

Analysis of Rework in Residential Building Projects in Palestine

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ABSTRACT

This study has been conducted to study rework in residential building projects in the West Bank in Palestine. It investigates the cost and causes of rework. A questionnaire survey of 86 contractors from the West Bank in Palestine was performed. 43 rework causes were identified during the research. The study investigates the average of rework cost and the severity of the identified rework causes. 62% of the contractors indicated that the average of rework cost in residential building construction projects that they have experienced during the last five years ranged between 10% and 15% of the original contract cost, which means that rework in residential projects is a severe problem, which should be studied more intensively to be solved in the future. The questionnaire survey also concluded that the most severe causes of rework in residential building projects as identified by the contractors are: poor communication of the client with the consultant, poor communication of the client with the contractor, use of poor quality materials, poor site management and poor communication of the client with the design consultant.

KEYWORDS: Rework, Causes, Building projects, Contractors, Severity, Residential, Cost.

INTRODUCTION

Construction is one of the largest industries and contributes to about 10% of the Gross National Product (GNP) in industrialized countries (Navon, 2005). However, it is considered one of the most risky and complex industries, because it is influenced by highly changing and unexpected variables. Rework was found by many previous studies (Kaming et al., 1997; Wasfy, 2010; Chan et al., 1997; Love, 2002a; Alwi et al., 2001; Enshassi et al., 2007) to be a main contributor to cost overrun, delay and poor productivity in construction projects.

Construction industry in Palestine plays a main role in providing homes, public facilities and infrastructure, as well as in improving the Palestinian national economy as a whole. It contributes to 26% of the

Palestinian GDP. For example, the gross domestic capital formation in the Palestinian territories rose from US\$10.8 million to US\$520.3 million between 1968 and 1987, and this was primarily attributable to the contribution of construction industry, which ranged from 43% to 82% during the same period (UN, 1994). The construction industry also plays a main role in the absorption of Palestinian labor force as opposed to manufacturing and agriculture industries. To demonstrate this fact, the volume of Palestinian workforce working in construction industry, in the Palestinian territories as well as in Israel, increased from 23,900 workers in 1970 to 97,000 workers in 1993 (Enshassi et al., 2006). However, many local construction projects report poor performance in construction projects in Palestine. According to a study conducted in the West Bank by Mahamid (2011), one of the most critical factors affecting time and cost overrun in Palestinian construction industry is rework.

Mahamid (2012) found that rework is the top affecting factor leading to poor labor productivity in building construction projects in Palestine. Therefore, this study is of significant importance, as it aims at investigating rework cost and causes in residential building projects in the West Bank in Palestine. To do so, 86 contractors working in building construction in the West Bank completed a structured questionnaire survey.

Objectives

The main objectives of this study include the following:

- To identify the causes of rework in residential building projects in the West Bank.
- To identify the importance of rework causes from contractors' perspective.
- To identify the average of rework cost in residential building projects.

LITERATURE REVIEW

Rework Definition

Love (2002 b) pointed out that rework has various terms and interpretations within the construction management literature. These include: "quality deviations" (Burati et al., 1992), "non-conformance" (Abdul-Rahman, 1995), "defects" (Josephson et al., 1999) and "quality failures" (Barber et al., 2000). Rework can be defined as "the process by which an item is made to conform to the original requirement by completion or correction" (Ashford, 1992); or "doing something at least one extra time due to non-conformance to requirements" (Construction Industry Development Agency, 1995). Rework has also been defined as the "unnecessary effort of redoing a process or activity that was incorrectly implemented the first time" (Love et al., 2000). Rogge et al. (2001) defined rework specifically for field operations as "activities in the field that have to be done more than once in the field or activities which remove work previously installed as part of the project". Oyewobi et al. (2011) defined rework as "a waste that involves

doing a certain task more than once". It may not be totally eliminated, but it is avoidable. Also, rework means that work must be redone, because it was not done the first time following the requirements (Hwang et al., 2009).

