

Rework Management in Construction Projects and Comparison with Time and Cost

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ABSTRACT: Rework, are activities in the field, which have been completed, but were required to be repeated or undertaken again as a result of some impeding correction that was necessary to be carried out during the project. This is regardless of source, or effecting a change, not due to change of scope by the owner. Fundamentally, rework becomes necessary either when an element of building works fails to meet customer requirements, or when the completed work does not conform to the contract documents. In either scenario, the product is altered so as to ensure conformity. At a certain moment during construction, for example due to an error, rework is necessary. But the rework might not be discovered until some form of quality control check is done, after which it can be concluded as to what kind of rework needs to be done. Rework can also have internal or external origins. Changes in clients' expectations are an example of an external factor that might lead to rework. Rework can cause many costs to be higher than calculated at the start of the project. Rework can result from various sources such as errors, omissions and changes.

KEYWORDS: Rework.

I. INTRODUCTION

Over the centuries, construction work across the globe has been a means for countries increasing their national economies. The construction industry has faced with the significant problems of high cost of project delivery, bad financial performance and inability to deliver value to customers on time to time. As a result, the industry has been criticized extensively for poor performance and inefficient output. A major factor contributing to this failure is rework. Rework is defined as the unnecessary effort of redoing an activity that was inaccurately done the first time or the process by which an item is made to conform to the original requirement by completion or correction. Rework and wastages have become recognized as non-value adding endemic symptoms that seriously affect the performance and productivity aspects of construction projects and the problem of rework has been largely ignored by the construction industry.

The adverse consequences of rework include reduced profit, loss of market share, worker injuries, damaged reputation, increased turnover of management and workforce, lower productivity, higher costs, and finally, costly litigation between participants over responsibility for overruns and delays. In the long term, rework can also affect a construction company's reputation and its ability to attract new business. However, little is known about the background and consequently, rework remains an innate problem. The lack of attention to the root causes of rework seems to be a global phenomenon. With this in mind, the aim of this research is to determine the underlying causes of rework during construction as well as the impact of rework on overall project performance so that effective prevention strategies can be developed. Most construction projects have.

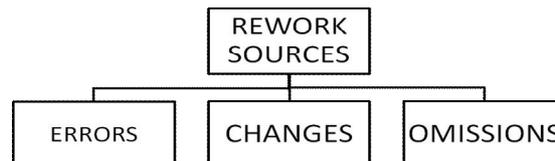
REWORK SOURCES:

Basically, rework can be obtained from various sources like errors, changes and omissions.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016



ERRORS:

The Researchers has indicated that rework is worsen by errors made during the designprocess, errors which then appear downstream in the procurement process. The Researcherhas argued that the longer an error goes undetected, the greater the possibility of rework occurring that significantly impacts cost and schedule. The Construction Industry Institute (CII)(1989) study of nine large industrial construction projects found that rework due to design error contributed an average of 79% of total rework cost. In relation to Busby and Hughes (2004) and Cooper (1993), errors are often not readily identifiable and often only become manifest after a period of incubation in the system. The extent of rework required, then, depends on how long the error has remained unnoticed. For instance, a dimensional error or spatial conflict contained within design credentials may not arise until the project is being physically constructed on-site. According to the researchers, errors occur as a result of a complex range of interactions, and hence attempting to segregate a singular causative variable is an unseemly strategy to undertake. Once an understanding of the typical nature and underlying dynamics of errors is acquired, only then can error reduction and error restraint strategies be implemented in projects.

CHANGES:

Many of them stated that a change is in essence a directed action that alters current established requirements. Changes can have an effect on the aesthetics and well-designed aspects of the building, the scope as well as the nature of work, or its working aspects. According to CII, rework, exclusively in the form of changes can have a negative impact on productivity and project performance. Moreover, stated that a design-change client, for example, would indicate that a client would initiate a change to the design of the building and therefore require rework due to redesign. Design-related rework in the form of change orders is the major source of rework in construction projects.

