

EFFECT OF ACCURACY AND TIMELINESS OF INFORMATION ON PERFORMANCE OF CONTRACTORS

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ABSTRACT

Improper information flow within the construction parties are most frequently experienced in Sri Lankan construction industry. Due to this situation, contractors faced several difficulties on their performance in terms of cost, time, and quality. Therefore, this paper intends to identify the accuracy and timeliness of information on performance of contractors. The aim is to identify how deficiencies in accuracy and timeliness of information affect performance of contractors in terms of cost, time, and quality. The outcome of this study will be beneficial for practitioners in Sri Lankan construction industry to reduce practical issues related accuracy and timeliness of information. Detailed questionnaire survey was used to identify the significant factors relating to accuracy and timeliness of information. Findings revealed that 'mistakes in design' and 'incomplete drawings' as the most significant factors on cost performance of contractors; 'delay in design', and 'slow drawing revision and distribution' as the most significant factors on time performance of contractors and 'mistakes in design' and 'incomplete drawings' as the most significant factors on quality performance of contractors. Further, factors were categorized as agreed factors and disagreed factors based on contractors' and clients' and consultants' perspectives. Important finding of the study is that there are number of factors considered highly significant by contractors but clients and consultants do not assume them to be so. Furthermore, the study recommended clients, contractors and consultants to hold their responsibilities with regard to information related issues on performance of contractors. Findings will be further useful to build a good relationship between stakeholders and improve the performance of contractors.

Keywords: Cost; Information; Performance of Contractors; Quality; Time.

1. INTRODUCTION

The construction industry faces a number of problems and challenges related to the successful completion of projects (Ofori, 2000; Krifa *et al.*, 2007). Further, construction industry largely depends on team work and every stakeholder have agreed goals with regard to cost, time and quality for achieving the project success (Leung *et al.*, 2004). Conventionally, client or consultant continually conveys the risks to the contractor (Acharya *et al.*, 2006). Therefore, performance of contractor is a critical component to the success of any construction project since it is the contractor who converts designs into practical actuality (Xiao and Proverbs, 2003; Wong *et al.*, 2008). Further, Xiao and Proverbs (2003) state that performance of the contractor has long been defined in terms of cost, time and quality.

Several studies have been conducted to examine factors impacting on performance of contractors in developing countries such as; planning and scheduling of work activities, errors in project design and documentation work, inaccurate estimating, inaccurate taking off, delays in approvals, delays in progress payments, slow decision making by client and information and communication between the parties (Assaf *et al.*, 1996; Alwi *et al.*, 2002; Nawaz *et al.*, 2013; González *et al.*, 2014). Therefore, effective management of information improves the performance of project and contractors (Davenport and Beers, 1995).

Information plays a significant role in modern construction industry. Further, information quality displays the degree of accuracy with which reality is represented and information should be available on time,

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when required and accuracy is characterized by perfect conformity to fact or truth; strictly correct and timeliness is defined as being at the right time (Chitkara, 1998). Therefore, contractor using incomplete and inaccurate design information is one of the problems that cause delays in construction. Furthermore, inaccurate design information cause defects in construction works and increase the reworks (Abdul-Rahman *et al.*, 2006). In addition, Lingard and Rowlinson (2005) state that the less accurate information related in as built drawings have an adverse impact on project completion. According to Toor and Ogunlana (2008), contractor waiting for information is one of the top ten problems causing construction delays. Due to this delay in information hinders contractor in receiving interim payments from public agencies which in turn can affect his cash flow affecting directly to construction performance. Further, the delay in design information causes difficulties in obtaining work permits and can affect to the performance of contractors.

In construction industry, the more detailed the information, the more realistic it becomes to plan the project in detail and hence, the more realistic it is to include detailed programs (Mawdesley *et al.*, 1997). Production information is prepared at an early stage of the project in sufficient detail to work out a tender or tenders to be obtained (Royal Institute of British Architects, 2007). According to Fewings (2005), production information flow is traditionally controlled by an information required schedule. Furthermore, information required schedule delivers a database about the contractor's estimation for the lead time plus a contingency from winning a given tender up to completion of works.

