specimens were prepared. They were cut into following dimensions (30cm×20cm). The thickness of the specimens varied with varying stacking sequence. Before immersing into water, the specimens were dried again inside a heating chamber at 105 °C for an hour. They were then taken out cooled in room temperature. Silica gel was added to absorb any excess moisture. All the specimens were weighed.

The specimens were then put into water tank at a temperature slightly higher than room average temperature (30 °C). The water intake test was conducted at a time span of 15 days. Fifteen sets of specimens were used. The first specimen was taken out of water after 24 hours and weighed. The increased weight was granted as the weight of absorbed water.

2.3.5 Soil Degradation Test

In pursuit of testing soil degradation, the composite specimens were cut into pieces of desired size (30cm×20cm). The specimens were dried at 100° C for an hour and then cooled at room

temperature. They were also dried properly using desiccators (silica gel). The specimens were then buried under soil and kept for 6 weeks. The soil was natural and not lab treated in any ways.

3. RESULTS AND DISCUSSIONS

3.1 Thickness

Since different stacking sequence was used the thickness of the composite specimen were different. Following is a list of the thickness of the various stacking sequence:

Table 1: data of the average thickness of the composites

Stacking sequence	Thickness (mm)
J1(single layer)	0.60±.05
J2(two layer)	0.95±.05
J3(three layer)	1.09±.05
J4(four layer)	1.60±.05
J5(five layer)	2.00±.05

3.2 Tensile Properties

Testing the tensile properties of the composite revealed that the tensile strength increased with increasing layers of jute fiber. Following is a table that lists the tensile strength for each stacking sequence:

Table 2: Data of the Tensile strengths of the composites

Stacking sequence	Tensile Strength (MPa)
J1(single layer)	86.50
J2(two layer)	89.78
J3(three layer)	95.36
J4(four layer)	108.04
J5(five layer)	117.7

Figure 1 shows this data. It can be said that J5 shows superior properties as an indication of better adhesion of matrix and fiber.

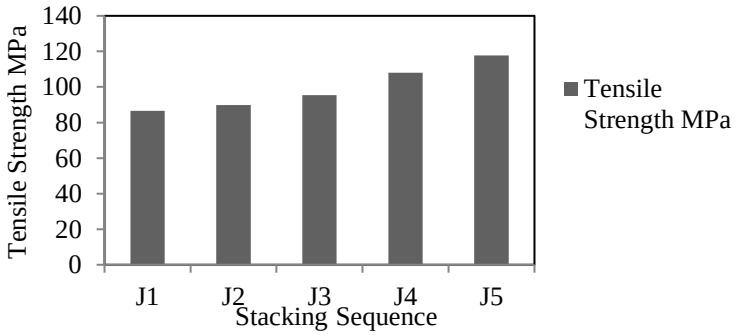

Figure 1: Variation of tensile strength with stacking sequence

The effectiveness of the interconnection of the matrix and the fibers and their ability to transfer stress across the interface is a key feature deciding the mechanical properties of the composite. It also

depends on the strength and modulus of the fibers, chemical stability of the cured matrix (Saheb, 1999; Park, Seo, Ma & Lee, 2002)

3.3 Bending Properties

Bending Strength for J1, J2, J3, J4 and J5 is 76.52, 117.6, 120.09, 124.09, 126.7 MPa as per the reading of the testing machine. Better bending qualities are observed with increased stacking sequence. Figure 3 illustrates the increasing trend. The bending modulus (showed in figure 4) also increases with stacking sequence. It is clear that both the tensile and the bending strength increase with increasing layers of fiber in the composite.

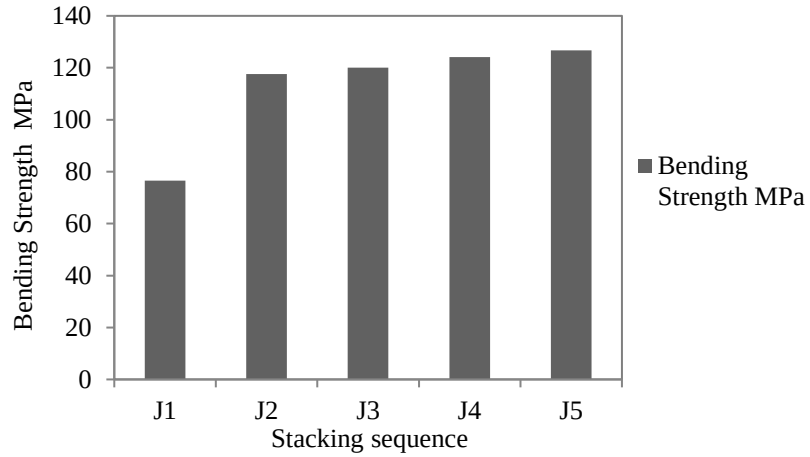

Figure 2: Variation of Bending strength (BS) with stacking sequence

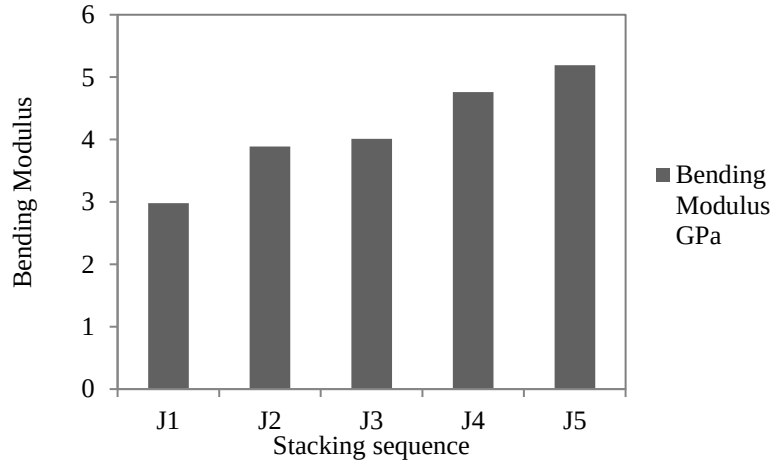

Figure 3: Variation of Bending Modulus with stacking sequence

3. 4 Impact Strength

The Impact strength of J1, J2, J3, J4 and J5 composites were found to be 14.01, 15.11, 17.44, 19.41 and 20.97 kJ/m² respectively . Unlike bending and tensile properties, the impact strength increases with increasing stacking sequences of jute fabric. Impact strength of the composite is influenced by the matrix and the fiber and their interfacial bond Strength. The fibers play an important role on the impact resistance of the composites as they interact with the crack formation in the matrix Figure 5 shows the increasing trend of Impact strength with increasing stacking sequence

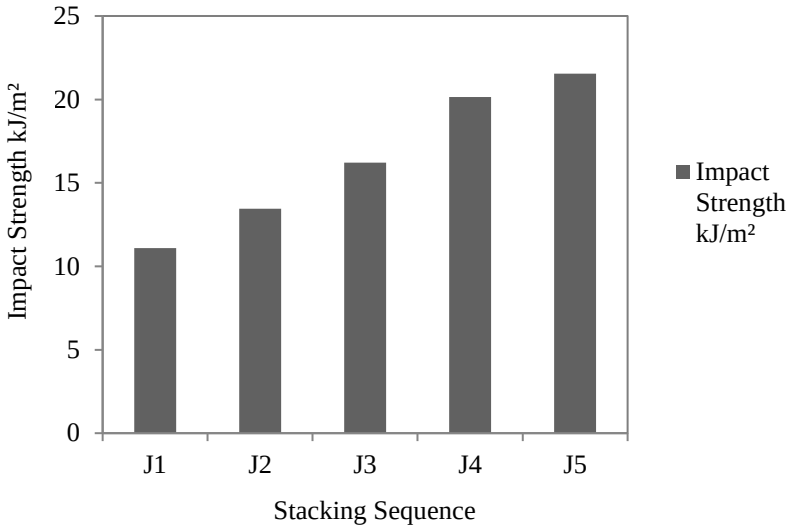

Figure 4: Impact strength with increasing stacking sequence

3.5 Water Intake Properties

It was observed that the absorption of water was very large at the begining but after a certain amount of time the intake rate stabilized. Figure 6 shows the increased water intake at the first 24 hours and then then the approximately stable state. It was clearly observed that on an average on the first 24 hours, the water intake increased rapidly in specimens of all stacking sequence (27.91% to 32.01%) After 1 day, the rate stabilized. After 15 days the water intake was lowest in one jute layered specimens (J1) and highest in five jute layered specimens (J5). The rates were 34.98 % for J1 and 38.90% for J5. This property is due to the very hydrophylic nature of jute which is mainly composed of cellulose.(S. Mishra, Mohanty, Drzal, M. Misra, Parija, Nayak, Tripathy). Another observation can be made that the tensile strength, bending strength, bending modulus and impact strength increase with increasing stacking sequence. These are desireable traits for the composite. But the increase of water intake is not desirable. Increasing Fiber content of the composite retains more water molecules and that is why water intake increase with the increase of fiber content.

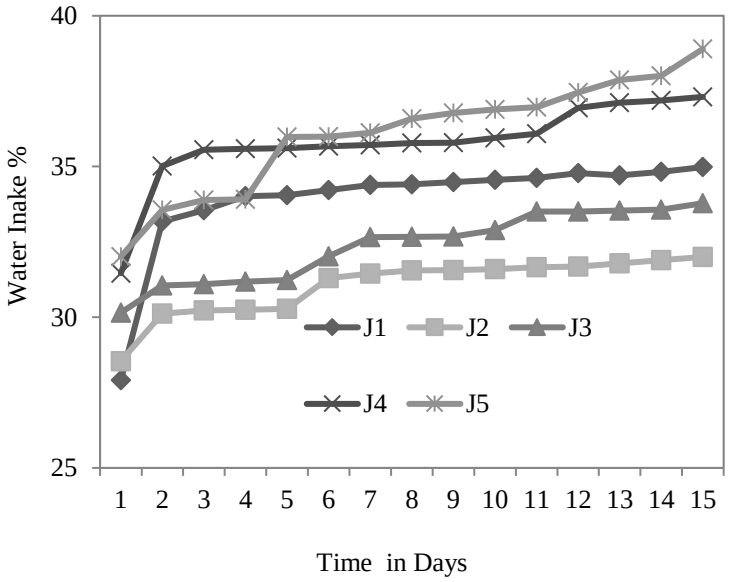

Figure 5 : Water intake increase with stacking sequence

3.6 Soil Degradation Test

After 6 weeks the specimens showed that the TS, TM, BS and BM were decreased to 31.2%, 24.6%, 23.5% and 30.1% respectively. The samples were kept for 6 weeks and the conditions were exactly natural. It is clear that the rate of reduction of TS, TM, BS and BM were slow. The results of Soil Degradation test are shown in Figure 6, Figure 7, Figure 8 and Figure 9.

