CAUSES OF REWORK ON BUILDING CONSTRUCTION PROJECTS IN NIGERIA

A.O. AIYETAN

Abstract

Construction projects all over the world involve many challenges, particularly for large public projects. The emerging complex nature of construction activities has brought with it characteristic features, such as, cost increases, delay in the delivery of project, to which rework (carrying out an activity more than one time) has a high contributing factor, stemming from imperfection. This study identified the sources of rework on construction projects in Nigeria from three perspectives: the client, contractor, and consultant. The study was concentrated on the South West part of Nigeria. The quantitative research method was adopted. Random sampling technique was employed in the selection of sample size. A total of one hundred and twenty (120) questionnaires were analysed using inferential statistics.

The following are the findings of this study: the contributions of the client leading to rework are in the form of poor communication, inadequate construction planning and poor management practices. From the consultant, they are: lack of understanding and correct interpretation of customer requirements, constraints in carrying out activities and inexperience of personnel and on the part of the contractor they are: wrongly laying of forming course, poor quality concrete, and poor plastering. Based on the conclusions reached, the following recommendations were drawn. They are: the development of a standard information gathering format relative to clients 'by designers and clients' writing down their intentions before visiting designers; formal technical training should be given to foremen on permanent appointments with organisations, attention should be given for adequate supervision, and construction methods should be analysed before selection and their use.

1. INTRODUCTION

The construction industry is mainly project based which consists of tasks that are complex and dynamic in nature while productivity is accompanied with variability e.g. dealing with diverse interests of multiple stakeholders and resultant changes/variations (Alwi, 2002; Josephson, 2002). Mohamed (2009) declares that construction projects all over the world involve many challenges, particularly for large public projects. These challenges affect the delivery of projects which have specified deadlines and fixed budget in some instances. Rework occurs when a product or service does not meet the requirements of the customer in the form of quality or function. Consequently, the product is altered in accordance with customer's requirements and specification of the engineers.

Rework and wastages are considered as non-value adding endemic symptoms that seriously affects the performance and productivity aspect in construction projects. Several definitions of rework have been given, for example, Ashford (1992) defines rework as "the process by which an item is made to conform to the original requirement by completion or correction." The Australian Construction Industry Development Agency (CIDA), however, defined rework as "doing something at least one extra time due to non-conformance to requirements" (CIDA 2001). Similarly, Rogge (2001) defined rework as activities in the field that have to be done more than once or activities that remove work previously installed as part of the project. Also, rework can be said to be the unnecessary effort of redoing a process or activity that was incorrectly implemented the first time (Love et al., 2000).Repair can also be included as rework, which is "the process of restoring a nonconforming characteristic to an acceptable condition even though the item may not still conform to the original requirement" (Ashford 1992).

Rework, according to Love et al. (2000) has been a primary cause of cost and schedule overruns in construction. A small percentage of rework means huge loss in investments and/or revenues. Even a minor reduction in the cost associated with rework can translate into substantial benefit for individual projects and for the industry as a whole.

Rework can be classified to be positive and negative. Positive rework adds value; these occur when designs are reworked and participants in the design process leave with a better understanding of customer requirements. Negative rework does not add value; for example, duct work which is initially installed and then has to be removed because interior walls were moved to accommodate a design change. Negative rework extends projects schedules and the total cost increases (Ballard 2001).

Rework occurrences adversely impact the project performance relative to cost, time, and stakeholder satisfaction Ballard (2001). The direct impacts of reworks on project management transactions include additional time, cost of covering reworks occurrences, materials for reworks, labour for rework, subsequent wastage handling, and related extension of supervision manpower. Therefore rework has become an endemic feature of the procurement process in construction that invariably leads to time and cost overruns in projects.

Reduction of rework and wastages is crucial for achieving good performance in project systems (e.g. Love et al., 2000; Fayek et al., 2004; Palaneeswaran et al., 2005a).Based on the foregoing, a study of causes of reworks was initiated, to identify them an suggest solution to mitigate them.

2. LITERATURE REVIEW

2.1 Origin of rework

Rework occurs when implemented design is lacking in required standard of quality, resulting on some of the implemented design being scrapped and reworked, and so the origin of the term. Rework generally originates from the identification of defect. It can also result from changes in requirements (Love & Edwards, 2004).