Since the information is not properly dealt, the construction projects mostly end up with delay and cost overrun (Al-Momani, 2000). The significant cost and time overruns subsequently leads for the quality issues in those projects. Those issues in cost, time, and quality are commonly identified as the poor performance in construction projects (Lo *et al.*, 2006). This poor performance is very much concerned by both client and contractor. Thus, it is highlighted that the accuracy and timeliness of information directly effects on performance of contractors.

Drawings, specifications and other contract documents are mostly used and given high priority as the sources of information for entire construction of a project (Institute for Construction Training and Development [ICTAD], 2007). In Sri Lankan traditional construction projects, the detailed information of these documents were unavailable during the initial stage. Therefore, contractors suffer without a clear picture of the project. This situation and improper information flow within the construction parties are most frequently experienced in Sri Lankan construction industry. Due to this situation, contractors faced several difficulties on their performance in terms of cost, time, and quality. Hence, the research gap was found to understand this effect of accuracy and timeliness of information on performance of contractor from existing literature. This paper is structured in six sections including a literature review, research methodology, and research findings. Finally, the conclusions have been drawn presenting the how deficiencies in accuracy and timeliness of information affect performance of contractors in terms of cost, time, and quality.

2. LITERATURE REVIEW

Increasing competition and deep variations are imposing construction professionals to constantly improve the performance in the construction industry (Ali *et al.*, 2013). In addition, the successful completion of a project is usually operated in terms of cost, time and quality performance (Hatush and Skitmore, 1997). Thereby, poor performance condemns the construction industry (Lee *et al.*, 2000; Kogioglou *et al.*, 2001; Bassioni *et al.*, 2005).

These stakeholders are performing in different ways relating to their own views (Lai and Lam, 2010). Chan and Chan (2004) state that every stakeholder have specific objectives related their field and criteria for evaluating achievement. Wang and Huang (2006) prove that criteria of project success significantly interrelated to the performance of clients and contractors. There is, therefore, a definite requirement for the client to have better performance of contractors in the construction industry.

Contractors should continuously improve the construction process and operation, project quality, project management and administration (Luu *et al.*, 2008). In addition, contractor is a responsible person for managing the construction project on site to the definite quality and to the planned schedule. Degree of

performance of contractor is gathered from many projects and contractors characteristics include; contract value, experience in construction industry, size of contractors, deviation between project value and second lowest bidder, homogeneity of manpower, deviation between contract value and estimated value, and the number of change orders (Assaf *et al.*, 1996). However, the performance of contractor is a controversial but significant issue in the construction industry. Furthermore, Xiao *et al.* (2000) emphasize many factors comprising, legal, technical, managerial, cultural, environmental, and economic issues impact on performance of contractors. Furthermore, information is one of the factor effect on the performance of contractors (Davenport and Beers, 1995).

Titus and Brochner (2005) elaborated that information plays a vital role in construction environment during all stages. Chitkara (1998) defines information as a collection of data which has been proven to be accurate and timely, reduces uncertainty and risks, must be reliable, comprehensive, error free, precise, clear, consistent and understandable by those who need it. Modern day construction industry is highly competitive and projects require teamwork and management with data and information exchange between whole parties that will be responsible for the conceptualization, design, construction, management, operation, and maintenance activities during all phases of the project life cycle (Soibelman and Caldas, 2000).

Viljamaa and Peltomaa (2014) discuss that combined information is required for efficient decision making in construction projects. Aouad *et al.* (1995) emphasized that every phase of a construction project involves a large amount of professionals who need lot of information at many times. Therefore, in the production of a large amount of complex information which is often managed uneconomically. Hence, Aouad *et al.* (1995) introduced the new idea to improve effectiveness and improve the combination of information within the construction industry, it is necessary to establish an appropriate information framework. It is also important to adopt and use a central database where information integrity and reliability can be maintained. The management of the construction network requires different information at different levels of decision making, such as planning, programming, to design and implementation (Prabodhani, 2012). Moreover, input of information is required at all stages of construction. Every party have some specific situation regarding the working conditions that affect needs for and use of information (Ambrose, 1997).

