
ABSTRACT

The importance of the construction industry is not limited to the different measures of economic development alone, slumps or upsurges in its activities, have a high multiplier effects on almost every phase in the social and economic structure of the nation. It has been concluded that the high cost of house ownership in India and other housing problems of the lower income groups are results of the defect in the construction industry. "There is no gainsaying that the twin problem of cost and time overruns may not yet be over as they still characterize construction projects in most parts of the world especially in developing countries like India". Cost and time overruns are common occurrences in the construction industry and these have continued unabated.

KEYWORDS: Rework in construction.

INTRODUCTION

The construction industry is almost as old as nature itself and unlike many manufacturing industries, is concerned mostly with one-off project. The construction is a sector that is sensitive to change in both fiscal and monetary disturbance. The construction industry is very important in the economic development of any nation especially in an expanding economy like India. An efficient construction sector is a pre-requisite to effective national development since building, civil and industrial engineering works are usually a major contribution to Gross Fixed Capital Formation, Gross Domestic Product and National Employment. The growth of construction industry in India in the past two decades indicates its success in greatly contributing to the country's Gross National Product. This industry sector is the second most important for absorbing human resources after the food.

The importance of the construction industry is not limited to the different measures of economic development alone, slumps or upsurges in its activities, have a high multiplier effects on almost every phase in the social and economic structure of the nation. It has been concluded that the high cost of house ownership in India and other housing problems of the lower income groups are results of the defect in the construction industry. "There is no gainsaying that the twin problem of cost and time overruns may not yet be over as they still characterize construction projects in most parts of the world especially in developing countries like India". Cost and time overruns are common occurrences in the construction industry and these have continued unabated. This is no exception as in the case of rework, as rework contributes to time and cost overruns. Earlier studies have shown that rework costs vary between 3 and 15 per cent of project's contract value. In addition, Rethinking construction stated that: up to 30% of construction is rework, labour is used at only 40-60% of potential efficiency and at least 10% of materials are wasted. It was posited that rework costs could be significantly higher than figures reported in the previous literature. Indeed, Barber, Sheath, Tomkins and Graves suggested that rework costs could be as high as 23 per cent of the contract value. Typically, previous research efforts have focused on determining the performance of construction industry with reference to time and cost overrun, of which rework is one of its causes and little or no attention has been directed towards this area whose effect is capable of increasing the contract sum and duration significantly. Love who sought to address this in Australia, found that indirect costs of rework could be as much as five times the cost of rectification.

Since rework has been seen as an ill wind that may blow no good to the construction industry because of its contributions to cost increases and time-delays couple with the facts that it cannot be totally avoided. Therefore, the

evaluation of rework and identification of significant factors leading to the occurrence of rework with a view to determining its impact on building projects to enhance project delivery processes is essential.

Based on all this foregoing, this paper therefore intends:

- To identify and evaluate the variables of the factors influencing the occurrence of reworks on building projects.
- To identify the variables with specific group and
- To assess the relationship of the identified factors to enable fully appreciation of the study.

OBJECTIVES OF THE PROJECT

- To identify the maximum possibilities of occurrence of rework in construction.
- To study the factors affecting rework in construction project.
- To analysis the rework factors in construction project.
- To identify the cost overrun due to rework.
- To reduce the construction rework cost.
- To minimize the over runoff time.

SCOPE OF THE PROJECT

- It increases productivity of a jobsite.
- Reduces cost of rework.
- To identify the root cause of the rework.
- To ranking the top five factors that affecting the rework.