Rework Cost

Rework means additional cost to the total project cost. Several studies have explored the cost of rework in construction industry. Informal surveys of design teams have revealed estimates as high as 50% of design time spent on needless rework (Ballard, 1999). Josephson et al. (2002) reported that the costs of rework in residential, industrial and commercial building projects range from 2% to 6% of their contract values. Oyewobi et al. (2011) found that the cost of rework for new buildings was averagely 5.06% of their contract values. Love et al. (2000 b) in their study of rework costs for a residential and an industrial building found the costs of rework to be 3.15% and 2.40% of the contract value, respectively. In addition, Love et al. (2000 a) found that when a contractor implemented a quality assurance system in conjunction with an effective continuous improvement strategy, rework costs were found to be less than 1% of the contract value. Barber et al. (2000) suggested that rework costs could be as high as 23% of the contract value. In a sample of private building projects in Hong Kong, the direct cost of rework was reported to be 16.1% of the original contract value, and the corresponding value for indirect costs was 4.8% (Palaneeswaran et al., 2005). Fayek et al. (2003) conducted a study in Canada, in which 108 field rework costs were summarized as follows: engineering and reviews (61% to 65%), human resource capability (20% to 49%), materials and equipment supply (14.81%), contract planning and scheduling (2.61%), leadership and communication (0.45%). Rhodes et al. (2002) conducted a research in South Africa and found rework cost to be 13% of the value of the completed project. Wasfy (2010) found that rework increases the cost of the different work categories in construction projects between 2% and

30% and leads to delays in the different work categories resulting in an increase in their original durations in the range from 10% to 77%.

Love (2002) conducted a study with the aim of determining the influence of different project types and procurement methods on rework costs in construction projects. The study was based on a questionnaire survey of 161 Australian construction projects. He found that, in contrary to expectations, rework costs do not differ according to project type or procurement method. In addition, he found that rework contributed to 52% of a project's cost growth and that 26% of the variance in cost growth was attributable to changes due to direct rework. He suggested that to reduce rework costs and thereby improve project performance, root causes should be identified and effective prevention strategies should be implemented.

Rework Causes

Oyewobi et al. (2011) pointed out that rework occurs as a result of so many factors; ranging from omission or error in design, construction failure and change orders to inadequate coordination and communication among stakeholders of the project. They suggested that in order to improve project performance and to reduce rework costs, a workable mechanism should be improved to bring together the client and the contractor to minimize change orders and introduction of additional works during the construction phase. Love et al. (1999 a,b) and Fayek et al. (2003) argued that rework occurs as a result of uncertainty, poor leadership and communication and ineffective decision-making.

Palaneeswaran et al. (2005) stated that rework in construction projects can result from an array of factors, such as: errors, omissions, failures, changes, poor communication and poor coordination. Hwang et al. (2009) conducted a study using the data obtained from 359 construction projects in order to identify the root causes of rework in construction projects. They found that owner change and design error/omission

appeared to be the root causes of rework having a relatively greater cost impact than other sources. They also concluded that constructor error/omission is one of the most affecting sources of rework.

Love and Smith (2003) contended that lack of communication between clients and design consultants is a big contributor to rework. Toole (2005) proposed that excessive overtime will cause fatigue to workers and consequently reduce productivity and result in poor quality of work which will lead to rework. Alwi et al. (1999) suggested that good supervisor and labor skills are among the fundamental prerequisites for implementing any construction project and that they are inversely related to rework costs. Nepal et al. (2006) suggested that schedule pressures can lead to working out of sequence, resulting in work defects, cutting corners and reduction of motivation to work which all may lead to rework. Wasfy (2010) studied the main causes affecting rework in construction projects in Saudi Arabia. He found that the main causes that lead to rework include: incompetent supervision, insufficient supervision, poor workmanship, improper subcontractor selection, improper work protection and improper work sequencing.