In accurate information describes error or omission or non-conformance or imperfection in information. It determines the quality of information (Jr *et al.*, 1992). Miscalculations, misinterpretations, and omissions are considered to erroneous acts. Although some actions are identifiable as being erroneous, defining the term “error” is an arduous task (Wantanakorn *et al.*, 1999; Lopez *et al.*, 2010).

Client or client’s representatives should issue the information and documents within a particular time to the contractor. If any delays occur in delivering documents or information, it should be occur many conflicts and disputes such as cost overrun, delays and scheduling conflicts. Moreover, International Council for Building Research Studies and Documentation (1993) reported that an error or an omission always leads to a defect. Thus, any inaccurate information are generate the problems in construction. Tan and Lu (1995) stated that cost, scheduling and performance problems can invariably be tracked back to the problem of the quality of design, such as error, incompleteness, and lack of constructability. Kululanga *et al.* (2001) highlighted that most of the claims were caused by contract documents owing to errors, defects, and omissions. Moreover, Royal Institution of Chartered Surveyors (2007) noted that inaccurate information issuing delays can mislead contractors, resulting in contract variations and potential time related or cost related claims. Furthermore, improper preparation of all documents may cause overruns, poor performance.

Many researchers have mentioned this factor which is affecting the performance (Ledbetter, 1994; Xiao and Proverbs, 2003; Acharya *et al.*, 2006; Enshassi *et al.*, 2009; Azis *et al.*, 2013; Memon *et al.*, 2014). Due to these causes, this paper had focused on accuracy and timeliness of information in construction industry. Summary of twenty previous researches on information related factors effect on performance of contractors during post construction stage were reviewed and categorized in Table 1. The review highlights many number of information related problems, considered by the authors.

Table 1: Impact on Information Related Factors on Performance of Contractors

Performance Criteria	Factors	Source
Cost	<ul style="list-style-type: none"> ▪ Lack of quality and detail of drawings ▪ Delay in design and approvals ▪ Absence of construction cost data ▪ Inaccurate cost estimation ▪ Slow information flow between parties ▪ Waiting time for approval of tests ▪ Poor provision of information to project participants ▪ Incomplete drawings ▪ Slow drawing revision and distribution ▪ Slow information flow between project team members ▪ Deficient documentation (specification and design) ▪ Inaccurate quantity take-off ▪ Inadequacy of plans ▪ Unclear information 	<p>Sonmez <i>et al.</i> (2007); Azhar <i>et al.</i> (2008); Le-Hoai, Lee <i>et al.</i> (2008); Enshassi <i>et al.</i> (2009); Creedy <i>et al.</i> (2010); Baloyi and Bekker (2011); Arcila (2012); Azis <i>et al.</i> (2013); Hwang <i>et al.</i> (2013); González <i>et al.</i> (2014)</p>
Time	<ul style="list-style-type: none"> ▪ Inaccurate estimates ▪ Mistakes in design ▪ Waiting time for approval of tests ▪ Poor provision of information to project participants ▪ Low speed of decision making within each project team ▪ Incomplete drawings ▪ Delays in design work / Lack of design information ▪ Slow drawing revision and distribution ▪ Slow information flow between project team members ▪ Inaccurate quantity take-off ▪ Mistakes and discrepancies in contract documents ▪ Design error due to unfamiliarity with the local conditions <ul style="list-style-type: none"> ○ environment, and the materials ▪ Lack of data in estimating the activity duration and resources 	<p>Arditi <i>et al.</i> (1985); Sullivan and Harris (1986); Chan and Kumaraswamy (1996); Ogunlana <i>et al.</i> (1996); Odeh and Battaineh (2002); Aibinu and Odeyinka (2006); Faridi and El-Sayegh (2006); Sambasivan and Soon (2007); Le-Hoai <i>et al.</i> (2008); Enshassi <i>et al.</i> (2009); Baloyi and Bekker (2011); González <i>et al.</i> (2014)</p>
Quality	<ul style="list-style-type: none"> ▪ Error or omission made by designer of product or process ▪ Incomplete drawings 	<p>Ledbetter (1994); Acharya <i>et al.</i> (2006)</p>

3. METHODOLOGY

The aim of this study was to identify how deficiencies in accuracy and timeliness of information affect the performance of contractors. Survey method proved to be the most appropriate. Hence, the study does not require the control of behavioural elements and focuses on contemporary events.

