

COST OVERRUN FACTORS AND PROJECT COST RISK ASSESSMENT IN CONSTRUCTION INDUSTRY - A STATE OF THE ART REVIEW

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ABSTRACT

This paper presents a state of the art review of major and frequently occurred cost overrun factors and project cost risk assessment models in construction projects. Construction industries play an important role in economic growth and development of any country. Recently it has witnessed that a large number of construction projects are facing the problem of cost overrun due to some factors. These factors are associated with some form of risk and uncertainty of the project. Therefore, project cost risk assessment is an important step for making decision in construction projects. Findings from the review are presented in form of tables and charts that classify cost overrun factors, ranking of the cost overrun factors. Project Cost risk assessment models and applicability of the past studies in Indian construction industry are also discussed. Then, directions for further future research for India is introduced.

KEYWORDS: Cost Overrun, Risk Assessment, Construction Industry, Modelling, Fuzzy Logic

INTRODUCTION

The infrastructural development and socio-economic progress of a nation utterly depend upon the conceptual visualization of major projects. Construction industries play an important role in economic growth and development of any country especially for developing countries like, India. In recent development, witnessed globally, it is observed that the construction industry has become one of the largest industries and its contribution is more than 10% of global economy. On account of characteristics possessed by the construction industry it is very prone to risk and uncertainty. Such associated risks may be of various kinds which depend on many factors. These factors are outcome of the uniqueness, complexity and dynamic nature of the construction activities. It involves large number of projects participants such as, contractors, clients, consultants etc. It has been observed that risks and uncertainties involve in construction project are not being addressed and managed efficiently. Therefore to improve the performance of construction industry, there is dire need to deal with these risk and uncertainty in integrated manner to achieve the success of project in terms of cost, time and quality. Among all the success parameters as mentioned above, the cost is considered as a very important and key parameter. Studies done by various authors (Franke, 1987; Paek et al. 1993; and Williams, 1995) suggest the use of risk cost as an assessment scale of any project. It has been observed that cost overrun is a very common issue associated with projects in the construction industry. Cost overrun is a major problem especially in developing countries where the cost overruns, many a times exceed 100% of the estimated cost of the project (Angelo and Reina, 2002).

Infrastructure investments in India have been growing rapidly. Many major projects are going on with the assistance of World Bank, Asian development bank. India has become one of the leading outsourcing hubs in the world. This sector is considered to be important key driver of economic growth of the country and occupies a pivotal position in

the national development plans. It is seen that economic growth is not being achieved at desired level due to cost overrun and delay. Despite the importance of construction industry in the economic development of the country. It has been observed that not much attention is being paid to handle the problem of cost overrun by the stakeholders of the construction industry in India. Therefore, it is an urgent need to identify actual causes of cost overruns so that the cost of any construction project and delay in time can be minimized. With the above background in view, the proposed work is undertaken.

The objective of this paper is to review the past studies related to construction cost overrun factor, their rankings and related cost assessment models for their application to develop a cost assessment model for Indian construction industry. The specific objectives of the present study are:

- To find out the problem of cost overrun in construction projects
- To find out the important factors responsible for cost overrun
- To study the existing cost assessment models
- To find out the best method of cost assessment model
- The applicability of the past studies in Indian scenario.

METHODOLOGY

A systematic literature review on cost overrun factors and project cost risk assessment of construction project was carried out. The articles on leading cost overrun factors and cost risk assessment of construction project were searched from various sources (Journals, Proceedings, Web). A much larger number of papers were examined. The papers related to cost overrun in construction project, articles identifying factors for cost overrun, models for assessing risk of construction project were selected. The articles published on tools and techniques used for risk analysis were also selected.

Cost Overrun in Construction Projects

Cost overruns are defined as the excess of actual project costs over budgeted costs. The cost overburden is obtained by the estimated cost, final cost and the contract between a contractor and an owner. The difference between estimated and final cost is termed as the magnitude of the cost overrun of a project (Akinici and Fischer, 1998). Angelo and Reina (2002) presented that cost overruns is serious problem. It is urgent need to address this issue. Morris and Hough (1987) have studied 40 reports about cost overruns in different types of projects. It has been found that approximately 50 percent of construction projects suffered with the problem of cost overrun, the value of which lies in between 40 and 200 percent.