OMISSIONS:

According to Reason (2002), omission errors arise when the mental process of action control is subjected to strain or distraction. Reason (2000) opined that omission errors are a result of pathogens within a system that translate into error-provoking conditions within the firm and project. Examples include time pressure, understaffing, fatigue and inexperience. He further lamented that pathogenic influences contribute to unworkable relationships and procedures as well as design and construction deficiencies which consequently contribute to rework.

Failure to undertake procedural tasks during the design process and continual design reuse (Busby, 1999) are leitmotifs that emerge as practices contributing to omission errors. The work practices are implemented by organisations can aggravate similar errors, regardless of the skills and experiences of the people involved in a project.

PRELIMINARY REVIEW OF LITERATURE

REWORK FACTORS:

According to Love and Edwards (2004a), the root causes of rework can be categorised into three different groups: 1) client-related, 2) design-related and 3) contractor-related factors, including site management and subcontractor factors. A basic overview of such rework factors is as follows:

CLIENT RELATED FACTORS:

Palaneeswaran (2006) identified some client-related factors: a lack of experience and knowledge of design and of the construction process; a lack of funding allocated for site investigation; a lack of client involvement in the project; inadequate briefing; poor communication with design consultants; and inadequacies in contract documentation. Defi-

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

iciencies in communication flow between the client and design team members can result in documentation errors and omissions occurring (Dalry and Crawshaw, 1973). Walker (1994) stressed that clients and their project team members must communicate and work together harmoniously if projects are to be delivered on or ahead of time.

DESIGN RELATED FACTORS:

Lack of design coordination and integration on the part of the design team leads to design deficiencies and exacerbates the causes of rework. This opinion is supported by Josephson and Hammarlund (1999) who pointed out that the source of design-related rework in construction is primarily communication problems. Similarly, Austin, Baldwin and Newton (1994) pointed out that the ineffective use of information technology in managing and communicating information aggravates the amount of rework that occurs in a project.

One cited study, conducted by Love and Li (2000), quantified the causes and cost of rework on construction of residential homes and industrial warehouses. The study found that poor coordination and integration between design team members hindered the flow of information among them. Engineers used CAD technologies and the architects used manual systems to document their designs, and as a result, some drawings were issued with dimensional errors and missing information (Love and Li, 2000). Love, Davis, Ellis and Cheung (2010) argued that lack of professionalism by design professionals.

CONTRACT RELATED FACTORS:

The inability of many supervisors to plan work, communicate with workers and direct activities adequately is fundamentally linked to increasing amounts and costs of rework (Business Roundtable, 1982). Site management team and subcontractors' project success is dependent upon the effectiveness of the main contractor's construction planning efforts (Chan, 1998; Faniran, Love and Li, 1999; Ireland, 1985; Walker, 1994). Cusack (1992) stressed that projects without a quality system in place typically experience a 10% cost increase because of rework. Other factors contributing to rework included:

- Setting-out errors: errors resulting from the misreading of dimensions on the working drawings and building out of alignment (Josephson and Hammarlund, 1999).
- Disturbances in personnel planning: errors resulting from increased defects and poor workmanship which may arise as a result of excessive workload, multitasking and unwarranted pressures for early completion. Also, a disturbance in personnel planning occurs when staff is reallocated (Love, Mandal and Li, 1999a).
- Failure to provide protection to works: errors resulting from, for example, erection of scaffold on floor finishes such as tiling without protection. Also, failure to provide protection during painting work whereby paint splashes on floor finishes and sanitary fittings. Failure to protect certain parts of a building during alteration works (Barber et al., 2000).

In the case of subcontractors, Josephson et al. (2002), Love and Smith (2003), and Love et al. (1999a) found specific factors that contributed to rework: inadequate supervision, damage to other trade work due to carelessness, low skill level of construction artisans and labour, and poor choice of materials.

II. STUDY OF LITERATURE

In this chapter, the literature review includes the definition of rework, the determination of rework in construction industry, methods of measuring rework, classification of the causes of rework, rework impact on construction projects performance, and measures for reducing the occurrence of rework in construction projects.

