

CAPTURING AND MAINTAINING THE CLIENT'S REQUIREMENTS

Full Paper

ASSESSING OWNERS' ROLE IN IMPROVING CONSTRUCTABILITY OF CONSTRUCTION PROJECTS IN INDONESIA

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ABSTRACT

Constructability is an approach that links the design and construction processes, which can lead to significant savings in both cost and time required for completing construction projects. Improving constructability of construction projects is the responsibility of all project stakeholders, ie owners, designers and contractors. However, as the owners have the most authority in enforcing the implementation of constructability, the owners' awareness of the benefit of improved constructability is the most important. Project owners must be aware that the decisions that are made in the initial stages of planning and design are difficult and costly to change once construction begins. This paper present the study performed on the construction project owners in Indonesia in regard to their current constructability practices and its impact on the project performance. The study, which used survey questionnaires, shows that Project owners in Indonesia do have some understanding of the importance of constructability. However, the traditional approach to project delivery, which is the preferred method by most of them, limits their option for involving construction personnel in the pre-construction phases. There were few significant differences between public sector owners and private sector owners, and among owners who developed different types of project, in their approach to constructability. Project owners improved their project performance by clearly stating their project objectives, project designers improved project performance by interfacing with construction personnel during preparation of design, and contractors improved project performance by providing the designers with timely construction input.

Key Words: Constructability, Project owner, Indonesia, project performance

1 INTRODUCTION

1.1 CONSTRUCTION INDUSTRY IN INDONESIA

The construction industry in Indonesia is a relatively young industry. However, it has grown significantly since the early 1970s. Its contribution to the GDP increased from 3.86% in 1973 to above 8% in 1997. Although it experienced a contraction of almost 40% in 1998, due to the economic crisis in the country, the construction sector contribution has started to grow again since then. It constitutes about 60% of gross fixed capital formation and the number of people has increased significantly from 413,000 in 1978 to about 4.2 million in 1997. Many construction projects are awarded on a competitive basis using the traditional approach. In this approach, professional designers and constructors are engaged in separate contracts. The contractors are usually not involved until the designs have been completed. The separation of design from production in the construction process has led to a certain amount of isolation of the professionals from technical development in construction industry (Wells 1986). This division has also been suggested as being responsible for the lack of constructability of the construction projects (Griffith 1984), which was cited as a reason for projects exceeding budgets and schedule deadlines. (Construction Industry Institute Australia 1992) By separating construction from design function the project stakeholders are ignoring opportunities of significant savings in project cost and completion time resulting from the careful interaction of planning, design, and engineering with construction (Tatum, Vanegas et al. 1986).

1.2 CONSTRUCTABILITY DEFINED

The concept of constructability in the US or buildability in the UK emerged in the late 1970s, which evolved from studies into how improvement can be achieved to increase cost efficiency and quality in the construction industry. It is an approach that links the design and construction processes. In this paper the constructability is defined as 'the optimum use of construction knowledge and experience in planning, design, procurement, and field operations to achieve the overall project objectives' (Construction Industry Institute 1986). It emphasizes the ability to construct and the importance of construction input to all project phases. The Construction Industry Institute (CII) in the US has developed Constructability Concepts to stimulate thinking about constructability and how to make it work. The CII has also shown benefits of implementing constructability, especially in terms of project cost and schedule. In implementing improvement in constructability, the study by the Australian Construction Industry Institute (Francis, Sidwell et al. 1996) suggests that it is important to consider the uniqueness of the construction industry in a specific country.

Improving constructability of construction projects is the responsibility of all project stakeholders, ie owners, designers and contractors. However, as the owners have the most authority in enforcing the implementation of constructability, the owners' awareness of the benefit of improved constructability is the most important. Construction project stakeholders, especially owners, must be aware that the decisions which are made in the initial stages of planning and design are difficult and costly to change once construction begins. This paper presents the study performed on the construction project owners in Indonesia in regard to their current constructability practices and its impact on the project performance. This study was conducted using a questionnaire survey.