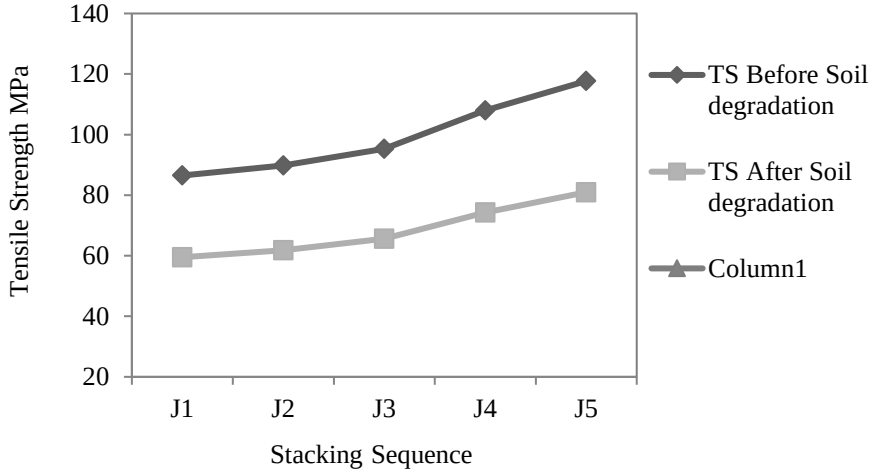

Figure 6: Reduction of tensile properties for Soil degradation

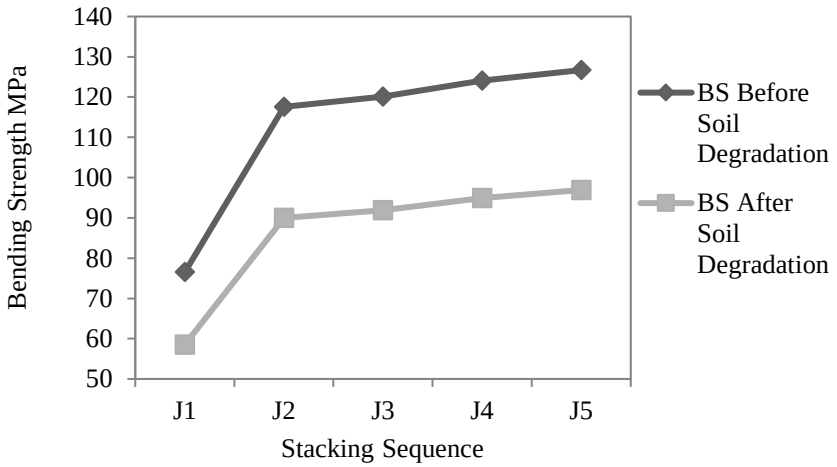

Figure 7: Reduction of tensile properties for Soil degradation

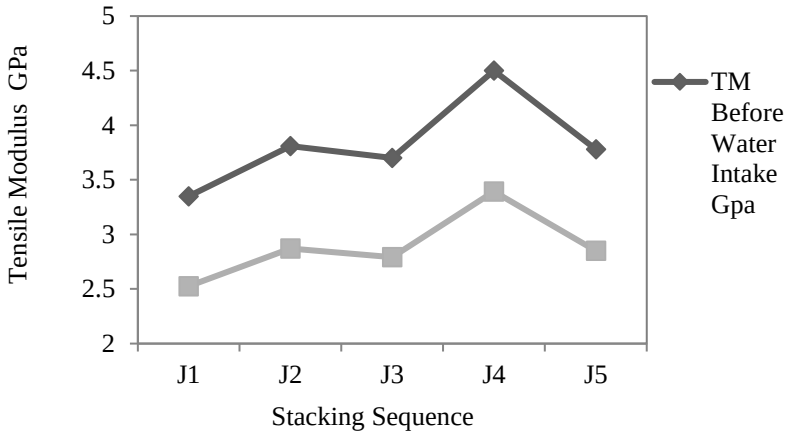

Figure 8: Reduction of Tensile Modulus for Soil degradation

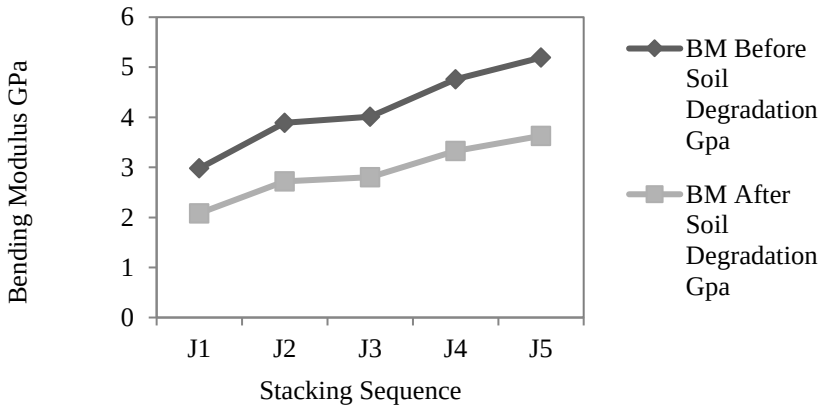

Figure 9: Reduction of Tensile Modulus for Soil degradation

4. COST ANALYSIS

A practical cost analysis was not easy since the whole process is still in an experimental stage. Still, a rough count was made for J5. Approximately 73tk/ft^2 was the estimated price of the J5 Jute-Polyester composite.

Item	Price (tk/ft^2)
Polyester	52
Jute	10
Utilities	1
Labour cost	10

The price of corrugated metal sheets was collected from local source and also compared with the price of online sources. (Prices of CI sheets, The Daily star, April 27, 2008), Appollo Ishpat Complex Ltd.

Figure 11 shows the compared price of jute-polyester composites with other common housing materials used in the rural areas of Bangladesh.

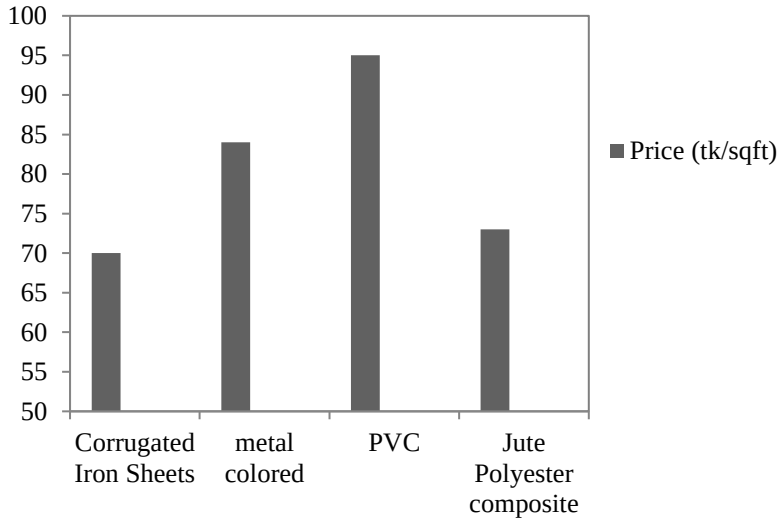

Figure 10: Price comparison of Jute-polyester composite

5. CONCLUSIONS

This study shows the potential of Jute-Polyester composite to be used as housing material. The mechanical properties were in many cases found superior to natural elements used from local sources whereas the price is lower than that of CI sheets or PVC. So, this composite can be used to build houses with superior quality than natural components in lower price. Also, the price of Jute-polyester composite will be even lower if manufactured on an industrial scale. Another important aspect is that also possible to manufacture in a small scale using no machinery or electricity. Local manpower if taught properly, can make this composite on their own. The use of jute will increase and the economy will mobilize. This composite will be durable as it has good mechanical properties but the water intake properties need to be improved for best results. Further research can be done in this regard.

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MEASUREMENT OF DEGREE OF SAFETY IMPLEMENTATION AT VARIOUS CONSTRUCTION SITES IN A DEVELOPING COUNTRY LIKE BANGLADESH

Md. Hamidul Islam*[1], Md. Mehrab Hossain[2] and Md. Nurul Islam[3]

[1]Assistant Professor, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: hamidcekuet@gmail.com
[2]Lecturer, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail:mehrabaopy@gmail.com
[3]Student, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh, e-mail: ikhan72929@gmail.com

***Corresponding Author**

ABSTRACT

Construction industry is one of the most vulnerable sectors considering degree of safety and its implementation in the site. All concerned personnel are involved in the safety policy and especially the workers more susceptible to accidents. In the world most of the developed countries have full proof law and legislation in the construction industry. Also, they have well organized safety implementation management systems which are planned to minimalize or abolish accidents at workplaces. Nevertheless, in developing countries such as Bangladesh safety in the construction industry is very alarming. This study investigates the widespread safety management practices and perceptions at the construction industry at Dhaka and Khulna city in Bangladesh. The study was conducted among 45 (forty-five) construction companies, government officials and also investigated 20 (twenty) ongoing construction sites through the method of a questionnaire survey, face to face interview and focus group discussion (FGD). The results of the study revealed that there are many occupational safety problems at the construction industries in Bangladesh. The most common safety problems are the lack of safety regulations, standards, data on safety at construction sites, competent manpower, safety training, documentation and organized safety management systems. The study also proposes some recommendations for safe construction.

Keyword: *Construction industry, Degree of safety, Safety implementation and policy, Developing country, Sustainable construction, Questionnaire survey.*

1. INTRODUCTION

It is commonly known that accidents have serious implications for the construction industry both in financial and humanitarian terms. Construction accidents may cause many problems, such as demotivation of workers; disruption of site activities; delay of project progress; and adversely affecting the overall cost, productivity and reputation of the construction industry (Mohamed, 2002). In the construction industry, the risk of a fatality is five times more likely than in a manufacturing based industry; whilst the risk of a major injury is two and a half time higher (Sawacha et al., 1999). Nowadays, construction industrial accidents occur everywhere in the world at a large amount of deaths or serious injuries and the world is paying heavily for accidents in terms of both human suffering and economic losses. In spite of some progress, the safety problem is still a serious question for the human resources who involve in this sector. Safety performance and its improvement at construction sites have received a great deal of attention since the implementation of the Occupational Safety and Health Act (OSHA, 2002). A key factor in the control and improvement of any performance aspect on site is the ability to measure the performance (Laufer & Ledbetter, 1986).

The construction industry's appalling health and safety record is a worldwide problem affecting both the developed and developing countries. Very few statistics exist on the nature of accidents and injuries affecting workers in developing countries primarily due to the poor or non-existent regulatory framework (Larcher & Sohail, 1999). Considering the adverse impacts of accidents, construction safety implementation is of genuine concern to all stakeholders in the construction industry. Government, unions, and insurers have spent a great deal of time and effort attempting to evolve legislation, rules, and regulations to help the reduction of the large loss of life and limbs, and the high number of "lost-work days" (Goldsmith, 1987). In the USA, the exercise of safety in construction is delimited by administrative agencies which provide harsh guidelines and principles to enforce safety and health standards on construction sites. Bangladesh National Building Code (BNBC) describes precautionary measures to be adopted to ensure the safety of public, environment and infrastructure, property, workmen, materials, services, plant and equipment and also covers the constructional responsibilities and practices in building sites; safe storing, stacking and handling of materials, equipment's and the resources; and mostly safety of personnel during construction operations.

In most developing countries, including Bangladesh, safety consideration in construction project delivery is not given a priority, and employment of safety measures during construction is considered a burden (Mbuya & Lema, 2000). At present, the largest and fastest growing sector in Bangladesh is construction sector and this sector also contributes one of the highest national gross domestic products (GDP) next to garments sector. However, occupational safety and health in the construction industry in Bangladesh is a very lower level. The construction industry, as such, needs to assess the safety situation, and accordingly, plan and implement safe construction in Bangladesh. Currently, there is a genuine set of data on safety at construction sites in Bangladesh. Apparently, there are no systematic and organized studies conducted specifically on the safety aspects of the construction industry in Bangladesh. Therefore, this research study was aimed to assess the existing safety management practices and perception in the Bangladeshi construction industry. The assessment was useful in providing information in terms of current safety practices administered in Bangladesh. Moreover, the perception was useful in finding out what are the main reasons for accidents in construction sites and identifying factors responsible for safety management problems (Dorji & Hadikusumo, 2006). Investigations were operated various construction companies/firms, government regulatory agencies, and some ongoing projects if they perceive different opinions on safety problems, the safety policy and law might not be able to solve the problems.

2. METHODOLOGY

Investigations were operated in the different construction field, companies, and firms as well as with consultants, project managers and field supervisors by face to face interview and focus group discussion (FGD) at several construction projects. A form of questionnaires was designed with essential elements for safety management system and factors responsible for safety management

problem and distributed to different construction companies in Bangladesh. This questionnaire was followed up by direct interviews in 45 (forty-five) construction companies and government officials to collect information about their safety management system. Also, 20 (twenty) on-going construction project sites were visited to collect data. All the respondent companies, firms, government regulatory offices and the ongoing construction sites are at Dhaka and Khulna city in Bangladesh. The relevant government regulatory agencies were also investigated for this questionnaire survey, interviews and discussions to concern with their safety and health administration in the construction industry in Bangladesh. The data mainly in terms of safety standards, safety rules and regulations, and safety laws were collected from the government officials that are being implemented and enforced by the government to ensure safety at the construction sites. The government regulatory agencies and construction companies both were asked to give their opinions about the factors responsible for the safety problems.

An exploratory or investigative study intended to evaluate the prevalent site safety management practices and procedures of the construction companies in Bangladesh is the most important part of this research. The steps to promote safety and health in the construction sites taken by the government regulatory agencies industry is also investigated and explored. As such, the collected data were analyzed for descriptive statistics to reflect the current overall safety situations in the construction fields of Bangladesh.

The other part of the research is compared the safety management activities between different construction companies or firms and the government regulatory agencies and concerned with how they perceive the safety problems in the construction industry of Bangladesh. In order to achieve this objective, 13 factors attributable to safety problems were identified from the literature review. Respondents were then asked to rank these factors according to their importance in addressing the safety problems.

3. RESULTS AND DISCUSSION

According to the Occupational Safety, Health, and Environment Foundation (OSHE) about 600 fatalities occurred in Bangladesh during the first six months of the year and 488 workers were injured in occupational accidents in 2015. At least 373 workers were killed in their workplaces in 282 separate accidents across the country in 2016, according to a survey conducted by Safety and Rights Society, a non-government organization. Safety concerns have been raised, of late, and earnest efforts are being made to promote safety and health in the Bangladeshi construction industry.