Rework Effects

From many reported cases, it could be affirmed that rework has a negative impact on the performance of projects in terms of cost overrun, time overrun and dissatisfaction of the participants in the project (Oyewobi et al., 2011). Palaneeswaran et al. (2005) argued that the direct impact of rework on the project is identified to consist of: additional time to carry out the rework, additional cost to rectify the occurrence, more materials for rework and wastage, as well as consequential increase in labor cost to fix the defect plus related extension of manpower supervision. Rework is a significant contributor to time overrun which will affect the cost, resources and quality (Love et al., 2004). Rework leads to clients' and contractors' dissatisfaction (Wasfy, 2010).

RESEARCH METHOD

Potentially relevant studies were retrieved from literature collections of published, peer-reviewed research articles and reports. Throughout this literature, causes and effects of rework in construction projects were defined. 43 rework causes are considered in this study. Similar rework causes are grouped under one main group; the causes were divided into 4 groups: client-related causes, contractor-related causes, consultant-related causes and environmental causes. A questionnaire survey is decided to be used for data collection.

A pilot study was conducted to verify the questionnaire and ensure that the information returned from the contractors would be appropriate to the objective of this study. This is done by sending the draft questionnaire with a covering letter to three experts in building construction to evaluate the content validity of the questionnaire and add more causes if needed. After receiving the answers from the selected experts, the questionnaire was slightly modified based on their feedback.

The target population consists of all contractors for building works who have valid registration by the Palestinian Contractors Union (PCU) in the West Bank. A sample of 100 contractors was randomly selected to fill out the questionnaire.

Questionnaire Design

The questionnaire is divided into two main parts. Part I is related to general information. Contractors were requested to answer questions pertaining to their experience in residential building projects and their opinions about the average of rework cost in residential building projects they have experienced. Part II includes the list of the identified rework causes. The degree of severity of rework causes is identified by the contractors using an ordinal five-point scale as follows: very high, high, moderate, low and very low (on a 5- to 1- point scale).

Data Analysis

The severity index (S.I.) is calculated for each cause and effect according to the following formula:

$$\text{Severity Index (\%)} = \sum a (n/N) * 100/5 \quad (1)$$

where, a is the constant expressing weight given to each response (ranges from 1 for very low up to 5 for very high).

n is the frequency of the responses.

N is the total number of responses.

The group index was calculated by using the average of the causes under each group such that:

$$\text{Group Severity Index (\%)} = \sum_{i=1}^n X_i / n \quad (2)$$

where, X_i is the severity index of cause i in the group.

n is the number of causes in the group.

RESULTS AND DISCUSSION

Participants

The questionnaire was sent out to a total of 100 contractors asking for their perception in ranking the identified rework causes and effects in terms of severity using an ordinal scale. A total of 86 contractors filled the questionnaire. The response rate by contractors was 86%. The participating contractors have an average of more than 10 years of experience in residential building projects.

Rework Cost in Palestinian Residential Building Projects

The analysis of the contractors' responses regarding rework cost in residential construction projects during the last 5 years shows the following results:

- 29% of the participating contractors indicated that the average rework cost in the projects they have experienced is less than 10% of the original project cost.
- 62% of the participating contractors indicated that

the average rework cost in the projects they have experienced is between 10% and 15% of the original project cost.

- 7% of the participating contractors indicated that the average rework cost in the projects they have experienced is between 15% and 20% of the original project cost.
- 2% of the surveyed contractors indicated a rework

cost of more than 20% of the original specified cost.

The aforementioned results about rework cost in residential construction projects in the West Bank in Palestine indicated that rework in residential projects is a severe problem which should be studied more intensively to be solved in the future.