A detailed questionnaire survey was carried out to identify the deficiencies in accuracy and timeliness of information affect the performance of contractors in terms of cost, time, and quality in contractors', consultants' and clients' perspective. Information on a total of 113 construction professionals was obtained consisting of 43 contractors, 39 consultants and 31 clients. Median, 1st quartiles, 3rd quartiles, and percentiles was calculated to achieve the aim of identifying the significant factors that influence the accuracy and timeliness of information on performance of contractors in terms of cost, time, and quality. Furthermore, median and 3rd quartiles have been used to identify the factors, which have same opinion among contractors, and clients and consultants, and which have conflict opinions by contractors, and clients and consultants. Mann-Whitney U test was used to identify the disagreement level of factors, which have conflict opinions from both groups of respondents. The Mann-Whitney U test was used

whether the medians of two sets of data are significantly different from one another. The ordinal scale was adopted and transformed to Mann Whitney U value as shown in the formula:

$$U_1 = (n_1 \times n_2) + (0.5n_1)(n_1 + 1) - \sum R$$

Where,

U = the test statistic

n_1 = number of samples in group 1

n_2 = number of samples in group 2

R = sum of ranks of group 1 or group 2 (If $R_1 > R_2$, $R_1 = R$) (Eq: 01)

4. FINDINGS

4.1. FACTORS IN AGREEMENT ON COST PERFORMANCE OF CONTRACTORS

Table 2 displays the factors in agreement for effect of accuracy and timeliness of information on cost performance of contractors based on overall rank derived from all the respondents viz. contractor, client and consultants organisations. It also shows the rank given by contractors for the same factors for comparison.

Table 2: Factors in Agreement on Cost Performance of Contractors

No	Factors	Contractors' Rank
D3	Mistakes in design	2
D2	Incomplete drawings	1
S1	Mistakes and discrepancies in specification	3
C3	Missing information	4
D1	Lack of quality and detail of drawings	5
S2	Multiple meanings and confusions in specifications	9
C1	Mistakes and discrepancies in contract documents	10
C2	Unclear information in contract documents	12
T2	Delay in design	6
T5	Waiting time for approval of tests	14

From the data in Table 2, all these factors were agreed on effect level of accuracy and timeliness of information on cost performance of contractors by contractors, clients and consultants unanimously. These agreed factors were arranged in descending order of significance based on calculations of 10th percentile, 90th percentile since, median, 1st quartile, and 3rd quartile were equivalent for both groups. Therefore, percentiles were selected and factors were ranked accordingly. According to Table 2, incomplete drawings, mistakes in design and mistakes and discrepancies in specifications were ranked 1st, 2nd and 3rd by contractors respectively.

4.2. FACTORS IN DISAGREEMENT ON COST PERFORMANCE OF CONTRACTORS

Table 3 displays the factors in disagreement for effect of accuracy and timeliness of information on cost performance of contractors among all the respondents from contractor, clients and consultants organisations.

Table 3: Factors in Disagreement on Cost Performance of Contractors

No	Factors in disagreement		Rank (Contractor)	Rank (Client and Consultant)	Test statistic
T3	Slow drawing revision and distribution	Most Disagreement	7	12	1734.5
T4	Delay in responding to request for information		8	13	1692
T1	Slow information flow between parties		13	9	1528.5
S3	Deficient documentation	Least Disagreement	11	8	1428.5

According to Table 3, slow drawing revision and distribution, delay in responding to request for information, slow information flow between parties, and deficient documentation have a conflict of opinion on cost performance from both parties. These factors were arranged based on disagreement level between both parties. Slow drawing revision and distribution had the most significant difference in opinion between both parties and deficient documentation had less significant difference in opinion between both parties.