Causes of rework differ from one country to another and from one project type to another therefore, the costs of rework between countries should not be relied upon, but simply suggestive, as levels and interpretations of quality will differ between countries. Local practices, industry culture, and contractual agreements may also have a significant influence on the incidence and cost of rework (Love, Mandal & Li, 1999).

Rework is a significant factor that contributes negatively to the construction process and directly leads to client dissatisfaction, reduces profitability and in extreme circumstance, litigation and other negative consequences.

2.2. Causes of rework

The nature of rework is that it is caused by problems in quality management processes (Mochal, 2005). Several research efforts have attempted to identify and classify the causes of rework, and to quantify its overall extent. Bon-Gang, (2009) suggested that rework is often due to the complicated characteristics of the construction processes and that it can also arise from a number of sources such as changes, non-conformances (e.g. quality deviations), and defects. Fayek et al. (2004) identifies five major causes of rework, they are: human resource capability, leadership and communications, engineering and reviews, construction planning and scheduling, and materials and equipment supply.

However, Love and Edwards (2004) classify the root causes of rework into design-related factors, client-related factors, and contractor related factors. This study investigated the cause of reworks based on these three factors.

2.2.1. Design-related factors

A large number of findings have emphasized the fact that most rework originates at the design stage than in the construction stage. Palaneeswaran (2006) identified seven ways the design-related factor results in rework;

(i) Ineffective use of quality management practices,
(ii) Ineffective use of information technologies,
(iii) Lack of manpower to complete the required tasks

(iv) Insufficient time to prepare the contract documentation,
(v) Incomplete design at the time of tender,
(vi) Poor conditions between different design team members.

According to Trigunarsyah (2004), problems attributable to design include:

- Detailing – inaccurate or inadequate detail;
- Specification – incorrectly specified or inappropriate materials and components;
- Legislation – inadequate knowledge of or disregard for legislation or guidelines;
- Co-ordination – inadequate coordination between client / designer, designers, and designers / contractors;
- Communication – poor interaction between client / designer, and designers /contractors;
- Supervision – inadequate supervision by designers, and
- Constructability – lack of design empathy for construction.

2.2.2. Contractor-related factor

The contractor related factor can be considered under site management related factor and subcontractor related factor.

2.2.3. Site Management related Factor

Palaneeswaran et al. (2005b) identify some site management – related factors as deemed to cause rework. They are:

(i) Poor planning and coordination of resources;
(ii) Ineffective use of information technologies;
(iii) Setting-out errors;
(iv) Ineffective use of quality management practices;
(v) Staff turnover or reallocation to other projects, and
(vi) Failure to provide protection to constructed works.

It was established that poor planning and coordination of resources and ineffective use of quality management practices are the most primary causes of rework related to site management. Furthermore, the extensive reliance on traditional approaches (e.g. conventional paper-based correspondences and documentation, face-to-face discussions etc.) and non-availability of specific IT-based rework tracking mechanisms were also identified as contributing factors.

2.2.4. Subcontractor-related Factor

Josephson et al. (2002) found that inadequate managerial and supervisory skills and the carelessness by subcontractors were the primary factors that contribute to rework. Multi-layered subcontracting and low skill level of labourers in subcontracted works are also widely recognized as a contributor to rework. The use of poor quality materials by subcontractors is identified as a cause of rework. Other subcontractor related factors that might cause rework includes damages, defects, poor workmanship, constructability associated concerns, poor site conditions and other environmental parameters such as failure to provide protection to construction works, changes in construction method errors due to inappropriate construction methods, and the omissions of some activity or tasks.

2.2.5. Client-related factor

Mainly, the client factor based rework causes are from design and construction related sources such as the design changes made at the request of clients and the construction related changes initiated by the clients. These include:

(a) after some work have been undertaken on-site, and
(b) when a product / process had been completed.

The client-related rework factors include:

i. Lack of experience and knowledge of the design and construction process;
ii. Lack of funding allocated for site investigations;
iii. Lack of client involvement in the project;
iv. Inadequate briefing;
v. Poor communication with the design consultants, and
vi. Inadequacies in contract documentation.