REWORK

To improve quality it is necessary to understand the root causes of rework, that is, the basic reason for its existence or set of conditions that stimulate its occurrence in a process. A process consists of a number of activities or operations which acting on inputs in a given sequence transforms them into outputs. A process may consist of both value adding or non-value adding activities. The former are activities that convert materials and/or information towards that which is required by the customer and the latter are activities that take time, resources or require storage and do not add value to the output. In other words, a non-value adding activity is waste and origin of waste is as contained in figure ii below. There has never been any systematic attempt to observe all wastes in the construction process. That the figures that have been presented tend to be conservative in as much as the motivation to estimate and share these figures has been by leading companies that have been attempting to implement best practice. Rework, however, has become an accepted part of the construction process. Those involved in the procurement of buildings invariably do not realize the extent of rework that actually occurs. There is an increasing need to improve the quality of operations throughout the procurement process, and therefore reduce the incidence of rework. It has been suggested that the major cause of rework is uncertainty. This uncertainty is generated by poor information, which often is missing, unreliable, inaccurate, and conflicting. The authors suggest that uncertainty is a consequence of numerous interrelated factors and not solely information. Therefore, to reduce rework we must identify what its causes are, then understand how these causes are interrelated.

THE CAUSES OF REWORK AS A WASTE IN THE DESIGN AND CONSTRUCTION PROCESS

Construction waste was classified into three main categories as materials, labour and machinery waste. However, any effort in terms of labour, materials and machinery which is directed towards the construction of a part or element of a building and which has to be done again due to non-conformity to the design constitutes a waste which is also seen as rework. Andy, Andrew and Simon viewed causes of waste at the design and construction process as: building complexity, poor coordination, fast tracking, inadequate communication, inefficient management practices and design process, poor quality management, lack of harmonious relationship among participants on the project and poor site management team. Many authors have different opinions as to the causes of rework as a waste. Koskela suggested that it "sometimes seems that the wastes caused by design are larger than the cost of design itself," and he further stated that "even if there is a lack of data on internal waste in design, it can be inferred that a substantial share of design time is consumed by redoing or waiting for information and instructions." Rounce suggested that much of the design-related rework generated in projects is attributable to poor managerial practices of architectural firms.

REDUCING COSTS BY ELIMINATING WASTE

Rework costs are determined from the point where rework is identified to that time when rework is completed and the activity has returned to the condition or state it was in original. The duration of the cost tracking includes the length of the standby/relocation time once rework is identified, the time required to carry out the rework, and the time required to gear up to carry on with the original scope of the activity. Waste in construction is prolific. The lead article of this issue refers to the report 'Rethinking Construction' which states that:

- up to 30% of construction is rework
- labour is used at only 40-60% of potential efficiency
- at least 10% of materials are wasted

Task force on the scope for improving quality and efficiency in construction. Since Latham, the industry as a whole was underachieving even with the fundamental and radical change proposed by this report. With the economic meltdown the industry had experienced low profitability; low investments in research and development, low levels of training with too many clients were dissatisfied with the present performance of the industry.

In summary, the Egan report identified several shortcomings with the construction industry, and they include;

- Underachievement of the industry as a whole
- Lack of predictability within the industry as a whole
- Unacceptable level of defects
- Lack of contractor profit
- Lack of investment in capital, research, and development and training
- Level of dissatisfaction amongst the industry's clients

Reflecting experience with similar occurrence where the industry as a whole were underachieving which is evident in the down turning nature of the industry's contribution to the nation's Gross Domestic Product (GDP).

DEVIATIONS IN CONSTRUCTION

Deviations that are related to the construction phase of the project and consist of those activities and tasks that take place at the project site during the construction interface. A construction change could be seen as a change in the method of construction and construction changes are usually made to enhance the constructability of the project. Deviations in construction could be seen as a construction errors are the result of erroneous construction methods or procedures. Construction omissions are those deviations that occur due to the omission of some construction activity or task.

CONCEPT OF QUALITY COST

Quality could be referred to as conformance to established requirement, therefore, any deviation from this requirement that affects with a severity sufficient enough to consider options on the projects to either accept or taken corrective action could also be seen as non-conformance.

Quality cost of construction work or design comprises of all costs incurred by client/contractor because the project refuses to meet the users' requirement. Rounce captured quality cost in the design process "as the cost of writing procedures and obtaining quality assurance certification". In broad term, quality cost to a client is the total expenditure incurred in given client best value for money both in term of functionality of the design and aesthetic value of the project.