3.1 General Information of the Respondent Construction Companies

Out of the fifty-five (45) respondents of the government regulatory agencies and construction companies, about 67% of them are established, 30% are temporary and only 3% are not established as shown in Table 1. So, most of the construction companies or firms are properly established and having a permanent office building and a little number of them have not any permanent office building because of this they operate theirs activates from their residences without proper establishments. Most of the respondent construction companies work on infrastructural development. Major parts of their constructions are residential buildings, educational buildings, buildings for business purposes, high-rise buildings, roads and bridges in the country.

Table 1: Status of the investigated construction companies/firms.

	Establishment			**Financial and Technical strength**		
	Established	**Temporary**	**Not established**	**High**	**Medium**	**Low**
Number of Company	30	12	3	9	24	12
Percentage (%)	67	27	6	20	54	26

However, most of the respondent companies were well-based into the construction business and having work experiences of above 10 to 15 years. Approximately 20% of the respondent's companies have high technical and financial strength, about 54% have medium and 26% have low financial and technical strength as illustrated in Table 1. Maximum construction companies have 20 to 100 employee and 50 to 100 permanent workers and they also hired labor as temporary or contract worker.

3.2 Safety Policy

Bangladesh is one of the developing countries where construction techniques and safety policy implemented is basically labor base with little mechanization. A few years ago traditional construction techniques have been used in Bangladesh but now a days, some of the companies used high mechanization and heavy machinery in the construction field. About 33.33% construction companies use labor base techniques, 54.33% companies use little mechanization and about 13.33% construction companies' use highly mechanized construction techniques out of the total respondents in Bangladesh as shown in Table 2.

Table 2: Safety policy of the investigated construction companies/firms.

Content		**Number of Company/Firm**
Types	Traditional	None
	Labor base	15
	High mechanization	6
	Little mechanization	24
	No mechanization	None
Written Safety Policy	Yes	15
	No	9
	Sometimes	21
Level of Safety Priority	Highest priority	21
	Medium priority	15
	Lowest priority	9

Here about 30% of the construction firms use written safety policy, about 50% of construction firms use it sometimes and 20% do not use written safety policy in Bangladesh as shown in Table 2. Respondents were also asked to rank the level of priority of their safety policy that they implemented in their construction fields.

3.3 Safety Operating

One of the essential elements of the safety management is the designation of an individual with responsibilities and accountabilities in the implementation of the construction safety programme and plan (Dorji & Hadikusumo, 2006). Safety department or committee operates how safety policy implementation is to be monitored, how safety budgets are fixed, determines the activities of how safety committees and safety representatives and how individual job descriptions should safety responsibilities and reflect health.

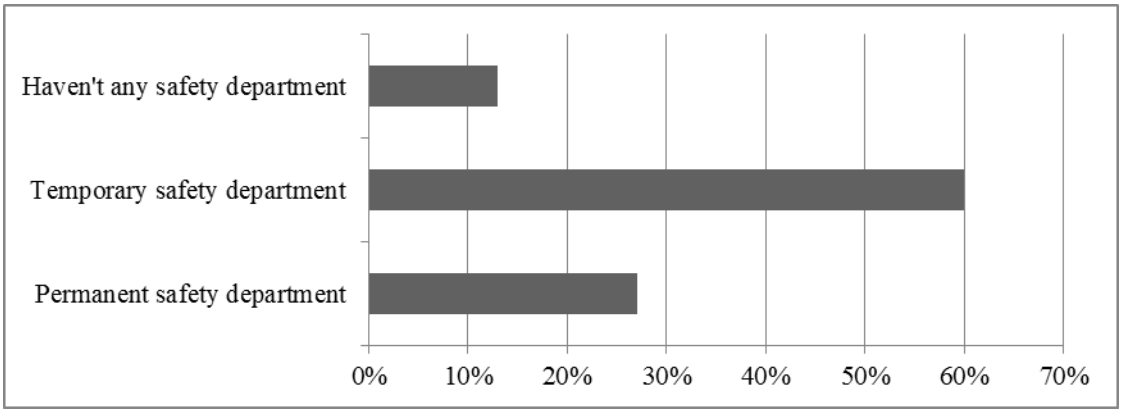

Figure 1: Percentage of safety department having in the investigated firms.

Out of the respondent's companies, about 27% and 60% have permanent and temporary safety department or committee respectively and about 13% have not any safety department or committee as shown in Figure 1 in Bangladesh.

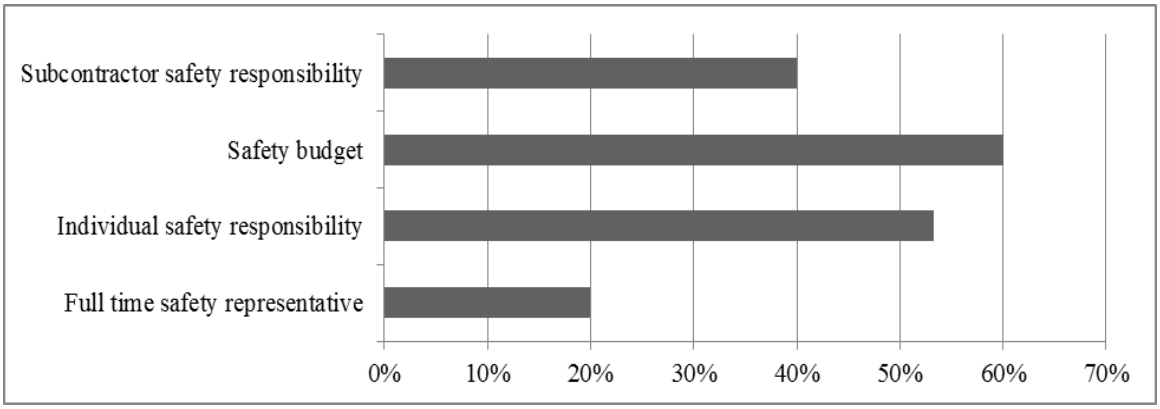

Figure 2: Degree of implementation of safety management of the investigated firms.

Moreover, approximately 20% companies have full-time safety representative, 53.33% companies have individual safety responsibility, 60% companies ensure safety budget and 40% companies have subcontractor safety responsibility from the respondent's construction companies and government regulatory agencies in Bangladesh as shown in Figure 2.

3.4 Planning and Implementation

Planning is the preliminary and critical step of the control and enforcement of a safety management program. It is a process that prepares, creates, implements and monitors the safety programmed, thereby addressing the workplace health and safety through an organized, step-by-step strategy (CSAO, 1993). In this study, about 18 (eighteen) respondent company out of 45 (forty-five) organize the meeting on planning and implementation of safety management before starting construction for every project in Bangladesh.

Table 3: Information about safety meeting and safety auditing of the investigated construction companies/firms.

	Meeting on Safety Planning & Implementation	**Safety Auditing**
Number of Company	18 out of 45	36 out of 45

Moreover, from the respondents about 36 (thirty-six) construction companies out of 45 (forty-five) operate auditing on an implementation of safety in the site in each project in Bangladesh. Some of their activities are safety inspection, safety training, job hazard analysis and control, accident investigation and reporting, safety promotion, and personal protective equipment (PPE) etc.

3.5 Safety Equipment

According to Bangladesh National Building Code (BNBC) data collected on 7 (seven) types of construction personal protective equipment from 20 (twenty) ongoing construction site in a different region in Bangladesh. Results of this analysis are following:

3.5.1 Eye and face protection

Safety glasses or face shields are worn any time of work operations can cause foreign objects to get in the eye (OSHA, 2002). For example: during welding, cutting, grinding, nailing (or when working with concrete and/or harmful chemicals or when exposed to flying particles). From the investigations of the construction site, it marked that about 10% of workers use eye and face protector during construction in Bangladesh as shown in Figure 3. That is very poor and risk for the workers.

3.5.2 Foot protection

Construction workers should wear work shoes or boots with slip-resistant and puncture-resistant soles. Safety-toed footwear is worn to prevent crushed toes when working with heavy equipment or falling objects (OSHA, 2002). From the investigations of construction site, it marked that about 45% of workers use foot protector during construction in Bangladesh as shown in Figure 3.

3.5.3 Hand protection

According to OSHA workers should wear the right gloves for the job (examples: heavy-duty rubber gloves for concrete work; welding gloves for welding; insulated gloves and sleeves when exposed to electrical hazards). A very little number of workers (11% approximately) use hand protection equipment during construction as shown in Figure 3.

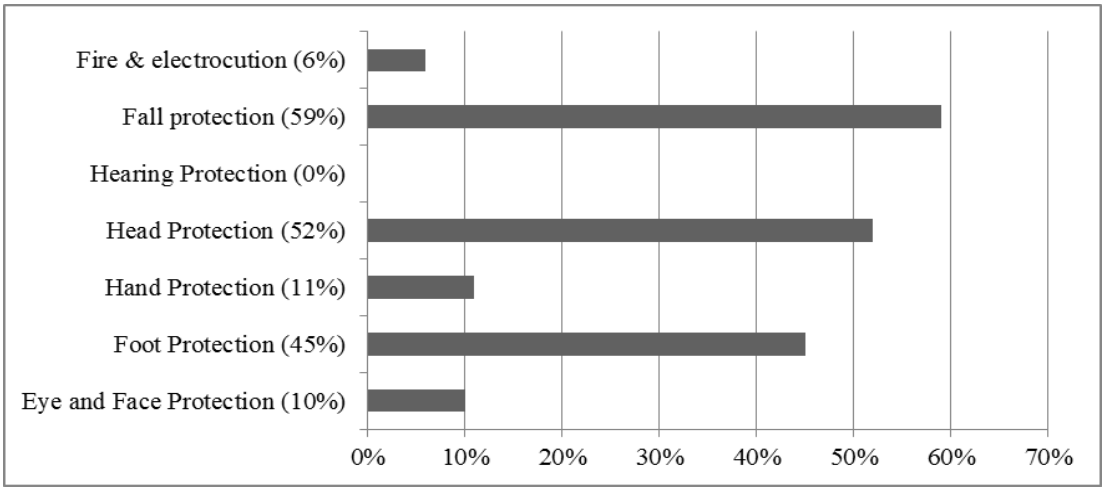

Figure 3: Approximate percentage of workers who use personal protective equipment during construction.

3.5.4 Head protection

Wear hard hats where there is a potential for objects falling from above, bumps to the head from fixed objects, or of accidental head contact with electrical hazards (OSHA, 2002). About 52% workers use head protector in the field during construction in the surveyed construction site in Bangladesh as shown in Figure 3.

3.5.5 Hearing protection

Use earplugs/earmuffs for workers in high noise work areas where chainsaws or heavy equipment are used; clean or replace earplugs regularly. It is not surprising to note that there is no worker (0%) who uses hearing protector equipment during construction in the field as shown in Figure 3. Unfortunately, that is very harmful to the worker's health and makes out-of-temper.

3.5.6 Fall protection

Previously, falls are the foremost cause of fatalities in construction, considering for about one-third of all fatalities in the industry. For example, the Bureau of Labor Statistics reported that there were 291 fatal falls to a lower level in construction in 2013, out of 828 total fatalities (OSHA, 2002). From the investigations of the construction site, it marked that about 59% of workers use fall protector equipment and fall restraint system during construction on the site as shown in Figure 3.

3.5.7 Fire and electrocution protection

From this study a very little number of workers (about 6%) use fire and electrocution protector in their working field. That indicates a very poor safety implementation system in this field in Bangladesh.

3.5.8 Factors Affecting Safety Problems

Safety at construction site is a multifaceted fact, and the theme of safety attitudes and safety performance in the construction industry is even more so. In the construction industry, the risk of a fatality is 5 (five) times more likely than in a manufacturing based industry; whilst the risk of a major injury is two and a half time higher (Sawacha et al., 1999). Respondents from the construction companies as well as the officials in the relevant government regulatory agencies were asked directly about the important factors attributable to the site safety management problems in the Bangladeshi construction industry. In this study identified 12 (twelve) factors that are more responsible for safety management problem. They are following: (i) Lack of safety regulations and standards, and their enforcement; (ii) Lack of safety awareness and understanding of safety benefits in the construction industry; (iii) Lack of safety training facilities; (iv) Finance/budgetary constraint; (v) Lack of formal labor union organization; (vi) Lack of certifies skilled labor; (vii) Extensive use of subcontractors; (viii) Poor safety consciousness of workers; (ix) Lack of personal protective equipment (PPE); (x) Poor mechanization; (xi) Lack of safety professionals and (xii) Lack of knowledge about safety management system.