2.3. Impact of rework on project performance

Rework has different impact on project performance depending on the time it occurs in a construction process. Since rework is the act of performing a task more than once, it can occur at different stages throughout the project life cycle. Fayek et al. (2004) declares that rework clearly has a huge impact on project performance whether or not projects can be completed within time and cost constraints. Rework also has a large general impact on the industry as a whole; the impact of rework can be direct or indirect. The following impact on project delivery resulting from rework can be identified, they are time overruns inflation, cost overrun, client dissatisfaction, contractor financial difficulties, contractor dissatisfaction, demotivation, design team dissatisfaction, poor contract management, and litigation.

These are the likely consequences of rework: end user dissatisfaction, inter-organisational conflict, stress, fatigue, work inactivity, demotivation, and damages to professional image.

3. METHODOLOGY

A total of 145 questionnaires were administered, of which 120 were returned which represents 80% response rate. This is considered adequate for statistical analysis relative to Kothari (2004), that the result of survey would be considered as being biased and of little value if the return rate is lower than 40%. Quantitative approach was employed in the analysis of data. The simple random sampling technique was used in the selection of samples for the study. Samples were drawn from the: Nigerian Institute of Quantity Surveyors, Federation of Contractor Institution, Nigerian Institute of Architects, and Nigerian Institute of Engineers (Structures). The aspect of the questionnaire relating to background information of respondents was analysed using percentile, and the result is presented on Table 1.

Table 1: Summary of Background Information of Respondents

Category	Classification	Number	%
Location	Lagos	71	59
	Ondo	49	41
Nature of Organization	Contracting	69	58
	Consulting	17	14
	Federal Ministry	6	5
	State Ministry	12	10
	Developer	16	13
Profession of the respondents	Architecture	32	27
	Engineering	12	10
	Quantity Surveying	15	13
	Building	61	51
Academic Qualification	OND/HND	14	12
	BSC/BTECH	84	70
	MSC/MTECH	16	13
	PHD	6	5
Professional Qualification	Graduate Member	68	57
	Corporate Member	10	8
	Fellow	0	0
	Non-member	42	35
Experience of Respondent	5 − 10	32	27
	11 – 20	65	54
	21 − 30	13	11
	31 – 40	6	5
	Above 40	4	3

Therefore, based on the foregoing analysis it can be concluded that the information provided by the respondents can be relied upon for the purposes of analysis.

3.1. Data presentation and Analysis

Table 2 reveals design-related factors that cause rework in building projects. Lack of understanding and correct interpretation of client requirements was ranked first among the causes. This may be as a result of architect not adequately documenting the intentions of the client or misunderstanding of intentions of clients. The most common means of communicating the client's brief and the project objectives to the design team is verbal in nature, which may result in misinterpretation. Constraint in carrying out activities is second in ranking. The reasons that can be attributed to this are time frame set for the project completion, availability of equipments and financial resources, cost and technological requirement that are limited or obsolete. Inexperience of personnel is third in ranking. This may be due to non-availability of experienced personnel in the management of construction processes, which result in increase in poor quality product that leads to reworks with the consequential effects such as time and cost overruns. The fourth factor that causes rework is poor communication. This may be a result of the lack of understanding of what to do and how activities should be carried out. Poor technology application is fifth in ranking among causes of rework. The reason for this may be, that design team do not have the requisite technological expertise relative to modern technology, which is employed in the execution of works. Incomplete documentation at the time of award of contract ranked least among the causes of rework. It could be due to the fact that construction work can be carried out alongside with the preparation of design documents. Error during design was ranked next to this factor in increasing order of impact of rework on project.