Frame (1997) showed that only 16% of 8000 projects were completed on time, within the budgeted cost and maintaining a high standard of quality, which are the three important criteria of success of any project.

Flyvbjerg (2000) conducted a research study on cost overrun in global construction. It was seen that 9 out of 10 projects had problem of cost overrun and 50 to 100 percent cost overrun was commonly varied for different project. Construction projects are supposed to experience an increase in cost of about 33% on average (Hartley and Okamoto, 1997). Avotos (1983) stated that it should be general practice to expect the final cost of a project exceed the initial budget by 10 -20 percent.

As per the study which carried out between 1980 and 2000 by the International Programme in the Management of Engineering and Construction (Miller and Lessard, 2000) for the 60 large engineering and construction project, with an average capital value of \$ 1 billion concluded that 18% were having extensive cost overrun. Baloi and Price (2003) presented that the problem of cost overruns are commonly observed. As per his statement, problem of cost overrun has now become a norm, rather than an exception in the construction industry. As far as the problem of cost overrun is concerned, India is not an exception. Around 60% of the projects are suffering with the problem of cost overrun. It has been observed that India could face financial loss in terms of GDP loss which may be approximately 10 per cent of its GDP in financial year 2017, if the present condition remains same (Gupta et al., 2009)

Factors Responsible for Cost Overrun

The variation of project cost depends upon many factors which are related to risk and uncertainties involve in the project. Many case studies are available in the literature related to cost overrun in the construction projects worldwide. Some of the important case studies have been discussed here.

Arditi, et al. (1985) conducted a questionnaire survey to identify the factors causing cost overrun in public projects in Turkey. It has been found that the main causes of cost overrun were due fluctuations in cost of materials. It has also been seen that delay in projects due to lack of resources, changes in design and specifications, financial problems are main causes of cost overrun. Okpala and Aniekwu (1988) studied the reasons of cost overrun in Nigeria Construction projects. It has been seen that the price fluctuations, additional works, delays, fraudulent practices, shortening of contract period, inaccurate estimates, were the main causes of cost overrun.

Elinwa and Buba (1994) carried out a survey in Nigeria. It has been found that the material cost, fraudulent practices, materials' prices increment, high cost of machineries and poor planning were the most important cause of cost overruns.

Mansfield et al. (1994) also carried out a questionnaire survey among key stakeholders (contractor, consultant and client organisations) in Nigeria. It has been found that poor planning, shortage in materials, imported materials, changes in site conditions, design changes were the main causes of construction delays and cost overrun.

Jackson (2002) carried out a study on building construction projects in UK. It was seen that the most important factors causing cost overrun were identified as poor project planning and management, unexpected ground condition, design development, lack of information , estimating method, time limit, commercial pressure, procurement route and external factor.

Koushki et al. (2005) found that the contractor-related problems, material-related problems and owners' financial constraints were main causes of cost overrun in Kuwait's Private residential projects.

Creedy (2005) studied the main causes of cost overrun in Australia Highway project. It has been seen that major factors influencing the cost overrun in highway projects are change in design in various components, changes in contract tender price, quantity increased measure, latent condition, remove and replacement of unsuitable material due to faulty design, change in design as environmental issues as per local conditions.

Several studies were also carried out in different parts of the world for the identification of cost overrun factors in construction projects. Morris (1990) investigated the factors affecting the cost overruns in 133 projects related to public

sector. The important causes of cost overrun in High-rise construction project were identified by Kaming et al. (1997) in Indonesia using a questionnaire survey. Frimpong et al. (2003) studied the main causes of cost overrun in Ghana ground water construction projects. A survey was also carried out by Omoregie and Radford (2006) in Nigeria Infrastructure project. Azhar et al. (2008) conducted a survey in Pakistan Construction projects.

Le-Hoai, et al. (2008) carried out a questionnaire survey to identify the main factors for cost overrun in Vietnam. A similar survey was conducted by Enshassi, et al. (2009) and Kaliba et al. (2009) in Gaza Strip and the highway projects of Zambia respectively. Ameh et al. (2010) investigated the major cost overrun factors in telecommunication projects in Nigeria. Jergeas and Ruwanpura (2010) studied the causes of cost and time overruns in oil sands megaprojects in Canada. Olawale (2010) conducted a survey to identify the main causes of cost overruns in UK construction projects. Wakjira (2011) surveyed the cost overrun factors in Ethiopian federal road construction projects. Rahman et al. (2013) studied the important factors causing cost overrun in construction industry in Malaysia. Aziz (2013) studied the cost overrun factors for constructing waste water projects in Egypt.