Quality cost = cost of conformance + cost of non-conformance

Rounce went further by positing that conformance cost is the minimum expenditure incurred or required to meet an established requirement of a client on a project. Non-conformance cost on the other hand contains all total sum incurred through redesigning and reworking construction work previously executed due to non-compliance is capable causing strain relationship among the participant due to loss of profit. It's important to note that error during design mostly lead to rework or fault during construction phase of projects blame is usually borne by the contractor because

of the gap between the design and construction. Josephson and Hammarland, asserted that averagely 32% of defect cost that either lead to rework or non-conformance emanated at the design stage where briefing are not well captured or interpreted by the designers, 45% of the cost originated on site while 20% is from defective materials or machine.

LITERATURE REVIEW

SinaMeshksar (2012) rework is one of the major factors that affect the success of a construction project. It causes to decrease the quality and productivity, and increases the cost and time of construction. Rework commonly happens due to insufficient supervision, poor workmanship, wrong or defective materials, etc. This research intends to determine the cost of waste and time delay due to reworks in the construction of reinforced concrete structure, to investigate the factors affecting the rework such as contractors, owners, and consultants. Also in this research the rework items, their frequencies, their correlation, and their impact on cost of waste and time delay were investigated. A case study project consisted of three 8-storeys buildings was observed and studied, and a questionnaire survey was undertaken among 22 construction projects to collect data. The case study and questionnaire survey findings revealed that, the reworks influenced the cost by 1.85% and 2.1% of construction cost respectively. Also the findings indicated that, the time delay of rework in case study and survey was 4.1% and 5.18% of construction duration respectively. It was obtained that, the major rework items affecting the cost were: 1- allocating inappropriate concrete materials, 2- changing the designed steel bar diameters due to unavailability, and 3- forming cold joint due to mismanagement of concrete delivering to the site. The major rework items that affecting the delay were: 1- collapsing excavation walls, 2- over excavation, and 3- falling formwork materials from top storeys that causes damage to them.

L.O. Oyewobi et al (2011) contribute to time and cost overruns in project. To enhance efficient project delivery processes the research work evaluated rework cost on elemental basis in some selected building projects in Niger State. The elemental cost of the selected 25 institutional building projects, total variation cost and total rework cost of each of the elements analyzed. The researcher personally source cost data on the selected projects from the participants on the projects using the developed research schedule and this was done by making use of the hard copy of all the valuations carried out on any selected project up to penultimate valuation including the final account summary of the selected projects. From the sought information on a total number of 25 selected institutional building projects and which was duly analyzed it was found out that virtually, all the elements of the projects overrun their initial cost with an average percentage cost-overrun of about 9.09%.

L.O.O YEWOB I and D.R. OGUNSEM (2010) identified some factors contributing to rework which was categorized under three main headings; technical, quality and human resources factors to actually dig down into the casual of rework. Construction waste was classified into three main categories by Ekanayake and Ofori as materials, labor and machinery waste. Rework costs are determined from the point where rework is identified to that time when rework is completed and the activity has returned to the condition or state it was in original. The ratings in this scale indicate only a rank order of importance of the factors, rather than how much more important each rating is than the other. In the case of human resources factors disturbance of personnel planning are most responsible for rework occurrence, carelessness was rank second while lack of skill and usage of inexperienced personnel have the same rank a piece.

Rework has become a menace in Nigerian construction industry and it has not been given required attention, it contributes to time and cost overruns in project. Hence, to improve the performance of projects the research work evaluated rework in some selected building projects in Niger State. The work identified some factors contributing to rework which was categorized under three main headings; technical, quality and human resources factors to actually dig down into the casual of rework. A structure questionnaire was self administered on projects identified to have experienced rework amongst the selected projects and these were ranked according to their perceived degree of severity. Response was further condensed using factor analysis to group the variables into identifiable factors and thus analyzed. The study revealed that sub-standard services rendered by professionals and lack of commitment to quality in term of project delivery by stakeholders are the main source of rework. Therefore, it was recommended that an improvement and total commitment to quality of services render and assurance would lead to a reduction in the occurrence of reworks as revealed by the research.