Table 2: Design-Related Factors relative to the causes of rework

S/N	DESIGN-RELATED FACTORS	NOT SEVERE	LESS SEVERE	SEVERE	MORE SEVERE	MOST SEVERE	Mean Score	Rank
1	Lack of understanding and correct interpretation of customer requirements	4	5	17	36	58	4.16	1
2	Constraint in carrying out activities	7	10	20	33	50	3.91	2
3	Inexperience of personnel	2	15	24	32	47	3.89	3
4	Poor communication	10	6	39	34	31	3.88	4
5	Poor technology application	8	17	24	33	38	3.63	6
6	Working under high time pressure	2	11	30	45	32	3.78	5
7	Poor quality contract documentation						3.51	7
8	Lack of information technology use	24	13	14	24	45	3.44	8
9	Design changes	6	34	21	19	40	3.44	8
10	Non-compliance to standards/ specification	11	23	36	12	38	3.36	10

11	Complex details	26	6	29	34	25	3.22	11
12	Omission during design	10	12	58	23	17	3.21	12
13	Poor information use	21	24	20	29	26	3.13	13
14	Error during design	35	7	13	40	25	3.11	14
15	Incomplete documentation at the time of award	30	10	27	30	23	3.05	15

Source: Field survey

Table 3 presents Client-Related factors that cause rework in building projects. Poor communication is first in ranking among the factors. The likely reason for this may be lack of understanding of communications regarding the next task to be carried out, either written or in sketch form. The second ranked factor that causes reworks is inadequate construction planning. This may be as a result of lack of adequate knowledge of activity sequencing which may lead to execution of activities wrongly and eventually leads to demolition and reworks. Poor management practice is third in ranking. This may be related to poor materials selection, lack of selecting skilled personnel to carry out work, not identify activities, and skilful allocation of resources required for the success of the project. Change in plan and scope by client is ranked fourth. Taste is a factor that keeps changing. As a result, the client may be interested in a new design that accommodates his new taste, which will lead to redesign and reconstruction (reworks). Incomplete information is fifth in ranking. This could be on the part of client or designer, which may lead to rework. Lack of commitment by participants to duties has the least ranking among the factors perceived by contractors as causing rework, followed by ccontractors' selection method, and lack of quality focus in increasing order of impact of rework on project.

Table 3: Client-Related Factors relative to the causes of rework

S/N	DESIGN-RELATED FACTORS	NOT SEVERE	LESS SEVERE	SEVERE	MORE SEVERE	MOST SEVERE	Mean Score	Rank
1	Poor communication	20	41	20	19	20	3.98	1
2	Inadequate construction planning	6	30	7	58	19	3.95	2
3	Poor management practices	8	14	28	21	49	3.83	3
4	Change in plan and scope by client	9	16	15	32	48	3.78	4
5	Inaccurate information	13	21	15	26	45	3.58	5
6	Lack of Quality management system	9	18	33	28	32	3.47	6
7	Unrealistic program	10	2	60	19	29	3.46	7
8	Poor information flow	11	14	25	52	18	3.43	8
9	Poor instructions	14	33	12	19	42	3.35	9
10	Cost pressure	1	12	44	47	16	3.38	10
11	Ineffective coordination and integration of project participants	4	25	47	12	32	3.36	11

12	Procurement method	12	23	19	52	14	3.28	12
13	Checking procedures	12	4	17	63	24	3.29	13
14	Poor contractual relationship	6	11	36	47	20	3.21	14
15	Inadequate resources	15	18	39	27	21	3.18	15
16	Conflicting information	27	12	27	22	32	3.17	16
17	Conflict of opinions between participants	3	16	78	11	12	3.11	17
18	Incomplete information	13	14	52	30	11	3.1	18
19	Change in specification by client	17	21	36	29	17	3.07	19
20	Lack of quality focus	19	13	55	23	10	2.93	20
21	Contractor selection method	15	34	40	12	19	2.88	21
22	Lack of commitment by participants'	2	20	25	39	34	2.87	22