Many studies [Hanna et al. 2004; Sambasivan and Soon, 2007] has shown that delay in projects has positive and linear relationship with the increase in cost. Hence, in order to study the common factors of cost overrun, the research studies on time overrun and project delay are also considered as a part of related literature review.

Assaf et al. (1995) studied the reasons of delays in construction projects in Saudi Arabia. Ogunlana et al. (1996) studied the delays in building projects in Thailand. Chan and Kumara Swamy (1996) evaluated the delay factors for construction projects in Hong-Kong. The causes of delay were classified by Odeyinka and Yusuf (1997) in Nigeria. To find the main causes of delay, Al-Momani (2000) examined 130 public building projects in Jordan constructed during 1990-1997. Odeh and Battaineh (2002) carried out a study to identify the most important reasons of delays in construction projects. Chang (2002) identified cost and delay factors in US. Assaf and Hejji (2006) conducted a survey to identify delay factors for construction projects in Saudi Arabia. Faridi et al. (2006) found the causes of delay and ranked them on the basis of their relative importance index in UAE construction industry.

Acharya et al. (2006) studied the time delay factors in Korean construction projects. Sweis et al. (2007) identified the most common causes of residential project delay. Some case studies are discussed below related to construction project in India.

Datta (2002) carried out a study and found that cost overrun and time delay occur due to the delay between the planning stage and actual implementation of large infrastructure projects. According to him this is a global problem in the construction industry.

A study was conducted by Iyer et al. (2005) for identifying the factors adversely affecting the cost performances of projects in India. It has been found that the main causes of cost overrun were observed as conflict among project participants, lack of knowledge, presence of poor project, climatic conditions, delay in decisions, tough competition at tender stage and short bid preparation time. The main reasons for delay were identified by Doloi et al. (2012) based on a survey questionnaire and personal interviews in Indian construction industry. Desai and Bhatt (2013) identified the causes of delay in residential construction projects in Gujarat, India. Total 59 causes of delay were recognised. The important factors causing delay includes original contract duration is too short, shortage of labours, delay in material delivery, low productivity level of labours, delay in progress payments by owner.

Classification of Risk Factor

Classification of risk is an important step in the analysis of risk assessment. It is a way of systematizing the risks factors for identifies the areas of the project that are most suffering due to the risks. There are different ways of classifying the risks that depends on nature of risk and their sources and origins, or project phase. Risks are categorised as internal and external in hierarchical risk breakdown structure (HRBS). Tah and Carr (2000) classified the risk based on origin and location of impact of risk by using a hierarchical risk breakdown structure. External risks are relatively uncontrollable and require observing continually while the internal risks are relatively more controllable. Jennifer and Shane (2009) classified the cost risks factors into internal and external factors. The factors related to delay were classified according to the sources of the delay i.e., related to client, contractor consultant, material, labour, equipment, project and external [Assaf and Hejji, 2004; Sambasivan and Soon, 2007]. Azhar et al. (2008) grouped cost risks factors into three broad category viz, macro-economic factors, management factors, business and regulatory factors. Ameh et al. (2010) classified cost overrun factors into five groups viz, environmental factors, construction factors, construction item factors, cost estimating factors and financing factors.

Cost Assessment and Forecasting Models

The main objective of modelling of risks and uncertainty in estimating and forecasting construction cost is to analyse the effect of associated uncertainty in the cost estimating process to have more realistic estimate. Several models are available in literature and used for various purposes. There are two approaches to develop a model (i) simple classical method (ii) advanced models. Examples of simple classical methods include sensitive analysis, fault tree analysis, event tree analysis etc. While the examples of advanced models of risk assessment are based on monte –carlo simulation for analysis of stochastic modelling and fuzzy logic. These methods can further be classified as either quantitative or qualitative. The quantitative models are based on numeric estimation. To develop the quantitative models, tedious calculations, mathematical knowledge and high quality of data are required, which are very difficult to obtain for construction project. Moreover, it is very difficult to address the uncertainties associated with construction activities. A model based on the qualitative approach to assess the risk is developed by incorporating linguistic variables. In qualitative methods, uncertainties associated with construction activities can be addressed. On account of some unknown and vague factors which are intrinsic characteristic of the project some uncertainties creeps in, which cannot be explained by the probability theories. The human intuitive thinking which is a cognitive process, can better be handled/accessed by the fuzzy set theory. The fuzzy set theory which in itself has the potential to deal with the vagueness, uncertainty and subjective nature of any problems, is better equipped to handle the almost same analogous which is found in the complex construction projects. Some of the important studies which were conducted by different researcher are discussed here.