4.3. FACTORS IN AGREEMENT ON TIME PERFORMANCE OF CONTRACTORS

Table 4 depicts the factors in agreement for effect of accuracy and timeliness of information on time performance of contractors based on overall rank among all the respondents viz. contractor organisations and clients and consultants organisations. It also shows the ranks given by contractors for the same factors for comparison.

As depicted in Table 4, delay in design, slow drawing revision and distribution, delay in responding to request for information, waiting time for approval of tests, slow drawing revision and distribution, lack of quality and detail of drawings, deficient documentation, missing information, unclear information in contract documents, and mistakes and discrepancies in contract documents were discussed based on effect level of accuracy and timeliness of information on time performance of contractors. All these factors were agreed on effect level of accuracy and timeliness of information on time performance of contractors by contractors, and clients and consultants in the same manner. These agreed factors were arranged in descending order of significance based on calculations of 10th percentile, 90th percentile since, median, 1st quartile, and 3rd quartile were equivalent for both groups. Therefore, percentiles were selected and factors were ranked accordingly.

Table 4: Factors in Agreement on Time Performance of Contractors

No	Factors		Contractors' Rank
T2	Delay in design		1
T3	Slow drawing revision and distribution		3
T4	Delay in responding to request for information		4
T1	Slow information flow between parties		2
T5	Waiting time for approval of tests		5
D1	Lack of quality and detail of drawings		7
S3	Deficient documentation		10
C2	Unclear information in contract documents		13
C3	Missing information in contract documents		11
T5	Mistakes and discrepancies in contract documents		12

According to Table 4, delay in design, slow information flow between parties, and slow drawing revision and distribution were ranked 1st, 2nd, and 3rd by contractors respectively. Mostly, time related factors had significant effect on timeliness of information on time performance of contractors.

4.4. FACTORS IN DISAGREEMENT IN TIME PERFORMANCE OF CONTRACTORS

Table 5 displays the factors in disagreement for effect of accuracy and timeliness of information on time performance of contractors among all the respondents from the contractor organisations, and clients and consultants organisations.

Table 5: Factors in Disagreement on Time Performance of Contractors

No	Factors in disagreement		Rank (Contractor)	Rank (Client and Consultant)	Test statistic
D3	Mistakes in design	Most Disagreement	6	9	1775
S2	Multiple meanings and confusions		10	13	1748.5
S1	Mistakes and discrepancies in specifications	↓	12	8	1675
D2	Incomplete drawings		Least Disagreement	8	6

According to Table 5, mistakes in design, multiple meanings and confusions in specifications, mistakes and discrepancies in specifications, and incomplete drawings have conflict of opinion on time performance of contractors from both parties. These factors were arranged based on disagreement level of both parties. Mistakes in design had most significant difference in opinion between both parties and incomplete drawings had least significant difference in opinion between both parties.

4.5. FACTORS IN AGREEMENT ON QUALITY PERFORMANCE OF CONTRACTORS

Table 6 displays the factors in agreement for effect of accuracy and timeliness of information on quality performance of contractors based on overall rank derived viz. all the respondents from the contractor organisations and clients and consultants organisations. Furthermore, all these factors were ranked according to all respondents' point of view from Sri Lankan construction industry. It also shows the rank given by contractors for the same factors for comparison.

Table 6: Factors in Agreement on Quality Performance of Contractors

No	Factors		Contractors' Rank
D3	Mistakes in design	Most Significant ↓ Least Significant	1
D2	Incomplete drawings		4
S1	Mistakes and discrepancies in specifications		2
D1	Lack of quality and detail of drawings		3
C2	Unclear information in contract documents		8
C1	Mistakes and discrepancies in contract documents		6
C3	Missing information in contract documents		9
T4	Delay in responding to request for information		10
T3	Slow drawing revision and distribution		12

From the data in Table 6, all these factors were agreed on effect level of accuracy and timeliness of information on quality performance of contractors by contractors, and clients and consultants in the same manner. These agreed factors were arranged in descending order of significance based on calculations of

10th percentile, 90th percentile since, median, 1st quartile, and 3rd quartile were equivalent for both groups. Therefore, percentiles were selected and factors were ranked accordingly.