4. CONCLUSIONS

A survey has been conducted with 45 (forty-five) construction companies and the government regulatory agencies relevant to the construction industry in Bangladesh to better understand their safety management practices. Also investigated 20 (twenty) ongoing construction sites to identify the percentage of using safety equipment by the workers during construction in various regions in Dhaka and Khulna city. In terms of safety policy, most of the companies did not have written safety policy and they had poor safety awareness. In terms of organizing, most of them did not have safety department, safety representative, and safety committee. Less than 40% of them did not have safety budget. In terms of preparation and execution, most of them were conscious of the safety regulation and claimed to have insurance schemes for the workers depending on the clients' necessities. Most of them also claimed that they provided PPE to workers although some of the workers did not want to use the PPE because they felt uncomfortable. However, in terms of measuring and reviewing safety performance, many of the companies did not have proper records to give the indication on the number of any kind of accidents occurring at their construction project sites. In addition, many did not employ safety audits. This study also concludes main factors for why the application of safety management system was not adequate. We identify that the five top most reasons were (i) lack of safety training facilities, (ii) lack of safety awareness and understanding of safety benefits, (iii) lack of safety professionals, (iv) lack of knowledge about safety management, and (v) lack of safety regulation enforcement.

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A CASE STUDY TO FIND OUT THE POSSIBILITY OF USING RECYCLED BRICK AGGREGATE OF NATORE AREA FOR LOW STRENGTH STRUCTURE

A.T.M. Rakibul Hassan[1], Md. Mahmudur Rahman*[2], Md. Jewel Rana[3] and Md. Moniruzzaman Akash[4]

[1]Student, Bangladesh Army University of Engineering & Technology (BAUET), Qadirabad, Bangladesh, e-mail: retrofits.atmrh@gmail.com
[2]Assistant Professor, Bangladesh Army University of Engineering & Technology (BAUET), Qadirabad, e-mail: rushalov@yahoo.com
[3]Student, Bangladesh Army University of Engineering & Technology (BAUET), Qadirabad, Bangladesh, e-mail: mjr2612960@gmail.com
[4]Student, Bangladesh Army University of Engineering & Technology (BAUET), Qadirabad, Bangladesh, e-mail: akashbauet@gmail.com

***Corresponding Author**

ABSTRACT

This paper aims to find out the possibility of using a recycled brick aggregate of Natore area fro low strength structure. To find out the efficiency of using recycled brick aggregate and compare the efficiency of recycled brick aggregate with fresh brick aggregate in this study, forty years, seventy years recycled brick aggregate and it's concrete with fresh brick aggregate and it's concrete properties have been observed. 70 years recycled brick was collected from 70 years old demolish building in Bonpara bazar, Natore and 40 years recycled brick was collected from 40 years old demolish building near Bonpara bazar, Natore. Fresh brick was collected from commercial suppliers at Doyarampur, Natore district. After collection ingredients, crushing recycles and fresh brick very carefully and do laboratory experiments. Then different experiments such as specific gravity, the compressive strength of concrete were conducted with these samples as per the requirements of the study. Results show that most of the properties of recycled brick aggregate were similar compare to fresh brick aggregate but the absorption capacity of recycled brick aggregate 7% to 12% greater than the fresh brick aggregate. but it was similar to other researcher's works. Moreover, the concrete compressive strength of recycled brick aggregates was 56% to 62% similar to fresh brick aggregate which was similar to other research works.

Keywords: *Recycled brick, Recycled aggregate, Natore area.*

1. INTRODUCTION

Brick is the main component and commonly used material for the fast-growing construction industry of Bangladesh. Brick is a prime element of concrete along with sand, water, and Portland cement. 2.5 tons per capita per year concrete expense is estimated in the world. (Equivalent to 17.5 billion tons for seven billion demography in the world) (CEMBUREAU, 2008; Mehta, 2009). About 2.62 billion tons of cement, 13.12 billion tons of aggregate, 1.75 billion tons of water are needed to make this huge volume of concrete (Torring & Lauritzen, 2002). Aggregates are culled by cutting mountains or breaking river gravels or boulders, or by breaking clay bricks. Brick is a very important material for aggregate. A huge quantity of naturalistic resources can be protected if the demolished brick is recycled for newish constructions.

Many old buildings in Bangladesh are constructed mainly from brick and brick aggregate concrete. Demolition waste from these old buildings may provide a significant generation of aggregate in the concrete industry of Bangladesh. Many works have been published recently on the recycled brick aggregate concrete use and its feasibility as coarse aggregate (Mohammed *et al*., 2015; Tam *et al*., 2018). However, extensively very few have examined permeability, shrinkage and other deformation related properties of recycled brick aggregate concrete.

Therefore, there is the scope of research in this area for a better understanding of recycled brick aggregate concrete. A correlative study of these properties between crushed clay fresh brick and recycled brick aggregate concrete will provide significant insight into the feasibility of using recycled brick as coarse aggregate. This study aims to find out the efficiency of using recycled brick and it's aggregate and compares their efficiency with fresh brick and it's aggregate.

2. METHODOLOGY

70 years old recycled bricks were collected from 70 years old demolish building in Bonpara bazar, Natore (denoted as RB70Y) and 40 years old recycled bricks were collected from 40 years old demolish building near Bonpara bazar, Natore (denoted as RB40Y). Fresh bricks were collected from commercial suppliers at Doyarampur, Natore district (denoted FB). After the collection of ingredients, crushing of recycling and fresh brick was done very carefully and carried out laboratory experiments. The 70 years old brick aggregate was denoted as RBA70Y, 40 years old brick aggregate was denoted as RBA40Y and fresh brick aggregate was denoted as FBA (Hemel *et.al.*2019). Portland Composite Cement (PCC) collected from the local market in Natore city which contains 65-79% clinker, 21-35% fly ash, slag, 0-5% limestone and gypsum was used in the experiment as a binding material. Padma river sand (brown in color) near Paksi, Pabna district was used as fine aggregate which is locally known as 'Paksi sand'. It is well-graded and having fineness modulus (F.M) 2.05. The property of water that was used in the concrete work is groundwater and being potable and also free from oil, dust, acid and other organic impurities. Then different experiments such as specific gravity, absorption capacity & compressive strength of concrete and bricks were conducted with these samples as per the standard procedure. Concrete cylinder molds were cast and cured at standard conditions in the university laboratory. Sieve analysis of sand and brick aggregates was conducted to get the gradation of aggregate. Characterizations of the strength of recycled brick aggregate concrete involving specific gravity and unit weight and compressive strength of concrete of recycled brick aggregate have been evaluated.

3. RESULTS AND DISCUSSION

3.1 Physical properties

3.1.1 Size and color of the recycled bricks

In Figure 1, it was seen that the dimensions of RB70Y, RB40Y and FB were sequentially decreased. The RB70Y, RB40Y was not similar to the first-class brick size which is 240*115*70 mm (http://www.lged.gov.bd) as these bricks were prepared far before Bangladesh Standard was set. These also conclude that earlier centuries residential buildings used larger size brick than current brick. It also shows that (Figure 2) RB70Y and RB40Y were red in colour like FB, where good brick generally red in colours as per LGED (http://www.academia.edu; http://www.lged.gov.bd).

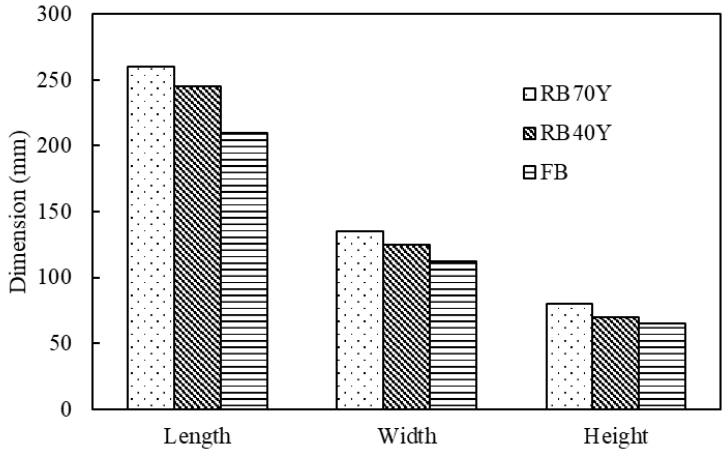

Figure 1: Dimensions of RB70Y, RB40Y and FB

(a) RB70Y (b) RB40Y (c) FB

Figure 2: Recycled and fresh brick after collection

3.1.2 Bulk specific gravity of recycled brick aggregate

It was shown in Figure 3 that, the value of bulk specific gravity of RBA70Y and RBA40Y was more than 1.5 and less than 2.0 but near to the value of FBA specific gravity (1.83). Zheng *et al.* (2018) and Reza (2013) reported that the bulk specific gravity of recycled brick aggregate was 1.7 and 1.61, respectfully which was almost similar to RBA70Y. These RBA70Y and RBA40Y couldn't be used for road pavement construction as it required specific gravity ranges from about 2.5 to 2.9 but it could be used in concrete mix design, water filtration plant design, slope stabilization project, railway bedding, sub-base road construction material, etc. (https://nptel.ac.in;https://www.in.gov).

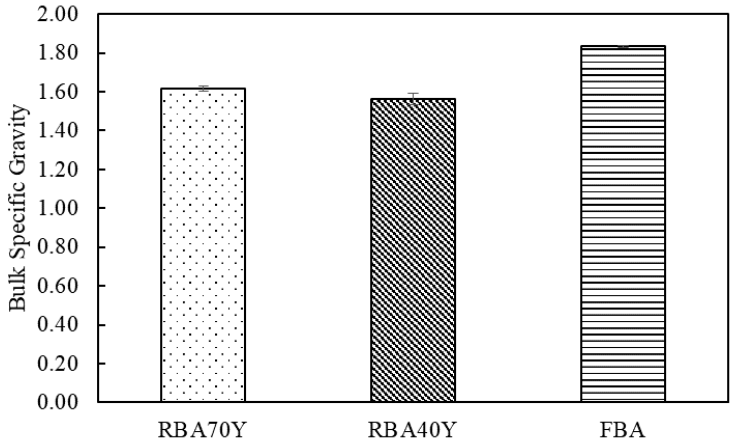

Figure 3: Bulk specific gravity of RBA70Y, RBA40Y and FBA

3.1.3 Absorption capacity of recycled brick and it's aggregate

It was shown in Figure 4 that the absorption capacity of RB70Y and RB40Y were higher than the FB absorption capacity (14.44%), but they were near the limit set by LGED which ranges from 12% to 24% by weight (http://www.lged.gov.bd). Whereas the absorption capacity of RBA70Y and RBA40Y were 7.48% and 11.91% more to the FBA absorption capacity (13.92%) as shown in Figure 5. The absorption capacity of RBA70Y was similar to Refractory brick from the demolition of an old cold storage building (19.1%), (Reza, 2013). The value of RBA70Y and RBA40Y was also similar to the recycled of 45 years brick aggregate (22.70%) (Mohammed *et al.*, 2015).

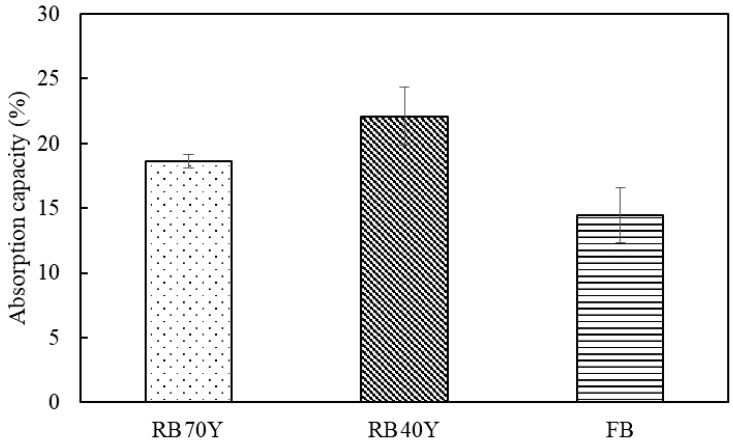

Figure 4: Absorption capacity of recycled bricks

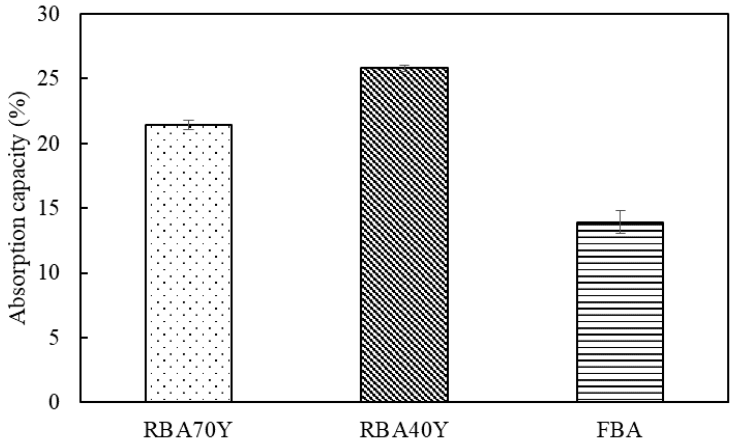

Figure 5: Absorption capacity of recycled bricks aggregate

3.2 Mechanical properties

3.2.1 Compressive strength of recycled brick

The compressive strength of RB70Y was similar to the 20% of the FB strength and was almost 50% of the FB strength in the case of RB40Y (Figure 6) where the RHD standard was 6.64 MPa which was similar to FB (www.rhd.gov.bd). The reason for being low strength may be caused by the aging of the recycled bricks and composition of the bricks. RB40Y can be used in footpaths, cycle-tracks and very unimportant road construction (village roads, etc).