Table 4 presents the ranking of Contractor-Related Factors that are responsible for the occurrence of rework in building projects. Top in ranking is, wrong laying of forming course in block work. The of lack of knowledge in the interpretation of drawings, poor workmanship, non-usage of spirit level when setting the blocks and wrong setting out and interpretation of drawings for block laying are the likely attribute of this factor. Poor quality concrete ranks next and this can result from the use of poor concrete constituents resulting in low strength. Poor plastering is third in ranking among these factors. This may be as a result of unevenness of the wall surface after plastering. The cause of this may be the lack of use of spirit level. Development of cracks may result from poor workmanship, and poor material usage. Deflection of part of slab is fourth in ranking. The reason for this can be the usage of poor quality timber in form work which eventually results in sagging of some part of the slab and poor workmanship. Other serious problems that leads to rework found in this study are: deflection of beam, Overlooked site condition, Errors during construction, Lack of proper monitoring and evaluation, Honeycombing of column and beam, Poor Safety considerations, Omissions during construction, Incorrect positioning of lighting switches and socket outlet and Incorrect laying of electrical pipes in slab. From Table 3, the three least contributors to reworks are: Incorrect laying of mechanical pipes, contractor initiated changes, and deflection of beam. Mechanical works in building projects are not large in scope and complex in nature, as such there may not be errors during construction that will lead to rework. When designs are constructable, the contractor would not initiate changes. The selection of a capable contractor will avoid construction errors that may lead to beam deflection.

Table 4: Contractor-Related Factors relative to the causes of rework

	CONTRACTOR-RELATED FACTORS	NOT SEVERE	LESS SEVERE	SEVERE	MORE SEVERE	MOST SEVERE	Mean score	Rank
1	Wrongly laying of forming course (block work)	3	21	12	42	78	4.33	1
2	Poor quality of concrete	13	4	21	68	30	4.22	2
3	Poor plastering	11	17	32	40	10	3.88	3
4	Deflection of part of slab	2	15	24	41	38	3.82	4
5	Lack of attention to quality	2	11	30	45	32	3.78	5
6	Lack of support to site management	6	30	58	19	7	3.76	6
7	Ineffective coordination and integration of components	4	25	12	32	47	3.75	7
8	Incorrect laying of slab reinforcement	3	24	31	10	52	3.70	8
9	Lack of straightness of beam at the top and bottom	7	10	34	16	43	3.69	9
10	Incorrect forming of deck	10	19	20	23	48	3.67	10
11	Collapse of projections	15	9	24	$26	46	3.66	11
12	Collapse of beam after construction	4	12	24	63	17	3.64	12
13	Use of poor materials in Sand						3.58	13
14	Defective materials as a result of handling	12	11	40	18	39	3.51	14
15	Wrong opening for windows and doors	7	17	35	35	26	3.47	15
16	Consultant initiated changes	7	14	31	52	16	3.47	15
17	Non-verticality of column	3	17	30	62	8	3.46	17
18	Use of poor materials in Steel						3.85	18
19	Collapse of part of slab	14	6	49	20	31	3.40	19
20	Contractor's request to improve quality	17	13	27	31	32	3.40	20
21	Construction error during excavation	4	30	28	31	27	3.39	21
22	Incorrect laying of electrical pipes in slab	5	16	59	7	33	3.39	22
23	Incorrect positioning of lighting switches and socket outlet.	2	18	48	41	11	3.34	23
24	Omissions during construction	8	18	48	19	27	3.33	24
25	Poor Safety considerations	15	34	12	19	40	3.29	25
26	Honeycombing of column and beam	19	12	27	44	18	3.25	26
27	Quality failure	11	19	29	52	9	3.24	27
28	Lack of proper monitoring and evaluation	13	21	26	45	15	3.23	28
29	Errors during construction	13	19	38	27	23	3.23	29
30	Overlooked site condition	26	6	29	34	25	3.22	30
31	Poor site practices	14	33	19	42	12	3.04	31
32	Deflection of beam	6	30	58	19	7	2.93	32
33	Contractor initiated changes	20	23	47	12	18	2.88	33
34	Incorrect laying of mechanical pipes	36	12	49	17	6	2.54	34

Source: Field survey

Table 5 reveals the effects of reworks on projects. The dominant effect of rework is time overrun. It is implied, that if processes will be repeated, it will require additional time to carry out the process. It is obvious that men are imperfect in their doings, therefore mistakes are likely to occur, leading to redoing work, and culminates in additional time for making good defective work. A delayed project may cause inflation, increases in prices of materials and result in project cost overrun. The least effect of rework relative to the perceptions of respondents is litigation. This suggests that there are various ways of settling the issues of reworks better than going through litigation. These options are adopted for the success of projects.