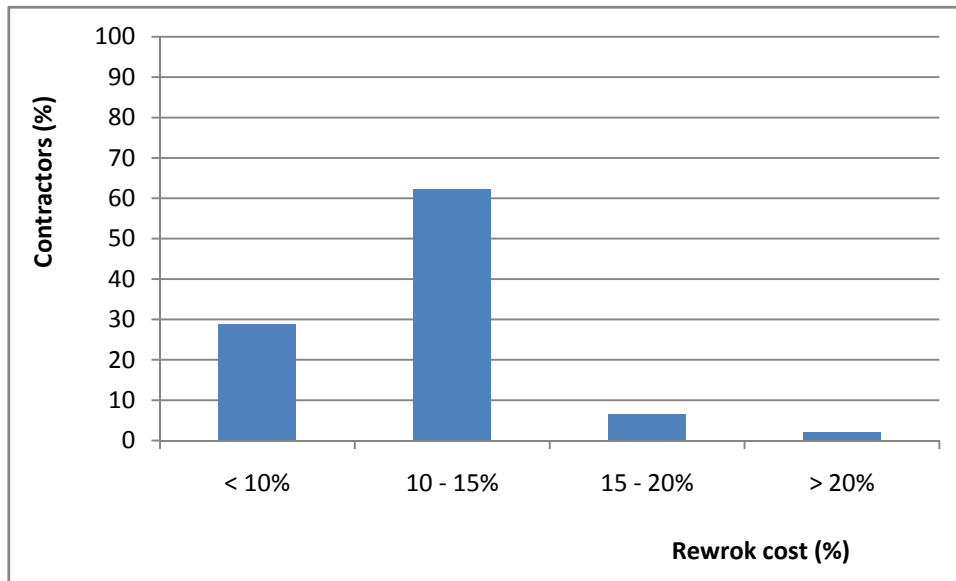


Figure (1): The average of rework cost in residential projects during the last five years according to contractors

Ranking of Rework Causes

The causes in each group are ranked by the measurement of severity index according to Equation (1).

Client-Related Causes

Table 1 shows the severity index and ranking of each cause in the client group from contractors' view. 8 causes were considered in this group. The table shows that the top three causes are: poor communication with

the contractor (S.I. = 84.13%), poor communication with the design consultant (S.I. = 81.25%) and lack of client involvement in the project (S.I. = 76.78%). These causes could lead to late changes in materials and specifications during the construction phase of the project that may lead to rework.

It is clear from the results that the severity index from contractors' view for causes in this group has a wide span; it ranges from 55.26% to 84.13% (severity level ranges from moderate to very high).

Table 1. Ranking of rework causes in the client group

Cause	S.I. (%)	Rank
Poor communication with the contractor	84.13	1
Poor communication with the design consultant	81.25	2
Lack of client involvement in the project	76.78	3
Lack of funding allocated for site investigation	72.43	4
Scope changes	68.45	5
Inadequacies in contract documentation	62.00	6
Lack of experience and knowledge in design	56.10	7
Lack of experience in construction process	55.26	8

Consultant-Related Causes

Table 2 shows the severity index and ranking of each cause in the consultant group from contractors' view. 13 causes were considered in this group. The table shows that the top three causes are: late design changes (S.I. = 79.43%), errors and omissions (S.I. = 78.98%) and lack of designers' experience (S.I. =

77.85%).

The results show that the severity index from contractors' view for causes in this group has a wide span; it ranges from 34.26% to 79.43%, which means that the impact of causes in this group on rework in residential building construction projects ranges from low to very high.

Table 2. Ranking of rework causes in the consultant group

Cause	S.I. (%)	Rank
Late design changes	79.43	1
Errors and omissions	78.98	1
Lack of designers' experience	77.85	3
Incomplete design at the time of tender	73.56	4
Inadequate staff to complete the required tasks	68.56	5
Insufficient time to prepare contract documentation	64.41	6
Poor planning of workload	59.55	7
Low fees for design works	54.66	8
Poor coordination between design team members	54.11	9
Fixed time for a task	54.00	10
Staff turnover	44.10	11
Specifications are difficult to handle	35.17	12
Complexity of the designs	34.26	13

Contractor-Related Causes

18 causes are listed under the contractor group. Table 3 shows that the top affecting causes are: poor communication with the consultant (S.I.= 85.8%), use

of poor quality material (S.I.= 84.12%) and poor site management (S.I.= 82.56%). The bottom three causes are: failure to provide protection for the constructed work (S.I.= 41.17%), damages (S.I.= 44.18%) and

errors due to inappropriate construction method (S.I.= 47.13%).