Based upon the preliminary exploratory study conducted which provided the basis for the main study, an operational definition of rework was required to clearly indicate what is and what is not considered rework from the researcher's perspective as well as from an industry-wide perspective. For the purposes of the research, the operational definition for rework is as follows: "the unnecessary effort of redoing a process or activity that was incorrectly implemented the first time". Rework will include the following: design errors and changes that affect construction activities, constructability errors, additional or missing scope due to designer or constructor errors and on-site fabrication errors that affect construction activities.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

.CHARACTERISTICS OF CONSTRUCTION INDUSTRIES IN INDIA

The construction industry is almost as old as nature itself and unlike many manufacturing industries, is concerned mostly with one-off project. It is one of the major industries in the economic growth and civilization. A huge amount of money, time and energy consuming in this part indicate the important role of this industry. The construction industry is very important in the economic development of any nation especially in an expanding economy. Construction sector has a significant impact on Palestinian economy and the tool through which a society achieves its goals of economic growth and development, its share of Gross Domestic Product (GDP) about 20% in normal time. The sector has played a crucial role in extending job opportunities for Palestinian labor force. Prior to the Israeli re-occupation of the territories on September 28, 2000 construction sector used to employ an average of 22.3% of labor force. However, the sector now employs 10.8% of the labor force only; this sector also employs about 30% of laborers indirectly in industries related to the construction sector and other services and productive sectors. On the other hand, the Central Bureau of Statistics (CBS) showed that the value added of the construction sector in the has declined from RS 130.1 thousand in 2005 to Rs 38.5 thousand in 2009, this is due to the general ban on the import of basic construction materials has been in place since the imposition of the blockade in 2007. During the period of 2010 – 2011 the contribution of construction sector in the GDP has increased gradually from 7.4% in Q1-2010 to 11.3% in Q3-2011 (MAS 2012). The rise contribution of the construction sector in GDP was mainly due to the significant growth in the construction sector during 2010 - 2011. This growth was spurred by the Israeli's relative ease of the siege in terms of partially allowing construction material.

PREVIOUS STUDIES ON REWORK

The State of the South African Construction Industry's report compiled in June 2011 revealed that the gross fixed capital formation in non-residential buildings in South Africa in 2010 amounted to R41 928m which constitutes 2.3% of gross domestic product (GDP). Based upon prior research undertaken and among general contractors in South Africa which determined that rework constituted on average, 13% of the value of completed construction, the cost of rework in non-residential buildings could have been 5 m. Rework in construction projects is attributable to lack of skills, quality management issues, lack of communication and coordination during design and construction, and emphasis on time and cost. In their status report, the Construction Industry Development Board (CIDB, 2004) revealed that design professions do not have enough knowledge of construction processes, and consequently, are not able to stay abreast of the changes in construction technologies. Furthermore, consultants do not provide sufficient design and construction process details, resulting in unnecessary design rework by contractors and construction delays. The CIDB (2004) also raised the issue of discounting of fees as a commonplace practice in the industry, in the order of 15 to 25%, with extremes of up to 50%. This discounting of fees places pressure on the quality of the work produced by consultants, who tailor their service to suit the price. Various studies conducted by Smallwood and among architectural practices and general contractors consistently identified construction and procurement-related barriers as the dominant barriers to the achievement of quality, often together with design-related factors as additional barriers.

- Design-related factors identified by the authors include inadequate details, inadequate specifications and poor design coordination.
- Procurement-related factors include emphasis on time and budget, shortened project periods, lack of prequalification, competitive tendering and awarding of contracts primarily on price.

III QUESTIONNAIRE AND RESPONSE

INTRODUCTION

This chapter presents the analysis of the data gathered in the survey using the questionnaire. It was an exploratory study aimed at gaining more insight into the causes and impact of rework during construction.