3.1. Discussion

Palneeswaran (2006) conducted a study titled "Reducing Rework to Enhance Project Performance Levels". Palaneeswaran (2006) reports the finding of the study of Fayek et al. (2003) on the root cause analysis of 125 field work incidences in Canada as, (a) engineering and reviews – 55.4%; (b) materials and equipment supply – 23.5%; (c) human resources capability – 18.3%; (d) construction planning and scheduling – 2.5%, and (e) leadership and communication – 0.4%.

The study of Palaneeswaran (2006), recommends strategies for zero rework on projects. Some of the strategies are, (a) avoiding defects, errors, non-conformances and quality deviations; (b) changes to design must be minimal and ensure good relationship between stakeholders; (c) fostering of systematisation through improved documentation, and information and communication arrangements, and (d) selection of knowledgeable and understanding clients; contractors; subcontractors, and suppliers.

Comparing the findings of this study with that of Palaneeswaran (2006), from Table 2, lack of understanding and correct interpretation of clients requirements, constraints in carrying out activities, and inexperience of personnel corroborates with the causal factors leading to strategy (d) with respect to Palaneeswaran (2006) study. From Table 3, poor communication, inadequate construction planning methods, poor management practices, and changes in plans and scope by clients agrees with the causal factors leading to strategy (c) and (b) of the study of Palaneeswaran (2006). Findings from Table 4, which are, wrongly laying of forming course (blockwall), poor quality of concrete and plastering, lack of attention to quality and support to site management agree with the causes which led to developing strategy (a) and (b) of palaneeswaran (2006) study. From the foregoing the causes of rework in the countries of these studies are similar.

Table 5: Effects of Reworks

S/N	Effects of rework						Mean score	Rank
1	Time overrun	98	12	3	7	0	4.68	1
2	Inflation	95	9	10	0	6	4.56	2
3	Cost overrun	69	31	9	9	2	4.30	3
4	Quality	71	19	24	5	1	4.28	4
5	Client Dissatisfaction	76	18	11	9	6	4.24	5
6	Contractor financial difficulties						3.58	6
7	Contractor Dissatisfaction	12	58	43	0	7	3.57	7
8	Demotivation	3	30	59	28	0	3.07	8
9	Design team dissatisfaction	13	4	53	47	3	2.81	9
10	Poor contract management	14	9	4	66	27	2.31	10
11	Litigation	0	13	5	37	65	1.72	11

Source: Field survey

3. CONCLUSION AND RECOMMENDATION

3.1. Conclusions

The study indicates the leading factors influencing the occurrence of rework under the design-related factors as: lack of understanding and correct interpretation of customer requirements; constraint in carrying out activities; inexperience of personnels; poor communication, and working under high time pressure.

Relative to client-related factors causing rework, change in plan and scope by client, poor communication, inadequate construction planning, poor management practices, change in plan and scope by client and inaccurate information are the leading factors influencing the occurrence of rework.

Top on the contractor-related factors causing rework are: wrongly laying of forming course in block work, poor plastering; deflection of part of slab; lack of attention to quality; lack of support to site management; ineffective coordination, and integration of components.

The prominent effects of rework on projects are: time overrun followed by inflation, cost overruns and quality. Whereas the factors of rework that have the least effects on building projects are poor contract management and litigation.

The analysis of areas that contributes to reworks in term of cost and time indicates that poor plastering, construction error during excavation , wrongly laying of forming course (block work), honeycombing of column and beam are more prone to rework. These originate from erroneous workmanship, poor machine or tools handling or mistakes in material selection.

3.2. Recommendations

Based on the findings of this study the following recommendations are made:

1. A standard format should be developed for capturing clients' needs. This will help in eliminating omissions in the gathering of client's requirements, which may lead to revision of design in the feature. Likewise, clients' are advised to write down their intentions prior to visiting the designer (Architect).
2. Skilled workers should be trained at regular intervals relative to being capable to read architectural drawings. Foremen of organisations, on permanent appointment should be given technical training in their various vocations it will reflect on productivity relative to their monitoring of quality of work of their subjects.
3. Attention should be given to adequate supervision of work at all levels of construction activities. In additionally, the various construction methods should be analysed, and the best for each activity be selected, before commencement of construction activities.