2 CONSTRUCTABILITY SURVEY

As suggested by Tatum et al. (1986), the awareness of the project owners were measured in terms of their responsibilities for constructability improvement. The awareness was measured on how construction project owners performed their responsibilities relating to the constructability of their project, which include:

- Setting the project objectives and priorities;
- Building and leading the project team based on the contractual approach selected, and leading the team effectively by fostering a team approach on a project;
- Making constructability a project concern by emphasising early cost influence, using constructability to meet project objectives, insisting on early construction involvement in major decisions, and resolving conflicts based on project objectives.

From one hundred questionnaires distributed to project owners, 40 responses were received consisting of 28 public sector owners and 12 private sector owners. Of these forty respondents eight developed infrastructure projects, eight developed industrial projects, twenty developed building projects and the other four developed residential projects. Table 1 summarises the different types of project developed by the different types of owner.

Table 1 Different types of project developed by different types of owner respondents

Type of Project	Type of Owner		Total
	Public sector	Private sector	
Heavy engineering	8	-	8
Industrial	4	4	8
Buildings	12	8	20
Residential	4	-	4
Total	28	12	40

The data collected from the constructability survey were analysed using statistical analysis software, SPSS 9.0 for Windows. Inferential statistics analysis was used to measure differences between variables and to measure association between variables. The measure of differences was used to analyse the differences in the current constructability practices among the project owners in different types of company, project and project delivery system. The measure of association was used to analyse the influence, if any, of the current constructability practices on the project performance. Since the collected data were in nominal or ordinal form, non-parametric tests were selected. The following tests were used to measure the differences between variables: (Bryman and Cramer 1997)

1. **Chi-square test** for two or more unrelated samples.
2. **Mann-Whitney U tests** for two unrelated samples to assess the significant differences when ordinal variables are used.
3. **Kruskal-Wallis test** for three or more unrelated samples to test for significant differences when ordinal variables are used.

Non-parametric correlation analysis was used to measure the association between variables. As most of data used in the analysis are ordinal variables, the **Spearman correlation coefficient** was selected.

For both the test of differences and the test of associations, the confidence level used was 95%, or the probability level (p-value) of 0.05. Differences or correlations are significant when the p-value is 0.05 or lower.

2.1 PROJECT PLANNING

The questionnaires distributed to construction project owners consist of four parts. The first part is about their roles in the project planning in regard to constructability. These roles are based on their responsibilities for improvement of constructability as suggested by Tatum et al. (1986). Those responsibilities include: defining the project objectives; stating the project priorities; the inclusion of commitment to finding the most cost effective means to meet project objectives; using project objectives as criteria in making major decisions; and considering new design approaches and construction methods.

Most of the respondents claimed that they had clearly stated their project objectives, especially the traditional project objectives of cost, time, quality and safety. These are logical responses, as defining project objectives is the first step in the overall project planning process.

All owners claimed that they had also clearly stated their project priorities and had used the project objectives as criteria in making major decisions. Most of them stated that they had included a statement on commitment to finding the most cost-effective means to meet the objectives, and in doing so they had included a consideration of new design approaches and/or construction methods.

The Mann-Whitney U test was used to assess how the different types of owner approached the overall project planning. There was no significant difference between the public-sector owners and the private-sector owners in their role/practices in the project planning related to constructability improvement, except for clearly stating project quality objectives. The mean rank¹ comparison between the two types of project owner indicates that the public sector owners gave a higher rating to consideration of project quality objectives than the private sector owners did.

A Kruskal-Wallis test was conducted to assess the approach to project planning in the different types of project. There was no significant difference in approaching the overall project planning among the owners in the different types of project except for variable defining the project objectives priority and considering new design approaches and construction methods. The mean rank comparison between these variables and the type of owner suggests that the industrial project owners are more likely to clearly state the 'other' project objectives, while the infrastructure and residential project owners are more likely to consider new design approaches and construction methods.