Kangari and Riggs (1989) presented a risk analysis model based on fuzzy set theory. Tah and Carr (2000) also proposed a model based on the qualitative approach to assess the risk by incorporating linguistic variables. This model had some limitations. Tah and Carr (2001) further developed a new combination rule based on the maximum assessment of a predominant risk factor. Through this model they tried to sort out the limitation of above model. Baloi and Price (2003) suggested fuzzy set theory as a vital solution for assessing uncertainty in construction project by comparing different theories and to tackle the global risk factors affecting construction cost performance.

KEY FINDINGS FROM THE REVIEW

The following issues are emerged from the literature review described in the paper.

The Problem of Cost Overrun

The problem of cost overruns is critical as per literature review. Therefore, it is essential to address the issues which are responsible for cost overrun in the future. This is common problem for different type of projects and locations. Indian construction industries are also facing the problem of cost overrun. A majority of projects close to 60 per cent are facing the problem of cost overrun.

Overrun Factors and Their Classification

The commonly occurred cost overrun factors found from the literature review are given in table 1. The factors related to cost overrun are classified into 11 groups according to the sources of the cost overrun. The factors for cost overrun belongs to each group are also shown in table 1. The cost overrun factors related to owner group are presented in the form of chart as shown in Figure 1. It is clear from the figure that slow decision making factor has highest frequency of occurrence in the owner group. It means that delay in decision taken by the owner is one of the main factors for cost overrun of construction projects. Similarly, Charts are prepared for cost overruns factors belongs to group of contractor, consultant, design, project, material, labour, equipment, contract, Coordination/communication and external factors and shown in Figures 2-11.

It is seen from the Figures 2-4 that poor planning and scheduling, contract management, frequent design change have the highest frequency of occurrence in the contractor, consultant, design group respectively. Whereas, Change in the scope of the project related to project group, shortage of material from material group, shortage of labours from labour group, equipment availability and failure from equipment group are found to be most important factor as shown in Figures 5-8. Factors related to group of contract, co-ordination/communication and external have the main factors as mistakes and discrepancies in contract document, poor coordination and lack of communication between parties, climate change respectively as shown in Figures 9-11. An analysis of the cost overrun factors is shown in Figure 13. Among major twelve factors, climatic condition variable has highest frequency of occurrence followed by poor planning and scheduling, shortage of construction material, fluctuation in price material, slow decision making, shortage of labours, inappropriate govt. policies and laws, unrealistic contract duration, differing site (ground) conditions, inflation, contractor' lack of experience and frequent design change.

Table 1: Cost Overrun Factors

S.N.	Cause of Cost Variation	Group
1	Slow decision making (SDM)	owner
2	Unrealistic contract duration (UCD)	
3	Interference by owner (IBO)	
4	Slow payment of completed work by owner (SPOCW)	
5	Mode of finance and payment (MOFP)	
6	Poor planning and scheduling (PPS)	contractor
7	Contractor' lack of experience (CLE)	
8	Financial difficulty faced by contractor (FDC)	
9	Obsolete and improper construction method (OICM)	
10	Rework due to error in construction (RDEC)	
11	Disputes on site (DOS)	