PILOT QUESTIONNAIRE AND ITS RESPONSE

The questionnaire comprises of two sections. First section is designed to gather the personal information of the respondent which includes gender, educational qualification, occupation, years of experience and the type of project that the

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(An ISO 3297: 2007 Certified Organization)

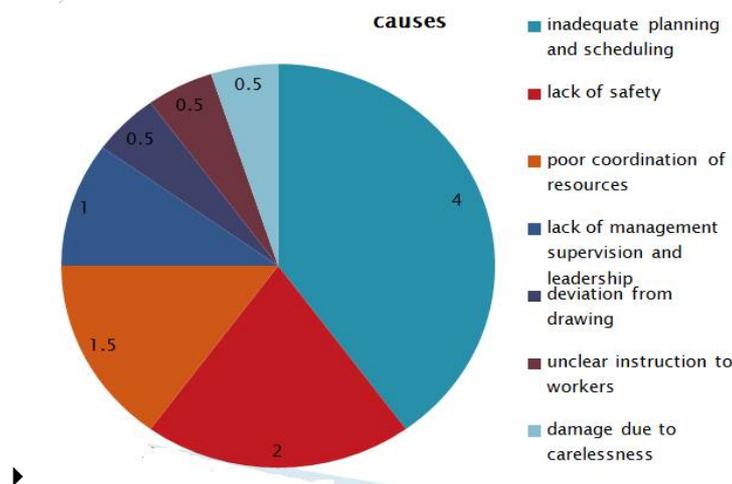
Vol. 5, Issue 10, October 2016

company takes. The second section involves the objective questions. From the literature scan, the four major causes of rework were selected and used to design the questionnaire. In order to achieve the crucial factors, the respondents were asked to rank each factors using Likert scale of maximum four. The Likert scale was provided for each set of questions. The questionnaire survey was conducted among the various construction companies and got 20 respondents. Respondents included contractors, owners, consultants, design engineers, quality engineers and project managers.

PROFILE OF RESPONDENTS

As per the the analysis up to date the main causes of rework in the construction site are due to:

- ▶ In adequate planning and scheduling
- ▶ Lack of safety
- ▶ Poor coordination of resources
- ▶ Lack of management supervision and leadership
- ▶ Deviation from the drawing
- ▶ Unclear instruction to workers



IV. CAUSES OF REWORK

CAUSES OF REWORK

The root causes of rework can be categorized into three different groups: 1) client-related, 2) design-related and 3) contractor-related factors 4) site management and 5) subcontractor factors.

4.1.1 Client-related Factors

This section explores the knowledge of respondents about the causes of rework. The causes of rework were identified using a scale where 1= least important, 2= slightly important, 3= important and 4= most important. Respondents were asked to indicate the extent to which the following client-related factors might be the cause of rework. Regarding other factors not mentioned, one of the respondents suggested monitor time and cost implications as one of the client-related factors that caused rework while the other one agreed that using different architects for various areas of work led to rework. Clients and their project team members must communicate and work together harmoniously if projects are to be delivered on or ahead of time.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

CLIENT RELATED FACTORS	NO	AVERAGE RANK
Lack of experience and knowledge of the design process	5	1
Lack of experience and knowledge of the construction process	5	1
Lack of funding allocated for site investigation	5	1.8
Lack of client involvement in project	5	1.6
Insufficient time and money spent on the briefing process	5	1.6
Poor communication with design consultants(architect/engineers)	5	2.8
Payment of low fees for preparing contract documentation	5	2.2
Poor selection of Suppliers ,vendors and subcontractors by client	5	2.6
Poor communication with design consultant by the client	5	2.6
Inadequate managerial skills	5	3

Design Related Factor

The causes of rework attributed to design-related factors were identified. The results in Table 4.1.2 indicate the perception of respondents relative to design-related factors that led to rework. However, the other factors recorded a mean score less than 3 implying that respondents disagreed that those factors didn't contribute much to rework during the design stage.

IMPACT OF REWORK

The occurrence of rework clearly has an adverse impact on project performance. Palaneeswaran (2006) maintained that rework has both direct and indirect impact on project performance. For instance, in poorly managed projects, the gross impacts of rework (that is, both direct and indirect) could be equal to or even exceed the anticipated mark up or profit margin levels. Also, in some cases there will be some carry forward ripple effects on different aspects such as stress, motivation, relationships and relationships and reputation.