¹ The mean rank is the sum of ranks divided by the number of cases from the test of significant difference using unrelated samples, ie Mann-Whitney U test and Kruskal-Wallis test

2.2 SELECTING AN APPROACH TO PROJECT DELIVERY

In the second part of the questionnaire the project owners were asked about their approach to project delivery. This approach is important for owners in terms of improvement in constructability, as it will determine the options for early involvement of construction personnel. Although it is possible to improve constructability under any contractual approach, the unique elements of the project and any special opportunities for increasing constructability should be considered in selecting both the contractual approach and the type of contract (Tatum, Vanegas et al. 1986).

Twenty-three of the owners used the traditional approach to delivering their projects. Seven delivered their projects using the owner-builder approach, and six selected the design-construct approach. Other project delivery approaches include the design-manage, the construction management, and the general contractor as construction manager.

Table 2 presents the cross-tabulations between the type of owner and the project delivery approach selected by the owner, as well as between the delivery approaches and the type of project. This table shows that public-sector owners were more likely to deliver their project using the traditional approach, whereas delivery methods selected by private-sector owners vary from the traditional approach to the design-construct approach.

Table 2 Project delivery approaches selected

Project Delivery Approach	Type of owner		Type of Project			
	Public (%)	Private (%)	Heavy Eng. (%)	Industrial (%)	Building (%)	Residential (%)
Traditional	71	25	75	38	50	100
Owner-builder	7	42	0	12	30	0
Design-construct	11	25	0	50	10	0
Others	11	8	25	0	10	0
Total	N= 28	N = 12	N = 8	N = 8	N = 20	N = 4

Table 2 also shows that heavy engineering construction projects tend to be delivered using the traditional approach. This is not surprising, as this type of construction is usually owned or developed by government institutions. Residential construction projects are also most likely to be delivered using the traditional approach. One of the main reasons could be that the construction of this type of project would be determined by market conditions. The owners who develop industrial projects prefer the design-construct approach. The types of project delivery approach in building construction projects vary from the traditional approach to the construction management approach. However, the traditional approach is still the preferred delivery method.

Table 3 shows the cross-tabulation between the types of owner and the phases of the project when they start to integrate construction inputs, as well as the method of incorporating the inputs. This table also shows when and how construction inputs are integrated in the different types of project.

Table 3 Method of incorporating construction inputs

Begin to incorporate construction input during this stage	Type of owner		% of Total	Type of project			
	Public %	Private %		Heavy Eng. %	Industrial %	Building %	Residential %
Conceptual	21	67	35	12	50	45	0
Design	47	33	42	12	38	45	100
Procurement	7	0	5	13	0	5	0
Construction	25	0	18	63	12	5	0
Total	N = 28	N = 12	N = 40	N = 8	N = 8	N = 20	N = 4
chi-square	9.12			21.9			
p-value	0.03			0.01			
Method of early construction involvement							
In-house	36	17	30	25	50	10	100
Consultant	50	75	58	38	50	80	0
CM	7	8	7	12	0	10	0
Contractor	7	0	5	25	0	0	0
Total	N = 28	N = 12	N = 40	N = 8	N = 8	N = 20	N = 4
chi-square	2.80			24.36			
p-value	0.42			0.00			

Thirty-five percent of the 40 owners stated that they had integrated construction inputs as early as the conceptual planning stage. Forty-two percent started to incorporate construction inputs in the design stage and five percent in the procurement stage. The other eighteen percent delayed construction input until construction itself began.

The most common method used by the owners to integrate the construction inputs was by involving construction personnel through their design consultant (58%). Another common method was by using their own construction personnel (30%). Only 5% of the owners engaged contractors' personnel to provide construction inputs, and the other 7% of the respondents used the services of construction management firms.

There is a significant difference in the phase where the respondents start to incorporate construction input. The private-sector owners are more likely to incorporate the construction input as early as the conceptual planning phase, whereas the public-sector owners tend to delay this input to the design phase.