According to Table 6, mistakes and discrepancies in contract documents, mistakes in design, mistakes and discrepancies in specifications were ranked 1st, 2nd, and 3rd by contractors. Mostly, time related factors had less significant effect of timeliness of information on time performance of contractors compared to other factors.

4.6. FACTORS IN DISAGREEMENT ON QUALITY PERFORMANCE OF CONTRACTORS

Table 7 displays the factors in disagreement for effect of accuracy and timeliness of information on quality performance of contractors among all the respondents from the contractor organisations, and clients and consultants organisations.

Table 7: Factors in Disagreement on Quality Performance of Contractors

No	Factors In Disagreement		Rank (Contractor)	Rank (Client And Consultant)	Test Statistic
S2	Multiple meanings and confusions		5	6	1652.5
T5	Waiting time for approval of tests		13	9	1523.5
T2	Delay in design		14	12	1364.5
T1	Slow information flow between parties		11	8	1321.5
S3	Deficient documentation		7	4	1215

According to Table 7, multiple meanings and confusions, waiting time for approval of tests, delay in design, slow information flow between parties, and deficient documentation have conflict of opinion on quality performance between both parties. These factors were arranged based on disagreement level of both parties. Multiple meanings and confusions in specifications had the most significant difference in opinion between both parties and deficient documentation had least significance difference in opinion from both parties.

4.7. FACTORS CONSIDERED HIGHLY SIGNIFICANT BY CONTRACTORS ONLY

Table 8 displays the factors in disagreement which are considered highly significant by contractors. However, clients and consultants do not assume them to be so.

Table 8: Factors Considered Highly Significant by Contractors Only

Cost	Time	Quality
Slow drawing revision and distribution	Mistakes in design	Multiple meanings and confusions
Delay in responding to request for information	Multiple meanings and confusions	

According to Table 8, slow drawing revision and distribution, delay in responding to request for information are considered highly significant factors by contractors on cost performance of contractors. Mistakes in design and multiple meanings and confusions are considered highly significant factors by contractors on time performance of contractors. Multiple meanings and confusions is considered highly significant factor by contractors on quality performance of contractors. However, Clients and consultants do not assume them to be so. Therefore, clients and consultants do not give more attention on these factors.

5. CONCLUSION

From the findings of the study, it can be concluded that accuracy and timeliness of information have very high significant effect on the performance of contractors in Sri Lankan construction industry. Moreover, drawings and specification related factors have significant effect on cost and quality performance of contractors. Time related factors have considerable effect on time performance of contractors. Contract documents related factors have moderate effect on performance of contractors. 'Slow drawing revision and distribution', 'delay in responding to request for information', 'slow information flow between parties', and 'deficient documentation are disagreement factors on cost performance of contractors. 'Mistakes in design', 'multiple meanings and confusions', 'mistakes and discrepancies in specifications', and 'incomplete drawings' are disagreement factors on time performance of contractors. 'Multiple meanings and confusions', 'waiting time for approval of tests', 'delay in design', 'slow information flow between parties', and 'deficient documentation' are disagreement factors on quality performance of contractors. However, the most important finding of the study is that there are number of factors considered highly significant by contractors but clients and consultants do not assume them to be so. These are 'slow drawing revision and distribution' and 'delay in responding to request for information' on cost performance of contractors, 'mistakes in design' and 'multiple meanings and confusions' on time performance of contractors, and 'multiple meanings and confusions' on quality performance of contractors. Clients and consultants do not give more attention on these factors. Therefore, contractors suffer with cost and time overrun and quality issues related these factors. Consultants and clients should realize the significant factors and decrease the errors and delays in information. It can be improve the performance of contractors.

Finally, this research gives rise to a further researches direction to study on design and build projects and contractors supplied documents. In addition, this study was limited to performance of contractors. Therefore, a similar type of research can be conducted to study the performance of project.

6. REFERENCES

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