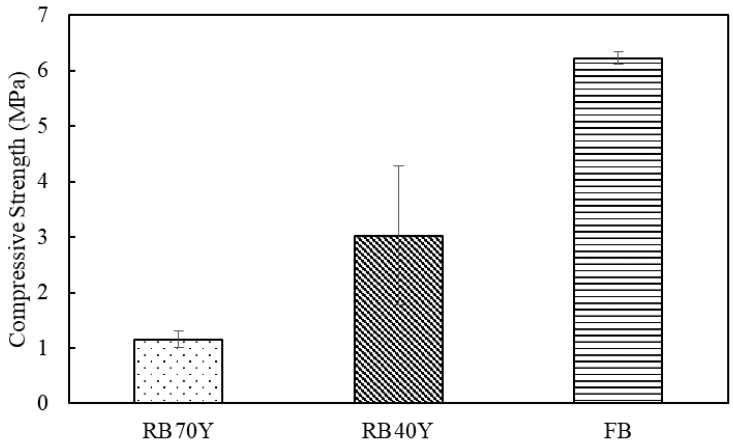

Figure 6: Compressive strength of recycled bricks

3.2.2 Compressive strength of recycled brick aggregate made concrete

The compressive strength of RBA70Y, RBA40Y and FBA for 7, 14 and 28 days were shown in Figure 7. As expected, the compressive strength of the specimen increased with curing age for recycled and fresh brick aggregates. It also is shown that the compressive strength of RBA70Y, RBA40Y and FBA were nearly similar at 7 days; but FBA had a high percentage increase in strength compared to RBA70Y, RBA40Y in 14 days (43%, 38% respectively) and in 28 days (44%, 38% respectively). However, the strength gaining characteristics of RBA70Y and RBA40Y shows that the strength of 28days within the range of 1.3 to 1.7 times of the strength of 7days (Aziz, 1995) which confirmed that the 14 and 28 days compressive strength of RBA70Y and RBA40Y are nearly similar. The compressive strength of RBA70Y and RBA40Y were similar to recycled brick aggregate made (Mohammed *et al*. 2015). This concludes that the RBA70Y and RBA40Y get compatible strength within 7 days although the strength is lower than FBA.

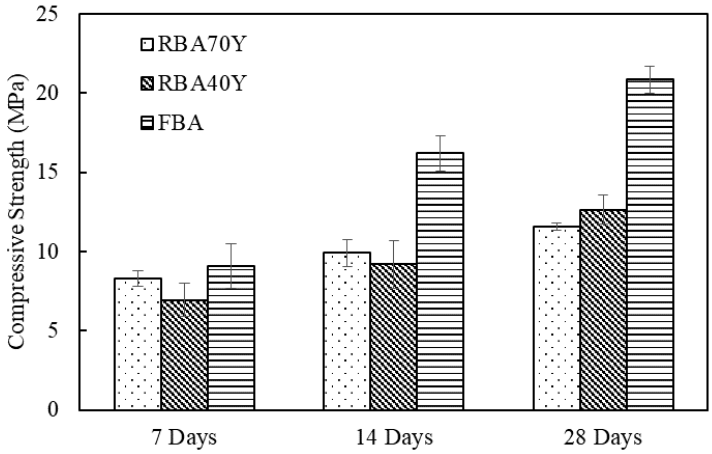

Figure 7: Compressive strength of recycled brick made concrete

Although the present study showed that by using RBA70Y and RBA40Y, around 12 MPa strength concrete can be prepared but it is reported that by changing cement content, W/C ratio, fine to coarse aggregate ratio, etc. and using 100% recycling brick aggregate, it is possible to make 20.7 MPa to 27.6 MPa strength of concrete (Mohammed *et al*, 2015).

4. CONCLUSIONS

In this study, it was found that the recycled brick and its aggregate had the potential to use in different construction works. The findings are listed below:

- Comparing the brick colour and size it was seen that the colour of the recycled brick (RB70Y and RB40Y) were similar to FB and meet the LGED standard whereas the size of recycled brick was larger than the FB. The absorption capacity of recycled brick was in the limit of the LGED standard. The compressive strength of the RB70Y seems very poor whereas RB40Y possess 50% strength of the FB. So, it may be not used in heavy construction but it could be used in footpaths, cycle-tracks and very unimportant road construction (village roads, etc).

- Comparing the physical properties of the recycled brick aggregate (RBA70Y and RBA40Y) and fresh brick aggregate (FBA) it was seen that the bulk specific gravity of recycled brick aggregate was similar to FBA. But the results of the bulk specific gravity of recycled brick aggregate showed similar to other researchers' work on recycled brick aggregate (Zheng et al.,2018; Reza, 2013). The absorption capacity of the recycled brick seems higher than FBA but it was similar to other researcher's works (Reza et al. 2013, Mohammed *et al*. 2015).

- In case of compressive strength of recycled brick aggregate (RBA70Y and RBA40Y) and fresh brick aggregate (FBA), it was seen that the strength gaining capacity at 7days is similar for both recycled brick aggregate and FBA whereas low for recycled brick aggregate compared to FBA at 14days and 28 days. But the compressive strength of recycled brickwork is similar to Mohammed *et al*. (2015) works.

- Finally, it could be concluded that the recycled brick aggregate (RBAY70Y and RBAY40Y) may be used in water filtration plant design, slope stabilization project, railway bedding, sub-base road construction material, etc. which are low strength structure as the strength of recycled brick aggregate was found low (10 ~ 12 MPa). The absorption capacity of recycled brick aggregate could be reduced by using a plasticizer admixture or by using a pre-saturation method or by adding water-reducing chemical admixture (Kesegić *et al*. 2008; Mohammed *et a*l. 2015). The recycled brick aggregate (RBAY70Y and RBAY40Y) also could be used for small to medium loads as like last floor slabs as lightweight concrete (Bashandy *et al*. 2017).

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FACTORS AFFECTING THE CONSTRUCTION PRODUCTIVITY IN THE CONTEX OF KHULNA CITY OF BANGLADESH

Md. Farhad Hossain Rakib*[1], Sujan Howlader[2] , Mizanoor Rahman[3] and Adnan Hossain[4]

[1,2]Graduate, Khulna University of Engineering & Technology, Bangladesh, e-mail: mfhrakib78@gmail.com ; sujanhowlader96@gmail.com
[3]Assistant Professor, Khulna University of Engineering & Technology, Bangladesh, e-mail: mizan16@becm.kuet.ac.bd
[4]Student, Khulna University of Engineering & Technology, Bangladesh, e-mail: adnanhossain353@gmail.com

***Corresponding Author**

ABSTRACT

The role of construction in the economy shows the necessity for the progress of construction productivity performance in the construction industry. In the construction industry, the most valuable asset is labor. It is necessary to increase the proficiency of production by increasing the productivity of labor. The key objective of this study is to identify the most affecting factors in construction productivity in the construction industry of Khulna city of Bangladesh. A questionnaire survey has been conducted for collecting the data among various stakeholders and projects in Khulna city. Factors influencing the construction productivity were analyzed by using an RII method. This study has shown that the top five ranked factors affecting construction productivity are Labor Supervision, Skilled Labour, Availability of materials, Availability of Equipment and Scheduling of work in Khulna city. The results obtained from this study fill a gap in knowledge of factors affecting construction productivity in Khulna, which can be used to provide industry stakeholders with guidance for improving the construction productivity in Khulna city.

Keywords: *Productivity, Factors, Construction, Labor, Khulna.*

1. INTRODUCTION

The building construction industry is considered as one of the fastest and largest sectors in Bangladesh. Construction productivity is key focus areas for the construction industry for any nation. It has a great contribution to the economy of a country. According to (Hannula, 2002), productivity is the ratio of total output to total input. Low productivity is a key point of anxiety for construction firms due to its bad effects on overall project progress in terms of time and cost performance (Jarkas & Bitar, 2011). The significance of controlling labor value is made into its overall performance to the project cost. It usually extents within 33% to 50% of total project costs (Jergeas, 2009). It is important to set what factors influencing construction productivity act positively or negatively. According to (Mahamid, Al-Ghonamy, & Aichouni, 2013), labor productivity plays a principal role in ensuring the attainment of a project. However, it could be affected by several unexpected variables. These variables may include factors related to labor, materials, equipment, construction methods, and climate. Poor labor productivity is one of the major causes of cost and time overruns in construction projects. So, high consideration should be taken to this factor in the construction industry. This study focuses on identifying and ranking the factors affecting construction productivity in the construction industry in Khulna city with respect to their relative importance so that the outcomes can be provided guidelines to stakeholders for actual planning and efficient utilization of the labors and cost-effective operation. The paper starts with a literature review of studies relevant to this investigation, discusses the research methodology, study area, data analysis, the results obtained, conclusions and finally recommendations.

2. LITERATURE REVIEW

The topic of construction productivity has been done by many researchers. It is important to set what factors influencing construction productivity act positively or negatively (Enshassi, Mohamed, Mustafa, & Mayer, 2007). If factors having a significance on construction productivity are recognized, it will also be feasible to forecast productivity (Lema, 1995). Several studies have been undertaken to identify the factors influencing construction productivity. In a survey carried out in the United States, material availability, tool availability, rework, overcrowded work areas and inspection delays were identified as major factors influencing productivity (Borcherding & Garner, 1981). In the Oman, stakeholders who participated in a survey towards identifying the factors affecting productivity ranked errors and omissions in design drawings, change orders during execution, delay in responding to requests for information, lack of labor supervision, clarity of project specifications, coordination amongst design disciplines, working overtime, rework, inclement weather, labor's physical fatigue (Jarkas, Al Balushi, & Raveendranath, 2015). A survey was done in Yemen, identified labor's experience and skill, availability of materials in site, leadership and efficiency in site management, availability of materials in the market, political and security situation, provides all drawing details during works, interruption of the work, architectural and structural designs, the accuracy and the level of project specifications, building technique, and technology, economic condition in the country, equipment required for work on the project among the most significant factors impacting construction labor productivity (Alaghbari, Al-Sakkaf, & Sultan, 2019). In a survey carried out in Jordan, illustrated that the following dimensions are almost equally important: planning, the worker–management relationship, education and experience, technology and equipment, and motivation (Hiyassat, Hiyari, & Sweis, 2016). In India, Analysis of the factors showed that the top-five ranking factors affecting labor productivity are skilled labor, availability of material, availability of tools, labor supervision and safety conditions on site (Ghate & Minde, 2016).

3. METHODOLOGY

The data of this study were collected using a questionnaire survey. The questionnaire was designed around factors influencing construction productivity collected from various studies and expert

interviews. The survey takes 15 factors propagated based on related research works on construction productivity. The structured questionnaire was built of two parts:

- The first part included general information about the respondents (respondent name, project name, and designation), whose initial aim was to narrate the respondents to effectively ensure reliability.

- The second part included a table, which represents 15 factors influencing construction productivity in Khulna. The questions were designed using a five-point Likert scale comprising ratings from 1 to 5. The respondents were said to give the range to which factor impacted construction productivity in their projects.

Finally, factor analysis was done in order to rank the factors.

3.1 Study Area

This study was performed at six selected areas KUET (Khulna University of Engineering & Technology), Fulbarigate, Boira, Sonadangha, Nirala, and Newmarket. These areas are located in Khulna division the southern part of Bangladesh. The areas are busiest places in this Khulna city. Construction of new buildings, infrastructure, the vertical and horizontal extension of the existing structures has become a regular phenomenon.

3.2 Data Collection

The study has adopted a questionnaire survey as a method to rank the factors affecting construction productivity in construction projects. Face to face survey was done for collecting the data. The required data for this study was collected from 100 respondents from construction projects in Khulna city of Bangladesh. Engineer, owner, contractor, and sub-contractor were performed as a respondent in this questionnaire survey who had very good experiences for more than 10 years in consultancy works in construction projects.