In heavy engineering construction projects, it is more likely that construction personnel are involved only in the construction phase. This is a logical consequence of most heavy engineering constructions being owned/developed by public sector owners, who are more likely to deliver their projects using the traditional approach. In industrial construction projects, the owners tend to incorporate the construction input as early as the conceptual planning phase. The complexity of the projects may

contribute to the early construction involvement, which is usually facilitated by the design-construct type approach. In building projects, the construction input is also incorporated early in the project life cycle. However, most of the inputs are provided by the construction personnel of the design consultant, as the traditional approach is still the preferred method of project delivery. In the residential construction projects the construction inputs are most likely to be incorporated in the design phase, and they are mostly provided by the owners' construction personnel.

In responding to questions about their approaches in selecting the project delivery method, most owners stated that they had assigned key individuals who had appropriate experience to the project team. They had also considered that being receptive to construction input was one of the important criteria in selecting a project designer and had established a pre-construction plan in developing their project. However, many of the owners did not feel strongly about provision of early involvement of construction personnel in selecting their contractual approach. This is one probable reason that many of them still preferred to use the traditional approach where in-house personnel or design consultant personnel provided early construction inputs.

The Mann-Whitney U test was used to assess how the different types of owner approached the selection of project delivery methods. There was no significant difference between the public-sector owners and the private-sector owners in approaching the project delivery method, except for considering the provision of early construction involvement. The mean rank comparison shows that it is the private-sector owners who are more likely to give a higher consideration to the provision of early involvement of construction personnel when selecting the project delivery method. The Kruskal-Wallis test, which is used to assess the differences in project delivery selection approaches among the owners in the different types of project, shows that there is no significant difference among the owners in the different types of project in approaching the project delivery selection.

2.3 CONSTRUCTABILITY AS PROJECT CONCERN

The third part of questionnaire given to the project owners relates to their activities in making constructability a project concern. These activities include: emphasising the importance of 'early cost influence' to the project team, including the designer and the contractor; using constructability to meet project objectives; insisting on involvement of construction personnel in major decision making; resolving conflict based on project objectives; and maintaining lessons-learned files from completed projects.

Most of the owners made or at least tried to make constructability a project concern. Most of them used the project objectives to solve project conflicts and insisted on construction involvement in making major decisions. They also stated that they maintained lessons-learned files of completed projects. Most of the owners emphasised the importance of early construction input and tried to use constructability to meet project objectives.

The Mann-Whitney U test was used to assess differences in implementing these activities between the two types of owner. There are significant differences between the two types of project owner in making constructability a project concern. The private sector owners put more emphasis on early cost influence and inclusion of construction involvement in major decision than the public sector owners. However, the public-sector owners are more likely to maintain the lessons-learned file from

their projects. A probable reason is that public-sector owners are more likely to build or develop more projects as part of the provision of public infrastructure.

The Kruskal-Wallis test results on the differences in making constructability a project concern among the owners in the different types of project show that there is no significant difference between different types of project.

2.4 PROJECT PERFORMANCES

In the last part of the questionnaire the owners were asked about their project performances relating to project schedule, project cost, project quality and project safety. For project time and cost performances, the respondents were asked to describe their project performances as behind schedule/exceeding budget, within schedule/budget, or ahead of schedule/less than budget.

Forty-one percent of the owners stated that their projects had been completed behind schedule. Fifty-one percent had completed their projects within schedule, and eight percent completed their projects ahead of schedule. Fifty percent of the owners stated that their projects had exceeded the budget. Forty-five percent of the owners completed their projects within the budget, and the other five percent completed their projects for less than the budget amount.

Most of the owners (>75%) claimed that their project quality and project safety were above average. Although there is a possibility of response bias, these questions were still asked to assess the influence of the current constructability practices among the project owners, if any, on the project performances related to project quality and safety.