12	Incompetent sub-contractor (ISC)	
13	Poor site management (PSM)	
14	Waste on site (WOS)	
15	Contract management(CM)	
16	Delay in performing inspection (DPI)	consultant
17	Inaccurate time and cost estimate (ITCE)	
18	Quality assurance (QA)	
19	Inadequate experience of technical consultant (IETC)	
20	Frequent design change (FDC)	design
21	Improper design and delay in producing design document (IDDP)	
22	Delay in approval of design (DAD)	
23	Additional work (AW)	project
24	Lowest bid procurement policy (LBP)	
25	Change in the scope of the project (CSP)	
26	Shortage of construction material (SCM)	material
27	Late material delivery (LMD)	
28	Delay in procurement of materials (DPM)	
29	Changes in material specifications (CMS)	
30	Shortage of labours (SOL)	labour
31	Unqualified labour (UL)	
32	Low level productivity of labours (LLPL)	
33	Labour disputes and strikes (LDS)	
34	High cost of labour (HCL)	
35	Equipment availability and failure (EAF)	equipment
36	Shortage of equipment (SOE)	
37	High cost of machineries and its maintenance (HCM)	
38	Mistakes and discrepancies in contract document (MDCD)	contract
39	Contractual procedure and type of contract (CPTC)	
40	poor coordination between parties (PCBP)	Coordination/ Communication
41	Lack of communication between parties (LCBP)	
42	Slow information flow between parties (SIFP)	
43	Climatic condition (CC)	external
44	Inappropriate govt. policies and laws (IGPL)	
45	Social and cultural factors (SCF)	
46	Differing site (ground) conditions (DSC)	
47	Fluctuation in price material (FPM)	
48	Inflation (IF)	
49	Accidents during construction (ADC)	
50	Fraudulent practices and kickbacks (FPK)	
51	Acts of GOD (AOG)	
52	High interest rate charge by bank and loan (HIRBL)	
53	Insurance cost (IC)	