Table 3 shows that the severity index for causes

related to contractors has a wide span; it ranges from 41.17% to 85.8%, meaning that the impact of these causes ranges from moderate to very high.

Table 3. Ranking of rework causes in the contractor group

Cause	S.I. (%)	Rank
Poor communication with the consultant	85.80	1
Use of poor quality material	84.12	2
Poor site management	82.56	3
Improper subcontractor selection	77.65	4
Use of inefficient equipment	73.07	5
Ineffective use of quality control system	72.09	6
Inadequate job planning	70.50	7
Lack of labor skills	68.21	8
Lack of supervisory skills	66.76	9
Inadequate supervision	65.00	10
Reduction of motivation to work	62.65	11
Non-conformance with specification requirements	61.90	12
Defects	54.92	13
Random human errors	54.12	14
Labor re-allocation to other projects	52.45	15
Errors due to inappropriate construction method	47.13	16
Damages	44.18	17
Failure to provide protection to the constructed work	41.17	18

Environmental Causes

4 causes are listed under the environmental group as shown in Table 4. The results show that the top affecting cause in this group is the weather (S.I. = 57.56%). The results show that no one of the causes in

this group has a high or very high impact on rework in residential projects. The impact span of the causes in this group ranges from low to moderate with a severity index ranging from 24.41% to 57.56%.

Table 4. Ranking of rework causes in the environmental group

Cause	S.I. (%)	Rank
Weather	57.56	1
Lack of safety	51.30	2
Poor site conditions	48.34	3
Natural disasters	24.41	4

Overall Cause Ranking

The severity index and ranking of all investigated 43 rework causes in residential building construction

projects in the West Bank in Palestine from contractors' view are listed in Table 5.

Table 5. Overall cause ranking

Cause	S.I. (%)	Rank
Poor communication with the consultant	85.80	1
Poor communication with the contractor	84.13	2
Use of poor quality material	84.12	3
Poor site management	82.56	4
Poor communication with the design consultant	81.25	5
Late design changes	79.43	6
Errors and omissions	78.98	7
Lack of designers' experience	77.85	8
Improper subcontractor selection	77.65	9
Lack of client involvement in the project	76.78	10
Incomplete design at the time of tender	73.56	11
Use of inefficient equipment	73.07	12
Lack of funding allocated for site investigation	72.43	13
Ineffective use of quality control system	72.09	14
Inadequate job planning	70.50	15
Inadequate staff to complete the required tasks	68.56	16
Scope changes	68.45	17
Lack of labor skills	68.21	18
Lack of supervisory skills	66.76	19
Inadequate supervision	65.00	20
Insufficient time to prepare contract documentation	64.41	21
Reduction of motivation to work	62.65	22
Inadequacies in contract documentation	62.00	23
Non-conformance with specification requirements	61.90	24
Poor planning of workload	59.55	25
Weather	57.56	26
Lack of experience and knowledge in design	56.10	27
Lack of experience in construction process	55.26	28
Defects	54.92	29
Low fees for design works	54.66	30
Random human errors	54.12	31
Poor coordination between design team members	54.11	32
Fixed time for a task	54.00	33
Labor re-allocation to other projects	52.45	34
Lack of safety	51.30	35
Poor site conditions	48.34	36

Errors due to inappropriate construction method	47.13	37
Damages	44.18	38
Staff turnover	44.10	39
Failure to provide protection to the constructed work	41.17	40
Specifications are difficult to handle	35.17	41
Complexity of the designs	34.26	42
Natural disasters	24.41	43

Group Ranking

Table 6 shows the ranking of the main groups of rework causes in construction projects from the contractors' view. It shows that rework in construction

projects is mostly affected by client-related factors (S.I. = 69.55%), followed by contractor-related factors, consultant-related factors and environmental factors.