Bon-Gang Hwang et al (2009) rework continues to affect both cost and schedule performance throughout the construction industry. The direct costs alone often tally to 5% of the total construction costs. Using the data obtained from 359 construction projects in the Construction Industry Institute database, this paper assesses the impacts of

rework on construction cost performance for projects in various categories. In addition, it identifies the sources of this rework, permitting further analyses and the development of rework reduction initiatives. The results of this study establish that the impacts of rework differ according to project characteristics and that the sources of rework having the greatest impact are not significantly different among project categories. By recognizing the impacts of rework and its sources, the construction industry can reduce rework and ultimately improve project cost performance.

Kiavash Parvan et al (2006) construction projects are complex as they include many activities which influence and interact with each other at different stages. The impact of design phase undiscovered rework on construction phase quality has been hypothesized as influential in project dynamics by many. However few empirical studies have measured this impact. In this paper we develop a simple system dynamics model, estimate it using data from 18 construction projects, and validate the model on a validation set of 15 projects. The model provides good fit for the calibration set and strong predictive power on the validation set. It also allows us to estimate the impact of undiscovered design changes on construction phase quality, which appears to be notable.

ZahirIrani, and David J. Edwards (2004) to reduce the incidence of rework throughout the construction supply chain, data from 161 completed projects were gathered using a questionnaire survey. The Building Research Establishment (BRE) in the U.K. [9]found that errors in buildings had 50% of their origin in the design stage and 40% in the construction stage. A questionnaire was developed from the literature review to examine the influence of project management influences on rework costs in projects. Changes initiated by a client or occupier when a product or process had been completed and design scope freezing were factors identified as contributing to rework. Research has indicated that design scope freezing is an effective strategy for reducing change orders. Value management and the effective use of information technology during the design process were found to be factors that could significantly reduce rework costs.

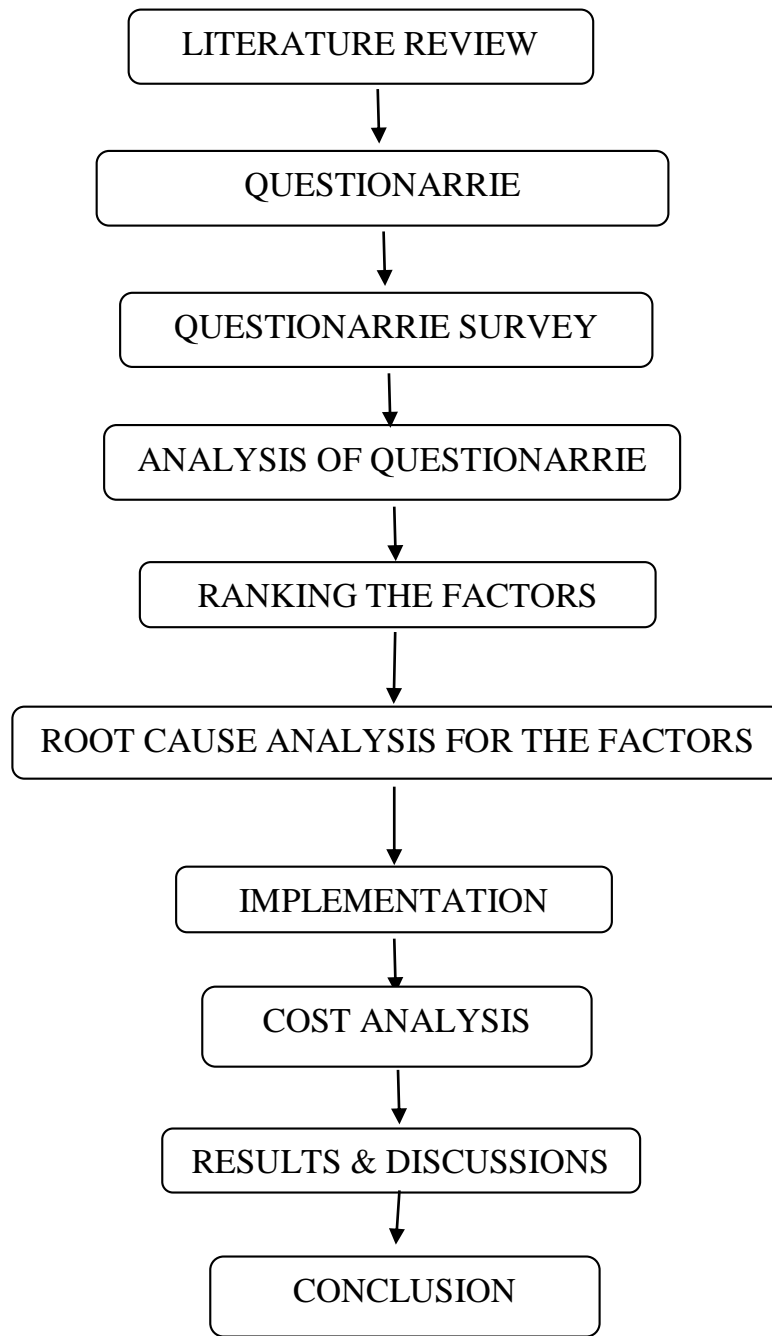
Peter E.D. Love et al (2004) endemic problem in building construction projects and is an area of research that has received limited attention. Recent research has shown that rework is the primary cause of time and schedule overruns in projects and that rework levels do not significantly differ between current procurement methods despite calls from government for the use of more integrated procurement approaches such as design-and-construct to improve project performance. To reduce the incidence of rework throughout the construction supply chain, data from 161 completed projects were gathered using a questionnaire survey. Stepwise multiple regression was used to determine the significant variables that contributed to rework in projects. In conjunction with previously reported research, these variables were used to develop an alternative procurement model for reducing rework in projects. It is suggested that the proposed model could be used to stimulate interorganizational relations and promote teambuilding during the formative stages of a project, which is essential for reducing design-related rework.