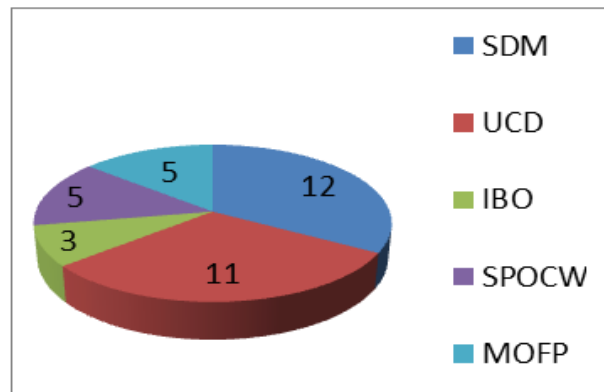


Figure 1: Frequency of Occurrence of Owner Related Factors

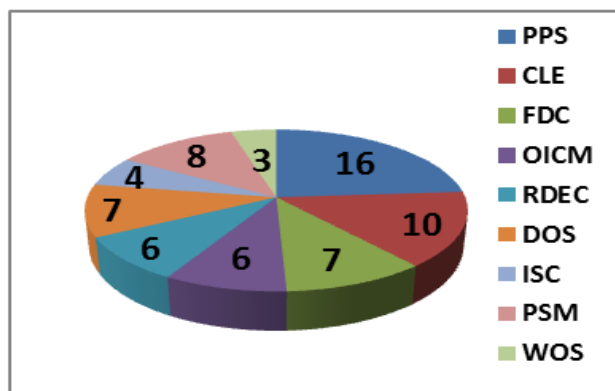


Figure 2: Frequency of Occurrence of Contractor Related Factor

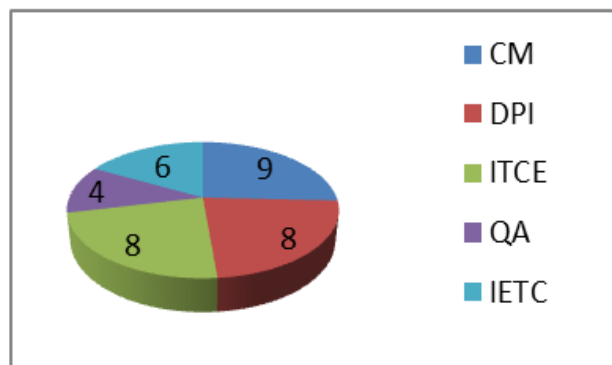


Figure 3: Frequency of Occurrence of Consultant Related Factors

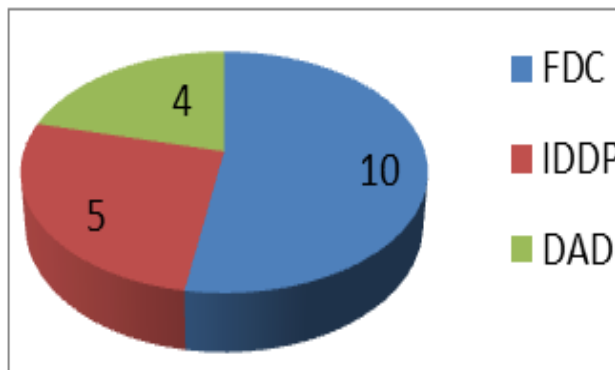


Figure 4: Frequency of Occurrence of Design Related Factors

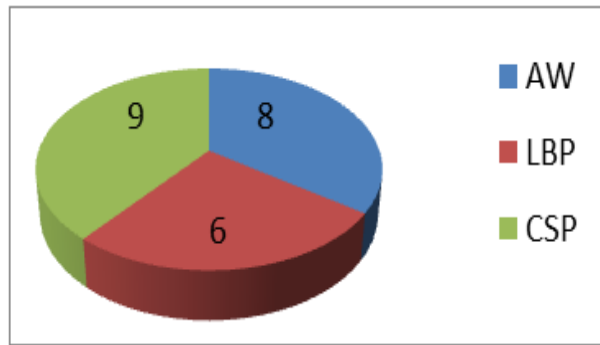


Figure 5: Frequency of Occurrence of Project Related Factors

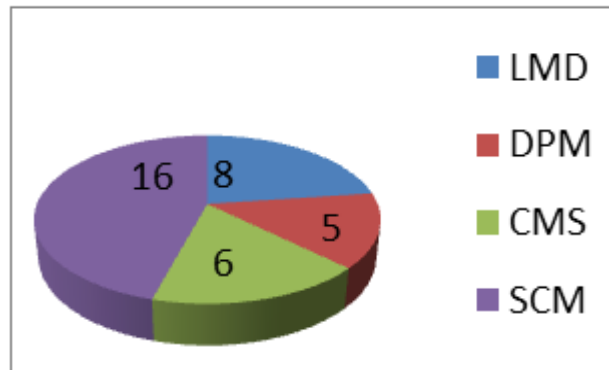


Figure 6: Frequency of Occurrence of Material Related Factors

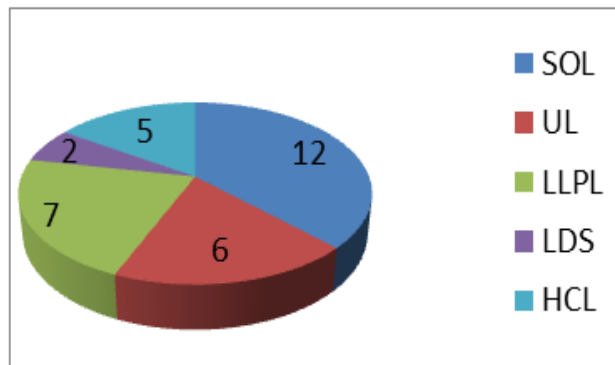


Figure 7: Frequency of Occurrence of Labour Related Factors

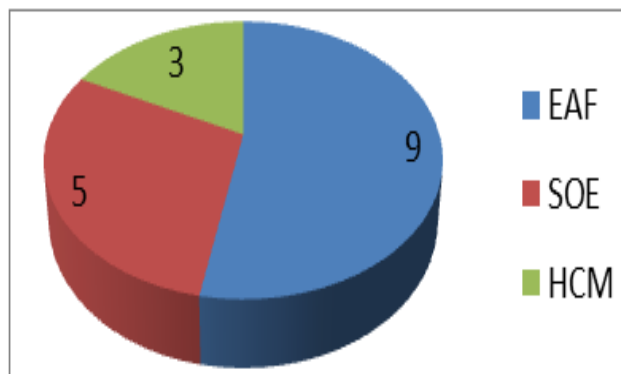


Figure 8: Frequency of Occurrence of Equipment Related Factors

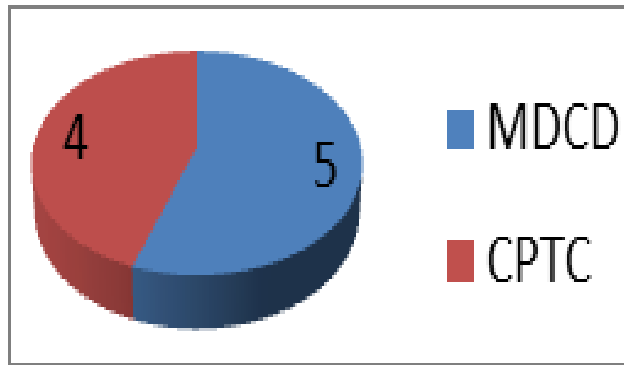


Figure 9: Frequency of Occurrence of Contract Related Factors

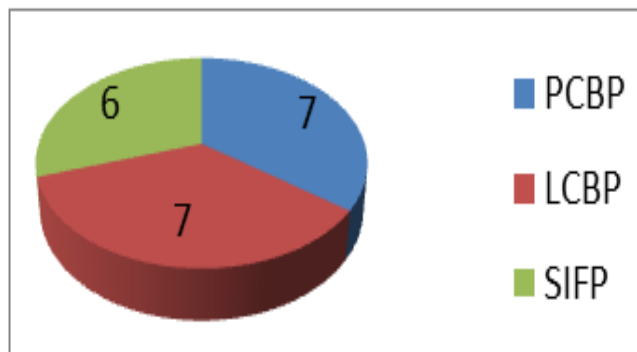


Figure 10: Frequency of Occurrence of Communication Related Factor

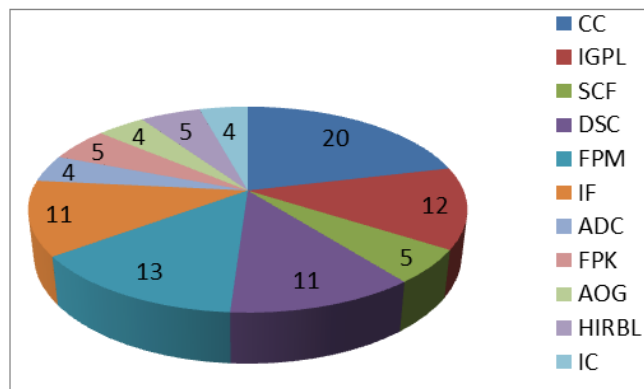


Figure 11: Frequency of Occurrence of External Factors