Table 6. Groups ranking

Group	S.I. (%)	Rank
Client-related factors	69.55	1
Contractor-related factors	64.68	2
Consultant-related factors	59.90	3
Environmental factors	45.40	4

Top Five Causes

Table 7 illustrates the ranking of the top five rework causes in residential building construction projects in the West Bank in Palestine and their related groups from contractors' view. It can be seen that three causes are related to the client group, whereas two are related to the contractor group. The results show that the top five causes have severity index values higher than 80%, meaning that they have a very high impact on rework in residential projects. These causes are discussed in more detail in the following paragraphs:

- 1) Poor communication of the client with the consultant, 2) Poor communication of the client with the contractor and 5) Poor communication of the client with the design consultant: these causes may occur due to the owner's farness from the project matters, owner or his representative not attending the project meetings regularly or due to bureaucracy in decision making and project management, leading to late changes in design,

changes in specifications, changes in materials and changes in scope of the projects that all lead to rework. Poor communication between client and other construction parties also may lead to conflicts between parties as well as to misunderstanding of the contract document requirements, thereby negatively affecting the work flow. Thus, this result illustrates the importance of caring about raising awareness among the contract parties in order to ensure team work climate and achieve a working climate which meets the desires of all parties participating in the projects. This result is supported by many previous studies (Oyewobi et al., 2010; Love et al., 1999a, b; Fayek et al., 2003; Palaneeswaran et al., 2005; Love and Smith, 2003; Masterbroek, 2010).

- 2) Use of poor quality material: one of the most common problems in construction contracting in Palestine is the policy adoption of awarding the bid to the lowest price and not to the most accurate

offer. Therefore, the contractor awarded the tender may use poor quality materials (cheap materials) during construction to make profit. To overcome this problem, offer examination commissions should be instructed to comply with bid referring to the best offer conforming with the tender invitation conditions and having the most appropriate price, taking into account the required quality degree, the possibility of execution within the specified period and the contractor ability to perform the required work according to the conditions and specifications. This result was not concluded by any of the

previous studies.

- 3) Poor site management: site management includes resource management, coordination with construction parties, procurement management, labor management and construction activities' management. So, poor site management leads to misunderstanding between supervisors and labor, as well as to less communication and coordination between construction parties to perform the job as planned, which may lead to conflicts between them that may lead to rework. This result is not in line with any of the other studies.

Table 7. Top five rework causes and related groups from contractors' view

Cause	S.I.	Rank	Related Group
Poor communication with the consultant	85.80	1	Client Group
Poor communication with the contractor	84.13	2	Client Group
Use of poor quality material	84.12	3	Contractor Group
Poor site management	82.56	4	Contractor Group
Poor communication with the design consultant	81.25	5	Client Group

CONCLUSIONS

Rework is one of the crucial problems that affect performance in construction projects. This study is conducted to study rework in residential building projects in the West Bank in Palestine. It investigates rework cost and causes. A questionnaire survey of 86 contractors from the West Bank in Palestine was performed. 43 rework causes were identified during the research. The identified causes were classified under 4 groups: contractor-related causes, client-related causes, consultant-related causes and environmental causes. 62% of the surveyed contractors indicated that the average of rework cost in residential building construction projects that they have experienced during the last five years is between 10% and 15% of the original contract cost. The results also show that rework in construction projects is mostly affected by clients, followed by contractors, consultants and the environment. The questionnaire survey concluded that

the most severe causes of rework in residential building projects as identified by the contractors are: poor communication of the client with the consultant, poor communication of the client with the contractor, use of poor quality materials, poor site management and poor communication of the client with the design consultant.

In order to improve project performance and to reduce rework costs and effects, the following points are suggested:

- 1) A workable mechanism should be developed to bring together the client, the design consultant, the consultant and the contractor to minimize change orders and the introduction of additional work during the construction phase.
- 2) Offer examination commissions should be instructed to comply with bid referring to the best offer conforming with the tender invitation conditions and having the most appropriate price, taking into account the required quality degree, the possibility of execution within the specified period

and the contractor ability to perform the required work according to the conditions and specifications.

- 3) Project consultants should develop quality control and quality assurance plans to review and revise

contractor submittals such as material submittals.

- 4) Site managerial skills of contractors and sub-contractors should be improved by conducting management courses and workshops.

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