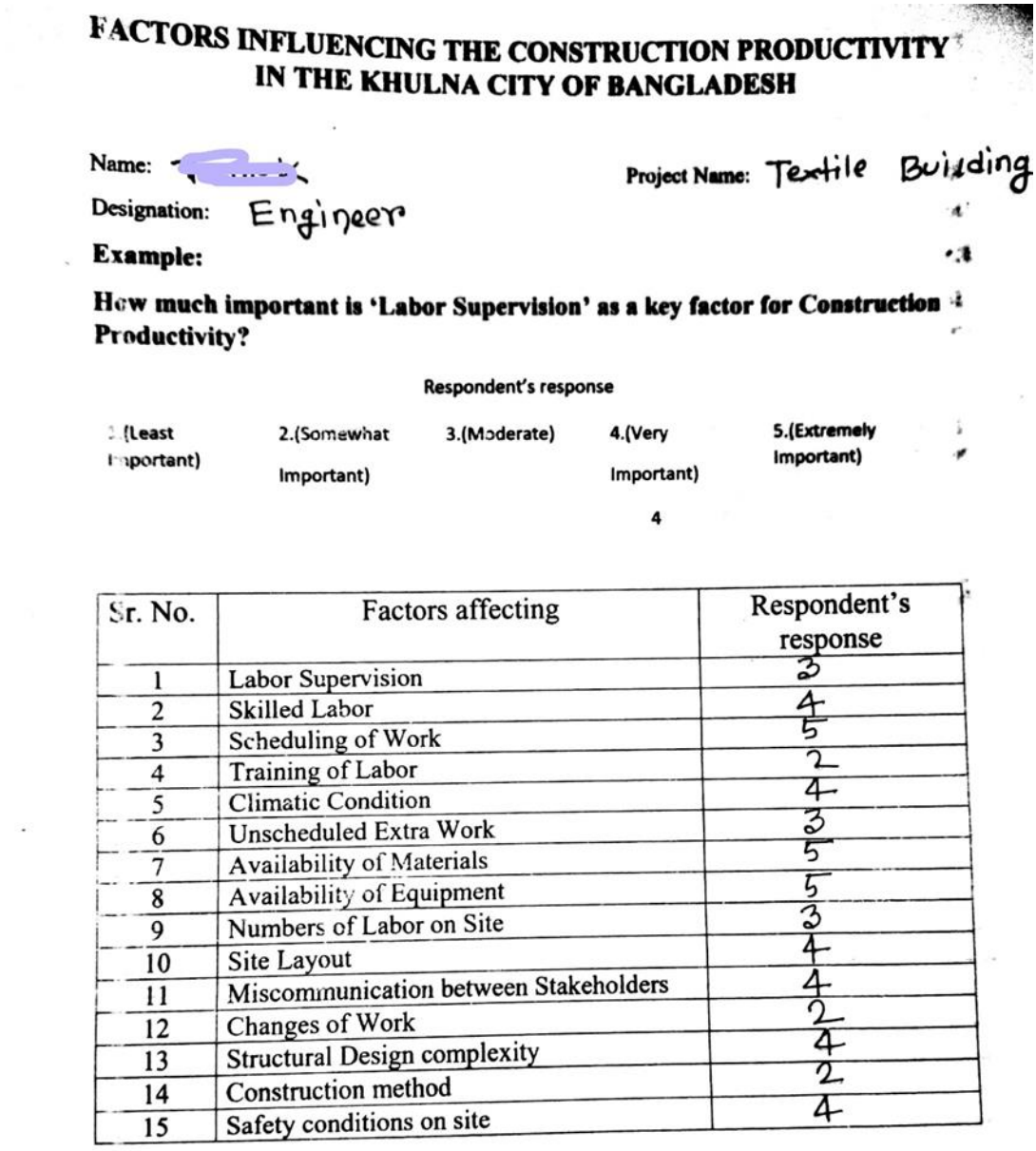
3.3 Data Analysis

To analyze the data received from the questionnaires, SPSS was used to calculate the Mean, Std. deviation. The Relative Important Index (RII) was used to analyses the ratings given by the respondents.
Data from 100 responses were analyzed for reliability. The Cronbach's alpha coefficient, the measure of internal consistency of the survey, was 0.730 indicating good consistency. This study also adopted a Likert scale rating of influence level from 1 to 5 where 1 stands for "Least Important" and 5 for "Extremely Important" influence of the factors collected via the face to face questionnaire survey. This study aimed to rank the identified factors in Khulna according to their importance, using the RII method. For each factor, the RII was calculated using the equation (1):

$$RII = \frac{\Sigma W}{AxN} \quad (1)$$

Where,
W = weighting of each factors given by respondents;
A = highest weight, which is 5 for this study;
N = total number of respondents.

Calculated RIIs range in value from 0 to 1 (0 not inclusive), indicating that the higher the RII, the more important was the factor.



FACTORS INFLUENCING THE CONSTRUCTION PRODUCTIVITY IN THE KHULNA CITY OF BANGLADESH

Name: [redacted] Project Name: Textile Building

Designation: Engineer

Example:

How much important is 'Labor Supervision' as a key factor for Construction Productivity?

Respondent's response

1.(Least Important) 2.(Somewhat Important) 3.(Moderate) 4.(Very Important) 5.(Extremely Important)

4

Sr. No.	Factors affecting	Respondent's response
1	Labor Supervision	3
2	Skilled Labor	4
3	Scheduling of Work	5
4	Training of Labor	2
5	Climatic Condition	4
6	Unscheduled Extra Work	3
7	Availability of Materials	5
8	Availability of Equipment	5
9	Numbers of Labor on Site	3
10	Site Layout	4
11	Miscommunication between Stakeholders	4
12	Changes of Work	2
13	Structural Design complexity	4
14	Construction method	2
15	Safety conditions on site	4

Figure 1: The questionnaire form for the factors influencing in the construction productivity

4. RESULT AND DISCUSSION

The mean value, std. deviation and variance of the survey result have been calculated in SPSS that's are tabulated in table 1. Finally, the Relative Importance Index (RII) was determined according to equation (1).

Table 1: Survey response result with RII

Factors	Mean	Std. Deviation	RII	Rank
Labour Supervision	4.340	0.878	0.868	1
Skilled Labor	4.070	0.819	0.814	2
Scheduling of Work	3.570	0.923	0.714	5
Training of Labor	2.970	1.086	0.594	8
Climatic Condition	3.310	1.001	0.662	6
Unscheduled Extra Work	2.470	1.029	0.494	11
Availability of Materials	3.850	0.857	0.770	3
Availability of Equipment	3.730	0.897	0.746	4
Numbers of Labor on Site	3.050	0.891	0.610	7
Site Layout	1.910	1.025	0.382	13
Poor Communication	2.550	0.957	0.510	10
Changes of Work	2.780	0.882	0.562	9
Structural Design complexity	2.200	1.100	0.434	12
Construction method	1.890	0.983	0.378	14
Safety conditions on site	3.310	0.872	0.662	6

4.1 Labor Supervision

With an RII of 0.868, labor supervision was highlighted as the most critical factor influencing productivity. Inadequate supervision of labor's work may be responsible for defective work and inappropriate application of tools and equipment. Labors also played false in the absence of supervisors. Proper monitoring of labor works by supervisors will be improved productivity in the construction industry.

4.2 Skilled Labor

The interviewed respondents identified that skilled labor has a high impact on productivity, it was ranked the second most diametrical factor with an RII 0.814. The project with skilled labor was delivered early in the time. The work with skilled labor can be done in the least time without compromising the quality of work. The consultancy firms, as well as Government, should be taken the necessary steps to make skilled labor.

4.3 Availability of Materials

The availability of materials as a factor was ranked third in respect to its impact on construction productivity, with an RII of 0.77. This is not amazing, as materials are important for the construction process. The owners claimed that this is principally due to the contractor's liquidity problems to procure the materials. For improving better productivity, engineers suggested the clients make progress payments to the contractors.

4.4 Availability of Equipment

With an RII of o.746, the availability of equipment was ranked fourth and is caused by inadequate management such as improper maintenance of equipment and use of old equipment. The improper maintenance schedule of equipment can find infrequent breakage. Rapid repair of faulty tools is also important to improve productivity. Construction productivity is disturbed if the equipment is not available on time at the construction sites, which causes long term effects on the cost and schedule performance of the projects. For improving productivity, the event of lack of equipment can be reduced by implementing preventive maintenance.

4.5 Scheduling of work

Scheduling of work was ranked fifth, as a critical factor influencing the construction productivity, with an RII of 0.714. Improper schedule reduced productivity due to let the work at the right time.

4.6 Climatic Conditions & Safety Conditions

With an RII of 0.662, Climatic conditions and Safety conditions onsite were ranked sixth jointly. For climatic conditions such as hot and cold weather, rain reduced construction productivity. Using personal protective equipment (PPE), workers can be moved easily in any palace without any fear and increased productivity.

4.7 Numbers of Labors on Site

The number of labors on-site was ranked seventh as a factor influencing construction productivity, with an RII of 0.61. The contractor or owner should be supplied with the number of labors on construction sites according to the work amount to increase productivity.

4.8 Training of Labor

With an RII of 0.594, training of labor was ranked eighth from the fifteen factors. The consultancy firms, as well as Government, should arrange the training program for labors to improve the skills and performance. The trained labors have a high productivity rate to finish the project earlies without losing quality.

4.9 Changes of Work

Changes of work were ranked ninth as a factor affecting the construction productivity, with an RII of 0.562. The changes in work were needed more rework and more time & cost for construction. Before starting the work, the design should be checked and completed.

4.10 Poor Communication

With an RII of 0.51, poor communication ranked tenth as a critical factor, influencing construction productivity. This factor allows defective works to occur due to incompetent communication skills. To overcome this problem, respondents suggest that instead of informal verbal communication, documentation should be used.

5. CONCLUSIONS

Construction productivity is one of the least practiced areas within the construction industry in Khulna. The key objective of this study, identification, and recognition of the factors affecting construction productivity in Khulna city is developed. For this study, fifteen factors were considered for the questionnaire survey and ranked these factors in a consistent way. Analysis of these factors showed that the top-five ranking factors affecting construction productivity are Labor Supervision, Skilled Labour, Availability of materials, Availability of Equipment and Scheduling of work. Labor supervision is a factor that highly affects the construction productivity and skilled labor, work can be done in less time without compromising the quality of work. The Availability of materials as a factor was ranked third with respect to its impact on construction productivity. The owners claimed that this is principally due to the contractor’s liquidity problems to purchase the materials. Improvement of

construction productivity in Khulna should be now focused on these factors since this will not only make the construction firms profitable but also increase its chance of progress in the industry.

6. RECOMMENDATIONS

Based on the findings, the following are recommended to improve productivity:

- The skilled site staff and experienced builders should be deployed in order to improve the productivity of Khulna city.
- To increase the productivity of Khulna city, Training and safety improvement programs should be taken by the various stakeholders as well as Government.

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CRISIS MANAGEMENT IN THE CONSTRUCTION INDUSTRY OF JASHORE CITY IN BANGLADESH

Md. Nurul Islam[1] and Md. Hamidul Islam*[2]

*[1]Undergradute Student, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh. email:*ikhan72929@gmail.com
[2]Assistant Professor, Department of Building Engineering and Construction Management, Khulna University of Engineering & Technology, Khulna-9203, Bangladesh. email: hamidcekuet@gmail.com

***Corresponding Author**

ABSTRACT

Crisis management is a way of overcome crisis by catching and assessing crisis signs and needs to take and implement required safeguards in order to overcome a crisis with a negligible damage. A construction firm can survive without considerable financial losses by perceiving the early warning signals. Considering all these issues, this paper is aimed to identify the potential factors that may lead to the crisis in construction projects and analyzing the factors governing the implementation of crisis management in the field of construction industries of Jashore city in Bangladesh. Risks and uncertain events are very common at construction industry in all over world. That's why the implementation of crisis management in a construction project is very vibrant to prevent construction costs and delay. In this research a detailed questionnaire survey was conducted among owners, engineers, contractors and laborer in the construction industry. This study identified major fourteen factors for crisis in construction project among them the poor initial estimation, financial issues and too many changes was governing factors for crisis management implementation in construction projects. In this study there were vital effects of the contractor's experience and worker strikes issues in crisis management of construction projects. Inadequate fund, inflation rate and political stability are also the vibrant cause of crisis in construction project. There was diverse observation between engineer, contractor, owner, worker for picking the crisis factor of project management.