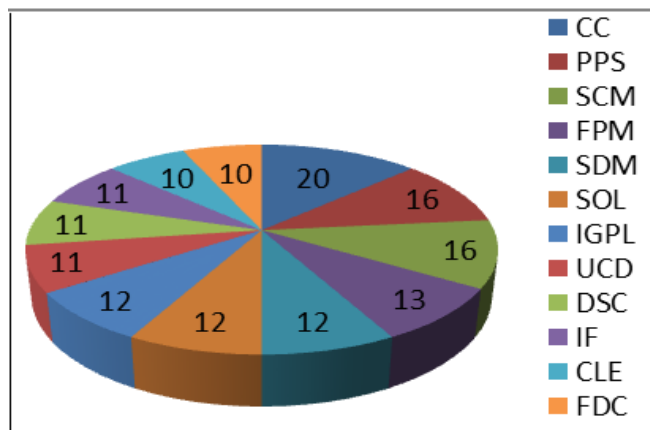


Figure 12: Major Cost Overrun Factors

Ranking of the Cost Overrun Factors

The review findings show that the authors have used different theories for ranking the risk factors. Most of the authors have used relative importance index (RII) to give the rank of risk factors. Relative importance weight was used by Frimpong et al. (2003). Assaf and Hejji (2006) used frequency index and severity index for giving the rank to the various risk factors of construction project. It has also been seen that none of the studies is comparable to any other study. Each study has different rankings for the cost overrun factors and their group. The problem of cost overrun can be country specific and project characteristics may be region specific also. The important five factors taken from the different studies in different parts of the world are presented in Table 2. This table shows that none of the studies is comparable to any other and each study has different rankings for the groups of the cost overrun factors. Depending upon the country and the region, the risk factors for cost overrun and project characteristics may change.