5. REFERENCE

Alwi, S., Hampson, K. & Mohammed, S. (2002) Non–value Adding Activities: "A Comparative Study of Indonesian and Australian Construction Projects". Proceeding of the 10th Annual Conference on Lean Construction, Gramado, Brazil, 1-12.

Ashford, J. L. (2000) The Management of Quality in Construction. London: E&F Spon.

Ballard, G. (2001) Positive vs. Negative Iteration in Design. Proceeding of 8th Conference of the International Group for Lean Construction (IGLC 8), 17-19 July, Brighton, United Kingdom.

Bon-Gang, H. (2009) Identifying key Sources of Rework Affecting Construction Cost Performance. The Construction and Building Research Conference of the Royal Institution of Chartered Surveyors, 138-149.

CIDA (2001) Measuring Up or Muddling Through: Best Practice in the Australian Non-Residential Construction Industry, Construction Industry Development Agency and Masters Builders, Sydney, Australia, 59–63

Fayek, A., Dissanayake, M., & Campero, O. (2004) Developing a Standard Methodology for Measuring and Classifying Construction Field Rework. Canadian Journal of Civil Engineering, 31(6), 1077-1089.

Kothari, C. R. (2004) Research Methodology, Methods and Techniques. Delhi: New Age international (p) Publishers.

Josephson, P. E., Larsson, B. & Li, H. (2002) Illustrative Benchmarking Rework and Rework Costs in Swedish Construction Industry. Journal of Management in Engineering 18(2), 76-83.

Love, P.E.D., Mandal, P., & Li, H. (1999) Determining the Casual Structure of Rework Influences in Construction. Construction Management and Economics. 17(4), 505–517.

Love, P.E.D., Mandal, P., Smith, J. & Li, H. (2000) Modelling the Dynamics of Design Error Induced Rework in Construction. Construction Management and Economics. 18, 567–574.

Love, P.E.D., & Edwards, D.J. (2004) Determinants of Rework in Building Construction Projects. Engineering, Construction and Architectural Management. 11(4), 259–274.

Love, P.E.D., Smith, J., & Li, H. (1999) The Propagation of Rework Benchmark Metrics for Construction. International Journal of Quality and Reliability Management, 16(7), 638-658.

Love, P.E.D., Smith, J. & Li, H. (1998) Benchmarking the Costs of Poor Quality in Construction: A Case Study. Proceedings of the Second International and Fifth National Confrence on Quality Management, 9-11 February, Monash University, Australia, 114- 124.

Mochal T. O. (2005) Minimize Rework as a Part of Quality Management Process. Journal of Management in Engineering. 18(4), 13-27.

Palaneeswaran, E., Kumaraswamy, M.M., & Love, P.E.D. (2005a) A Framework for Monitoring Rework in Building Projects, Tall Buildings from Engineering to Sustainability, World Scientific, Hong Kong, Editors: Y K Cheung and K W Chau, 710-715.

Palaneeswaran, E., Kumaraswamy, M., Chi-ming, T & Love, P. (2005b) Management of Rework in Hong Kong Construction Projects. The Queensland University of Technology Research Week International Conference Proceedings, July, 2005, 1-9.

Palaneeswaran, E. (2006) Reducing Rework to Enhance Project Performance Levels. Proceedings of the One-Day Seminar on “Recent Developments in Project Management” in Hong Kong 12 May 2006, 1-10.

Per-Erik, J., Larssonm B. & Li, H (2002) Illustrative Benchmarking Rework and Rework Costs in Swedish Construction Industry, Journal of Management In Engineering. 76-83.

Rogge, D.F., Cogliser, C., Alaman, H., & McCormack, S. (2001) An Investigation of Field Rework in Industrial Construction. Construction Industry Institute, 153-186.

Rounce, G. (1998) Quality, Waste, and Cost Consideration in Architectural Building Design Management, International Journal of Project Management, 16(2), 123-7.

Trigunarsyah, B. (2004) A Review of Current Practice in Constructability Improvement: Case Studies on Construction Projects in Indonesia. Construction Management and Economics, 22, 567-580.