Keywords:*Crisis management, Factors in crisis implementation, Questionnaire survey, Project management, Construction industry.*

1. INTRODUCTION

Negative event is the cause of crisis and thereby affects construction companies gradually in today's globalized world. Normally these events may occur suddenly or after a long process. When a crisis happens in an organization, then they are unable to maintain their normal routine procedure (Öcal et al., 2006). Companies have no or a very little control over environmental causes of crisis. These are generally related with economic, political, legal, natural and rivalry conditions, clients' expectations and technological developments (Health, 1998). Unexpected changes and uncertain events are the reasons behind this kind of situation. Crisis management is a continuous process and it is applied in extra-ordinary situations. Its aim is to identify the crisis signals, planning for response to the same and preventing its negative impacts on construction projects (Loosemore & Hughes, 1998).Management during the crisis starts with the preparation of a management plan so that they can guide both the management and the employees on what should be done to get the situation under control with minimum loss (Sahin et al., 2015). The management should not only maintain the crisis plan but also focus on increasing the productivity and the motivation of employees. Any action like buffering employees should be avoided at this stage (Öcal et al., 2006). Establishing an early warning system which provides some time to take required precautionary steps in confronting crises is one of the most important aspects of crisis management process and such a system helps the construction companies to successfully manage potential crises (Jia et al., 2013). A construction company can overcome any crisis with or without minimum damage by estimating a crises situation well and executing crisis management techniques effectively (Sahin et al., 2015). Crisis is inevitable in construction projects. Therefore, companies that deal in construction projects as an ongoing basis thus must learn to deal with such crises on a regular basis (Hillson, 1997). A crisis threatens to damage reputation of a company because it gives people to think negative regarding the company's performance (Coombs, 2007).

There are several studies concerning crisis management has been conducted in the construction management area. They are specifically about theory formulation (Loosemore, 1999), communication structure (Loosemore,1998e), contractual conditions (Loosemore & Hughes, 1998), real estate-based analysis (Kaklauskas et al., 2011), triple constraints composed of communication, sensitivity, and responsibility (Loosemore, 1998c), environmental and organizational factors(Öcal et al., 2006), organizational behavior (Loosemore, 1998b), reactive communication and behavior (Loosemore, 1998a), disorganization (Loosemore & Hughes, 2001), preparedness (Loosemore and Teo, 2000), social adjustment (Loosemore, 1997), and social network analysis (Loosemore, 1998d),the nature and management of crisis in construction projects (Hällgren & Wilson, 2008), the importance of crisis communication in construction project's crisis management (Vondruška, 2014), organization's preparedness for effective crisis management practices (Mitroff et al., 1987), crisis management in Turkish construction industry(Öcal et al., 2006), managerial competency of crisis managers (Tomastik et al., 2015),crisis management team effectiveness (King, 2002).A very few research was found on crisis manage in the construction project in all over the world especially in Bangladesh. Therefore, in this study, contribute on potentials factors lead to crisis and governing factors to manage crisis in the construction project at Jashore city in Bangladesh.

2. METHODOLOGY

The scope of this study is to confine with the views of engineering and managerial personnel involved in the construction site for the successful implementation of crisis management in construction projects. A in depth questionnaire survey was used for this research. The questionnaire survey was conducted among 50 respondents including owners, engineers, andcontractors, workers. The questionnaire was included 20 questions, which mainly focused on 14 main factors. Those were poor initial estimation, financial issues, too many changes, political issues, natural issues, contractor's issues, scheduling variance issues, technical issues, natural issues, worker strikes issue, inadequate knowledge of worker, worker availability, conflicts between the contractor and other parties, compressing project schedule. Questions were arranged in three different groups. First type of questions were scaling question. Scaling was used for those questions. The questionnaire was framed

using five points scale rating system. Respondents were asked to express their agreement or disagreement of the choices of answers to a particular question on a five points scale, from 0 to 4(0 being 'strongly disagree', 1 being 'disagree', 2 being 'agree or disagree', 3 being 'agree' and 4 being 'strongly agree'). This type of question's answer was expressed by the pie chart. Thus, mean (xi)and variance co-efficient (V) values were calculated from all the responses in order to get the general tendency and the variations. Second group of questions were related with the scaling of the relative importance of each choice with respect to the others in that particular question. These type of questions were calculated by percentage. Third type of questions were not related with scaling. This type of question's answer was expressed by percentage. These types of questions were calculated by pie chart.

3. RESULTS AND DISCUSSION

In this study, the detailed and descriptive statistical analysis was performed to obtain the mean scores for fourteen identified major variables. The frequency analysis method was used for calculating the descriptive statistical analysis. The frequency analysis is based on the number of the point chosen by the respondents.

Table 1: Mean score analysis of crisis factors of project management.

Crisis Factor	Number of Respondents (N)	Standard Deviation	Variance (V)	Mean (Xi)	Rank
Poor initial estimation	50	0.4431	0.1963	3.74	1
Financial issues	50	0.4629	0.1251	3.70	2
Too many changes	50	0.5803	0.1568	3.70	3
Lacking of contractor's experience	50	0.6091	0.1701	3.58	4
Worker strikes issues	50	0.7060	0.1994	3.54	5
Inadequate knowledge of workers	50	0.7071	0.2020	3.50	6
Workers unavailability	50	0.5047	0.1450	3.48	7
Conflicts between parties	50	0.8628	0.2479	3.48	8
Target cost	50	0.5035	0.1455	3.46	9
Technical issues	50	0.9596	0.2961	3.24	10
Political issues	50	1.0214	0.3152	3.24	11
Natural issues	50	0.8806	0.2751	3.20	12
Schedule variance issues	50	1.2501	0.4496	2.78	13
Compressing project schedule	50	1.1350	0.4112	2.76	14

The crisis factors for project management in the study area have been illustrated in Table 1. The table is the self-explanatory for major factors of crisis management. The table showed that poor initial estimation is the main crisis factor in the construction project of Jashore city, Bangladesh. Financial issues and too many changes have 2ndhighest mean score of 3.70 but their numbers of variance are different. The number of variance of the financial issue is less than the number of variance of too many changes. That's why the financial issue is the 2nd major factor and too many changes is the 3rdvital factor that governs the implementation of crisis management in construction projects. It is then followed by lacking of contractor's experience (Xi =3.58, V=0.1701), labor strikes issue (Xi =3.54, V=0.1994). Likewise, the lowest-ranked factor is compressing the project schedule (Xi =2.76, V=0.4112).

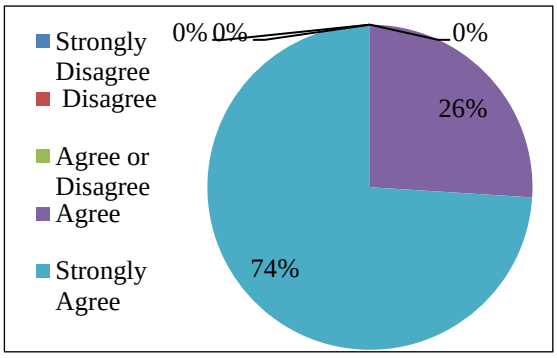

Figure 1: Crisis occurs due to financial poor initial estimation in construction project.

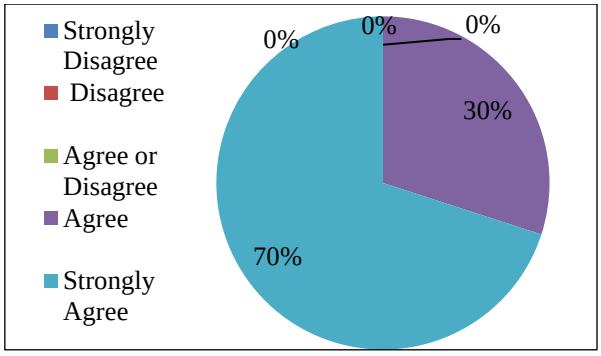

Figure 2: Crisis occurs due to financial problem in construction project.

The crisis occurs in the study area due to poor initial estimation and due to financial problems in the construction project that have been described in Figure 1 and Figure 2. It has been found that no participant strongly disagreed, disagreed, agreed or disagreed but 26% of the participants agreed and 74% of the participant strongly agreed that crisis occurs due to poor initial estimation as described in Figure 1. From Figure 2, it has been found that no participant strongly disagreed, disagreed, agreed or disagreed but 30% of the participants agreed and 70% of the participants strongly agreed that crisis happened due to financial issue. It can be concluded that greater than 4% of the participant strongly agreed that crisis occurs due to poor initial estimation compared to financial problems in the construction project. The accurate estimation considering current market price by the engineering or actual will be the solution to manage poor initial estimation and financial related problems.

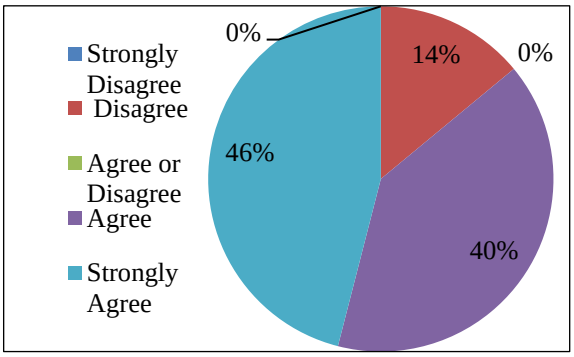

Figure 3: Crisis occurs due to target cost incident in construction project.

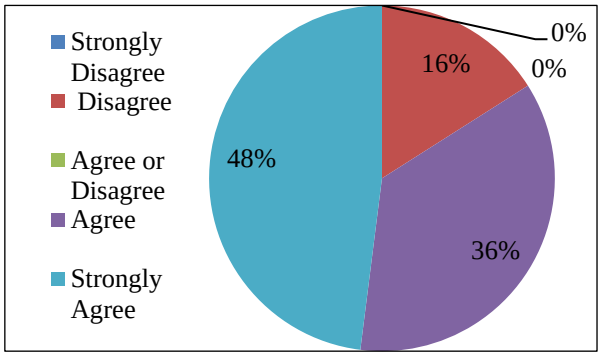

Figure 4: Crisis occurs due to too many changes in the construction project.

A crisis occurs due to the target cost incident and too many changes in the construction project that have been pronounced in Figure 3 and Figure 4. From Figure 3, it has been found that no participant strongly disagreed, agreed or disagreed but 14% of the participants disagreed, 40% of the participants agreed and 46% of the participants strongly agreed. From Figure 4, it has been found that no participant strongly disagreed, agreed or disagreed, but 16% of the participants disagreed, 36% of the participants agreed and 48% of the participants strongly agreed. From the Figure 1 and Figure 2, it can be picked up that greater than 2% of the participants strongly agreed that crisis occurs compared too many changes than target cost and 2% of the participants disagree that crisis occurs due to too many changes than due to target cost in the construction project. These crises can be controlled by proper initial design and professional managerial behavior.

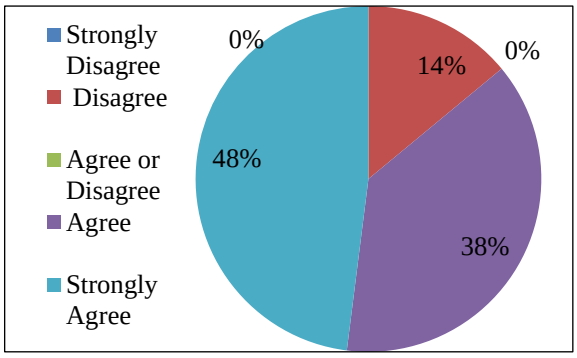

Figure 5: Crisis occurs due to political issue in the construction project.

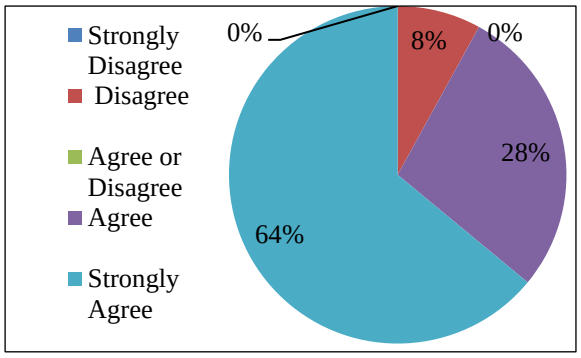

Figure 6: Crisis occurs due to conflict between two parties in the construction project.

The crisis occurs due to political issues and conflict between two parties in the construction project that have been narrated in Figure 5 and Figure 6. It has been found that no participant strongly disagreed, agreed or disagreed but 14% of the participants disagreed, 38% of the participants agreed and 48% of the participants strongly agreed as explained in Figure 5. From Figure 4, it has been found that no participant strongly disagreed, agreed or disagreed, but 8 % of the participants disagreed, 28% of the participants agreed and 64% of the participants strongly agreed. It can be finalized that greater than 16% of the participants strongly agreed that crisis occurs due to conflict between two parties than due to political issue in construction project and greater than 6% of the participants disagreed that crisis occurs due to political issue than due to conflict between two parties in the construction project. Creating democratic environment and equality between contractors would be the solution to handle political issue and conflicts related project crisis.