Table 2: Ranking of the Cost Overrun Factors

Studies	Main Cost Overrun Factors from Different Countries				
	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Okpala and Aniekwu, (1988) Nigeria	Fluctuation in price Material	Time delays	Fraudulent practices	Additional work	Shortening of contract period
Elinwa and Buba (1994) Nigeria	Shortage of material	fluctuations in price Material	Financing and payment of completed goods	Time delays	Additional work
Kaming, et al. (1997) Indonesia	Inaccurate material take-off	Fluctuation in price Material	Increase in Labour cost	Lack of experience of location	Lack of experience of project type
Frimpong, et al. (2003) Ghana	Monthly payment difficulties	contract management	Material procurement	Inflation	Contractor’s financial difficulties
(Koushki, 2005) Kuwait	Change orders	Financial constraints	Owner’s lack of experience	Materials	Weather
(Long et al, 2008)Vietnam	Poor site management and supervision	<i>Poor project management assistance</i>	Financial difficulties of owner	Financial difficulties of contractor	Design changes
(Azhar et al, 2008) Pakistan	Fluctuation in price material	Unstable cost of manufactured material	High cost of machineries	Lowest bidding procurement method	Poor project(site) management/poor cost control
(Olawale, 2010) U.K.	Design Changes	Risk and uncertainty associated with projects	Inaccurate evaluation of project’s time/OR duration	Non-performance of subcontractors and nominated suppliers	Complexity of works
(Memon, A.H, 2011) Malaysia	Poor design and delay in design	Unrealistic contract duration and requirements imposed	Lack of experience	Late delivery of material and equipment	Relationship between management
(Rahman, 2013) Malaysia	Fluctuation in price materials	Cash flow and financial difficulties faced by contractors	Shortages of materials	Shortage of site workers	Financial difficulties of owner
(Aziz, 2013) Egypt	Lowest bidding procurement method	Additional work.	Bureaucracy in bidding/tendering method	Wrong method of cost estimation	Funding problem

Cost Assessment Models

It has been seen that models can be categorized into simple classical method and advanced models. These methods can be either qualitative or quantitative. Many researchers used sensitive analysis, fault tree analysis, event tree analysis for risk assessment, Monte –Carlo simulation for stochastic quantitative modelling analysis and fuzzy set theory for qualitative analysis. Several authors recommend Fuzzy set theory (FST) which is a branch of modern mathematics to model vagueness. Fuzzy set theory is suitable for modelling of uncertainties that involves human intuitive thinking as a vital solution for assessing risk for construction Industry.

Applicability of the Cost Overrun Studies for Indian Construction Industry

The case studies related to the cost overrun factors and risk assessment models show that none of the study is comparable to any other and each study has different rankings for the cost overrun factors and their group. The problem of cost overrun may vary from country to country or from region to region. Therefore, it is essential to take into account country specific and area specific uniqueness before arriving at or evaluating the rank and degree of risk factors for developing a model for cost overrun factors in Indian construction industry.

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

Worldwide the problem of Cost overrun in construction industry is very acute & severe. And there is a need to study more to improve this critical situation. This is a common issue found generally in every type of projects and locations. Indian construction industries are also facing the problem of cost overrun. And if the situation is not handled properly India could suffer a GDP loss of US\$ 200 billion around 10 per cent of its GDP in financial year 2017.

Therefore it is required to study the cost overrun factors and project cost risk assessment model for developing a model for Indian construction industry. the most frequently occurred factors from literature are found as change in climatic conditions, poor planning & scheduling by contractor, shortage of material, fluctuation in price material, slow decision making, shortage of labour, inappropriate govt. policies, differing site condition, unrealistic contract duration and contractors lack of experience. Comparison study from different part of the world illustrates that none of the studies is comparable to any other and each study has different rankings for of the cost overrun factors and groups.

The problem of cost overrun can be country specific. And project characteristics may be region specific also. Therefore it is imperative to take into account country specific and area specific uniqueness before arriving at or evaluating the rank and degree of risk factors for developing a model for cost overrun factors in Indian construction industry. Previously globally studied risk factor criterion should be revaluated and re-examine viz- a-viz the current technological know –how and modernity of equipment's and their consequent application in the project.

Many authors recommend Fuzzy set theory (FST) which is a branch of modern mathematics that was formulated by Zadeh to model vagueness intrinsic to human cognitive processes. it has been used to tackle poorly-defined and complex problems due to incomplete and imprecise information that characterize the real-world systems. It is, therefore, suitable for modelling of uncertainty in construction that is based on human intuitive thinking. Due to paucity of data, it is very difficult to develop quantitative model for Indian conditions. It is propose to model to assessing risk using fuzzy set theory.

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