Aminah Robinson Fayek et al (2003) the Syncrude Aurora 2 Project in Fort McMurray, Alberta was selected for use as a case study. The Aurora 2 project is a mega-project, performed under an engineering, procurement, and construction (EPC) arrangement. It consists of a mining expansion to process 58 million t/a of ore to provide 38 million bbl/yr of feedstock for a related upgrader expansion project (UE-1). The project is a cost reimbursable project, which is part of an Alliance contract consisting of AMEC E&C Services Limited (design/engineering), TIC Canada (structural/mechanical), Chemco Electrical Contractors Limited (electrical), North American Enterprises Limited (civil) and Syncrude Canada Limited (owner). All parties involved are working together under an agreement of full disclosure of information. The selection of the Aurora 2 Project in particular was primarily based on the suitability of the project type, which is reflective of major industrial projects in Alberta, and on the availability and willingness of the Aurora project group to participate and provide in-kind funding for the pilot study.

Alwi, Sugiharto et al (2001) The quality of site supervision has a major influence on the overall performance and efficiency of construction projects. Inadequate supervision is believed to be one of the major causes of rework. Therefore, experienced and well-trained supervisors have an important role in minimising the amount of rework due to construction defects. This paper argues that the quality of site supervision Indonesia is directly related to the supervisor's level of experience gained through formal training. Hence, the paper attempts to explore the relationship between the quality of site supervision, expressed as training cost, and the rework cost borne by contractors in high-rise building construction. Based on site data collection targeting ten building construction sites in Indonesia, this

paper suggests that inadequate site supervision is the principal cause of rework during construction. It also offers insights into the statistical relationship between the cost of supervisors' training and the cost of rework. This research was carried out in the developing economy of Indonesia.

WORKING METHODOLOGY



CONCLUSION

Total 14 factors affecting construction rework identified through literature study & experts opinion. A questionnaire survey is conducted on building construction projects for find out factors influencing rework in construction projects. The study received 7 respondents the collected data was analyzed through Microsoft excel. According to their rank indexes the top 5 factors has been ranked accordingly for 7 completed surveys. The top 5 factors are quality are Client influence, Lack of labor work knowledge, Speedy construction, Lack of communication and Construction error. Rework analysis was done in three different sites. Quantity and cost of rework has been arrived from quantity survey and cost analysis. Implementation of ideas to avoid top five factors that influence rework had been done to improve the quality of construction and also to reduce the cost and time taken for rework.

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