V. CONCLUSION

CONCLUSION OF STUDY

The aim of this thesis was to determine the underlying causes of rework during construction, and its impact on the overall project performance in order to develop effective prevention strategies. The study suggests that rework is a problem faced in most of the construction industry and better understanding of the causes will assist the project manag-

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

ers to identify the methods to improve or eliminate rework. A literature review was performed in order to analyze the major factors that leads to rework in construction .After having analyzed the data, a questionnaire was designed and sent to construction professionals, both with engineering firms and contractors firms. The questionnaire mainly concentrated on identifying the main causes of rework and how it had impact on the construction projects as well as the organisation. The outcome reveals the top rework causes occurring in the construction industries, the impacts and its effects on the organisation.

Causes of rework in construction projects

During the initial comparative case study, it was evident that changes made at the request of the client and design team contributed to rework. Love, Edwards and Smith (2005) established that variations during the design process are often captured too late because of the sequential communication structure of supply chains, and the lack of coordination and integration between design team members. This was apparent in the case study, where the lack of coordination among design consultants led to major design-related changes which affected all the design firms involved. This subsequently resulted in changes on site, which affected most of the subcontractors. Furthermore, setting out errors, due to poor communication and coordination between the main contractor and subcontractors and the lack of skills on the part of the artisans, were identified. In addition, inexperience on the part of the leading hand and trades foremen and their inability to interpret the structural drawing contributed to rework during construction. Similarly, the analysis of the research instrument found that the most predominant source of rework included non-compliance with specification, setting out errors, changes made at the request of the client, poor communication with design consultants and low labour skill levels. Nevertheless, the causes of rework were found not to vary significantly with various project types.

Impact of rework

The analysis of the comparative study revealed that reworks caused inter-organisational conflict that led to decrease in supervision and resulted in the de-motivation of workers. The study also revealed that the incidence of rework increased project cost. This was due to additional materials for rework, subsequent wastage handling, costs for covering rework occurrences and additional labour to rectify activities. Besides, additional time to rework and related extensions of supervising manpower were also identified, ultimately leading to customer dissatisfaction and reduced profit for contractors.

The analysis of the response of the questionnaire revealed that respondents tended neither to agree, nor disagree, that the cost overrun, time overrun and design team dissatisfaction as a result of rework impacted on project performance. Similarly, respondents expressed sentiments of disagreement and neutrality that reduced profit, de-motivation of workers and inter-organisational conflict all impacted on organisational performance.

VI. SUGGESTION AND RECOMMENDATION

SUGGESTIONS

It was found during the questionnaire survey that the majority of the respondents do not have systems to track and record incidences of rework and its cost impact, as it is difficult to accurately calculate. This was also apparent in the case studies, where the respondents revealed they had experienced lots of rework on site. However, there were no mechanisms in place for recording incidences of rework and capturing their costs. To eliminate rework it is important that the events are identified early and they are evaluated. From the study it is seen that the reduction of rework in construction projects must be a continuous process. Now improvements have to be introduced to avoid these failures from happening again in future projects.

Some suggestions based on the data analysis for the reduction of rework in the construction project are as follows:

- Rework can be reduced by developing adequate awareness about the root causes and what constitutes rework and implementing systematic approach to measure rework
- A fulltime supervisor is to be placed in site who is very well trained to avoid mistakes made by the unskilled labourers

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 10, October 2016

- The employment of unskilled labour should be limited and if employed they should be given proper training so that the errors are minimised. Inspections must be conducted on a daily or weekly basis by the senior managers or senior staffs so as to avoid the errors in the early stage.
- Proper inspection of the materials being supplied should be made compulsory so that defective materials can be identified. Improvement and total commitment to quality management would render and assure reduction in rework. Site documentation should be carried out as early as possible and at every stage to check work done and highlight rework. Formal training must be given to supervisors to improve supervisor's skills like planning work, communication, leadership, motivation.

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