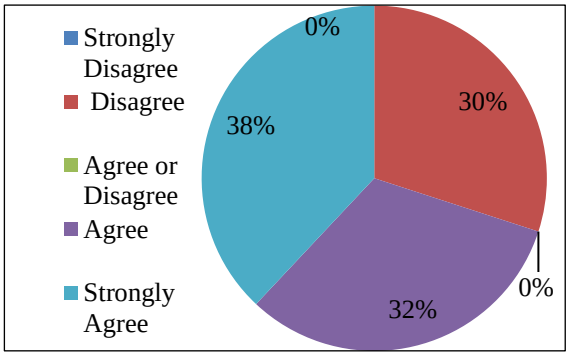

Figure 7: Crisis occurs due schedule variance in the construction project.

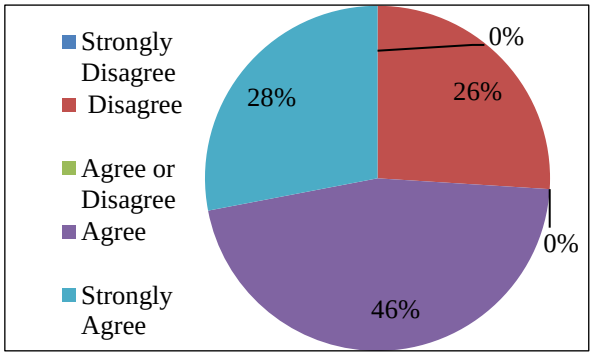

Figure 8: Crisis occurs due to compressing project schedule in the construction project.

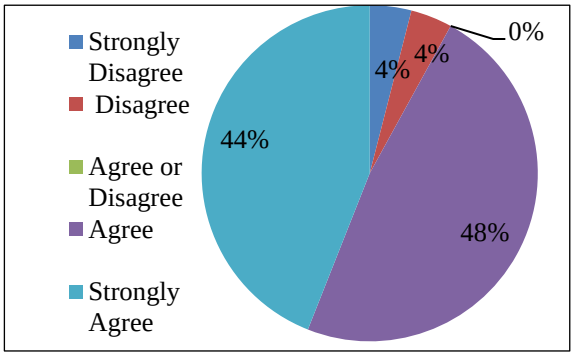

Figure 9: Crisis occurs due technical issues in the construction project.

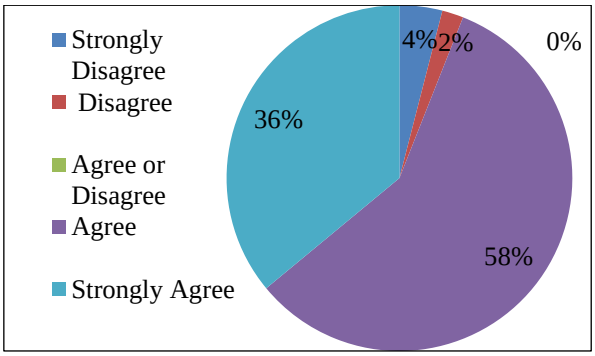

Figure 10: Crisis occurs due to natural issues in the construction project.

The crisis in construction project occurs due to schedule variation, compressing project schedule, technical issues and natural calamities have been self-explained in Figure 7 to Figure 10 respectively. From the Figure 7 and Figure 8 it could be flashed that greater than 10% of the participants strongly agreed that the crisis occurs due to schedule variance than compared to compressing project schedule in construction project and greater than 4% of the participants disagreed that crisis occurs due to schedule variance than compared to compressing project schedule in the construction project. Considering all datas it can be narrated that the technical and natural issues related crisis are more vibrant than schedule variation and schedule compression of a construction project.

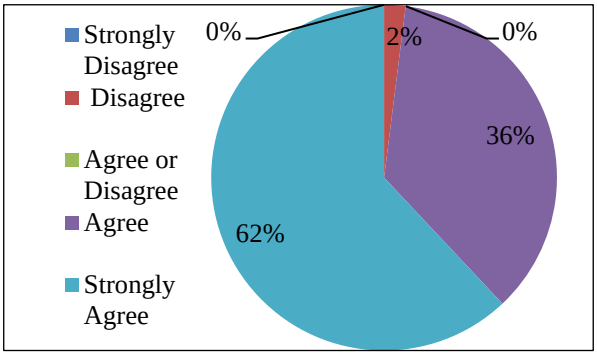

Figure 11: Crisis occurs due to lack of the contractor's experience in construction project.

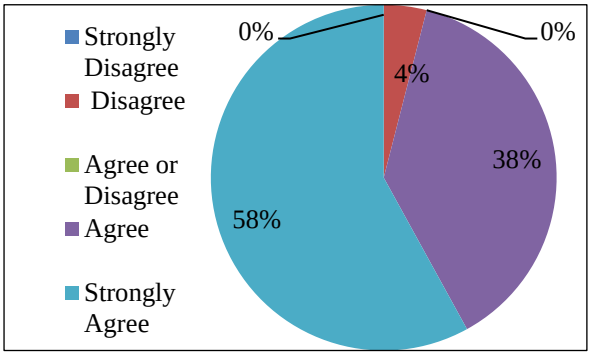

Figure 12: Crisis occurs due to worker's inadequate knowledge in construction project.

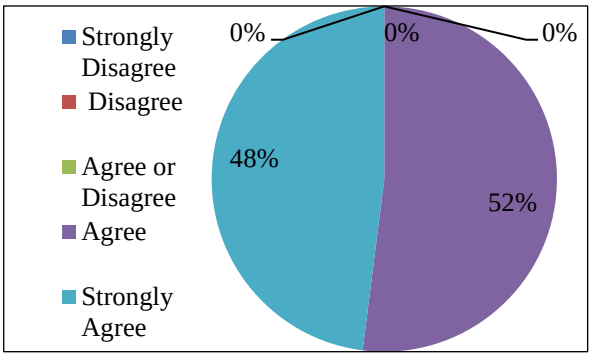

Figure 13: Crisis occurs due to workers unavailability in the construction project.

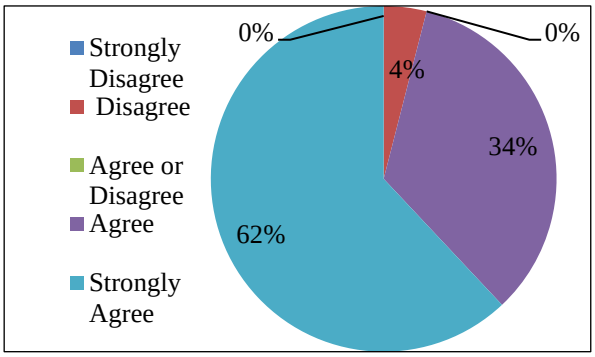

Figure 14: Crisis occurs due to worker strikes issues in the construction project.

The crisis in construction project occurs due to lack of contractor's experience, inadequate knowledge of workers, worker unavailability and worker strikes issues in construction project have been showed in Figure 11 to Figure 14 respectively. The above figure could be self-explanatory and easily understandable to narrate crisis in construction site. From the Figure 11 and Figure 12, it is found that greater than 4% of the participants strongly agreed that crisis occurs due to lack of the contractor's experience compared to worker's inadequate knowledge in construction project and greater than 2% of the participants disagreed that crisis occurs due to worker's inadequate knowledge than due to lack of the contractor's experience in the construction project. From the Figure 13 and Figure 14, it is obtained that more than 14% of the participants strongly agreed that crisis occurs compared to worker strikes issues than workers unavailability in the construction project and higher than 4% of the participants disagreed that crisis occurs relative to worker strikes issue than due to workers unavailability in the construction project. The above crisis will be solved by proper training of contractors, worker and application of construction laws.

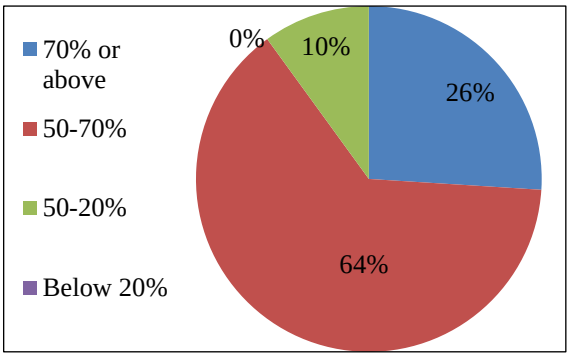

Figure 15(a): Construction project having inadequate fund.

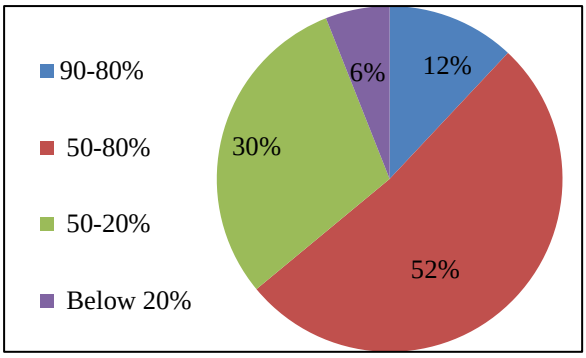

Figure 15(b): Effects of inflation rate on construction projects.

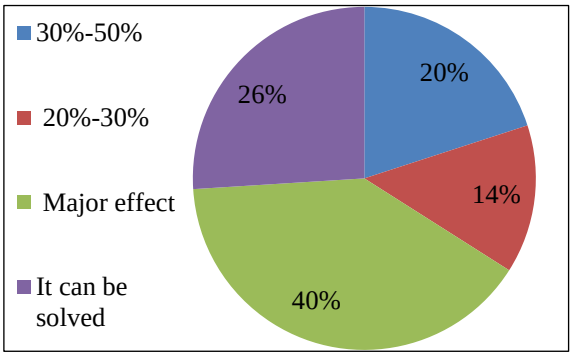

Figure 15(c): Effects of political instability on projects.

Questionnaire survey results of construction project having inadequate fund, inflation rate and political stability have been designated in Figure 15(a) to 15(c). Figure 15(a) labeled that the almost 64% of participant thought that 50-70% of project have inadequate fund in their organization. Figure 15 (b) showed that the 52% of participant responded that 50-80% negative effect is occurred due to inflation in projects. Approximately, 40% of participant thought that political instability has major negative effect on the projects illustrated in Figure 15(c).

Table 02: Causes of estimation inaccuracy in construction project.

Factors	Respond (%)
Poor estimation delay and inflation	6%
Lack of detailed plan, too many changes in order and big sap between market price and official price	38%
Too many changes in order and unpredictable inflation	56%

Table 03: Reasons behind the too many changes in construction project.

Factors	Respond (%)
Poor feasibility study	0%
Poor feasibility study and unpredictable issue	14%
Poor understanding client's requirements and clients change their mind	68%

Table 04: Effects of political issues in construction project.

Factors	Respond (%)
Due to political reasons some projects complete	8%
Due to political reasons some projects are almost closed	12%
This type can be controlled	64%
No adverse effect on project	16%

Table 2 to Table 4 showed as a self-explanatory regarding estimation inaccuracy, too many changes and effects of political issues. Table 2 narrated that the participants, almost 56% of the participants thought that most often estimation are not accurate due to too many changes in order and unpredictable inflation and 38% of the participants responded that most often estimation are not accurate due to lack of detailed plan, too many changes in order and big sap between market price and official price. Table 3 showed that almost 68% of the participants responded that the factor causes too many changes in order in project are poor understanding client's requirements and clients change their mind and 18% of the participants responded that the factor cause too many changes in order in project are poor feasibility studies allocated time of feasibility studies is too short. It can be found that almost 64% of the participants responded that effect of political issues on project can be controlled and 16% of the participants responded that no adverse effect of political issues on project has been described in Table 4.

4. CONCLUSIONS

Fourteen major variables are identified and critically analyzed by this paper which is influencing on crisis management implementation in construction projects of Jashore city in Bangladesh. Those are poor initial estimation, financial issues, too many changes, lacking of the contractor's experience, worker strikes issues, inadequate knowledge of workers, workers unavailability, conflicts between parties, target cost, technical issues, political issues, natural issues, schedule variance issues, compressing schedule. The study found that the variables i.e. poor initial estimation, financial issues and too many changes showed greater mean scores as the governing factors for crisis management implementation in construction projects. The study also confirmed that there is a significant influence of the variables such as lacking of the contractor's experience and worker strikes issues in crisis management implementation for construction projects. This study also found that the crisis in construction project happened due to inadequate fund, inflation rate and political stability. Also, it found that the causes of estimation inaccuracy, too many changes and effects of political issues were affecting points of construction project. There is diverse perception between engineer, contractor, owner, worker for choosing the crisis factor of project management.

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