The Mann-Whitney U test was used to assess the differences on project performances between the two types of owner. The Kruskal-Wallis test was used to assess whether there were any differences in the project performances in the different types of project and the differences in the performances due to the time of construction input as well as the method of construction input.

There are no significant differences in project performances between the two types of owner. However, there is a significant difference in project time performance for different types of project: the performance of the infrastructure and building project owners is a better than that of the industrial or residential project owners. It is surprising that the project time performance of industrial project owners was lower than those of heavy engineering and building project owners. The reason for this is not clear. As for the residential project owners, one probable reason for this situation was the access to project sites. It is common that land acquisition process for residential project was still on going when the construction phase started. There is no significant difference in the overall project performance due to different phases of incorporating construction inputs or from the different methods of providing construction inputs.

Table 4 summarises the results of the non-parametric correlation analyses between the project performances and the different variables that represent current practices/activities of project owners in regard to constructability. These analyses were performed to identify the influence, if any, of current constructability practices of the project owners on project performances.

Table 4 Non-parametric correlation coefficients for project performances

	F18		F19		F20		F21	
	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
C1a	0.06	0.74	-0.10	0.54	0.23	0.15	0.17	0.30
C1b	-0.04	0.80	0.07	0.68	0.27	0.09	0.34*	0.04
C1c	0.37*	0.02	0.11	0.50	0.30	0.06	0.35*	0.03
C1d	-0.12	0.48	0.13	0.42	0.38*	0.02	0.61*	0.00
C1e	-0.04	0.80	-0.06	0.72	-0.01	0.98	0.04	0.82
C2	0.25	0.13	-0.01	0.95	0.28	0.09	0.33*	0.45
C3	0.41*	0.01	0.04	0.79	0.23	0.17	0.32	0.05
C4	0.16	0.32	0.10	0.54	0.04	0.79	0.23	0.16
C5	-0.15	0.36	0.06	0.73	0.04	0.79	0.13	0.44
D7	0.01	0.95	0.18	0.28	-0.08	0.64	-0.06	0.73
D10	0.28	0.08	0.23	0.16	-0.32*	0.04	-0.15	0.39
D11	0.08	0.65	0.24	0.14	-0.02	0.92	0.01	0.95
D12	0.07	0.66	0.08	0.64	-0.18	0.28	-0.15	0.35
E13	0.02	0.91	0.04	0.79	-0.29	0.07	-0.15	0.36
E14	-0.08	0.62	0.04	0.83	-0.33*	0.04	-0.06	0.71
E15	0.08	0.65	0.18	0.28	-0.02	0.92	0.26	0.12
E16	0.01	0.96	-0.02	0.91	0.13	0.43	0.38*	0.02
E17	0.31	0.06	0.02	0.88	0.20	0.24	0.24	0.15

* correlation is significant for p-values less than or equal to 0.05

This table shows that there are some correlations between current constructability practices and project performances. When project quality objectives (C1c) are clearly stated, this may lead to improved project performance related to project cost (F18) and project safety (F21), and to a lesser extent on project quality (F20). Project cost performance (F18) is also improved when the objective statement includes a commitment to finding the most cost effective means to achieve project objectives (C3). Project safety (F21) is the project performance that is most influenced by current constructability practices. Project safety is improved when project objectives and their priorities are clearly stated (C1b-d, C2), and project conflicts are resolved based on project objectives (E16). Project quality performance (F20) is improved when the project objectives regarding safety (C1d), and to a lesser extent the project quality objectives (C1c), are clearly stated. The analysis also shows that project quality performance decreases when constructability is used to meet project objectives (E14) and being receptive to construction input is used as one of the main criteria in selecting a project designer (D10). The reason for this is unclear.

3 CONCLUSIONS

Project owners in Indonesia do have some understanding of the importance of constructability. However, the traditional approach to project delivery, which is the preferred method by most of them, limits their option for involving construction personnel in the pre-construction phases. The most common methods of integrating construction input were through construction personnel of the project owners or the project designers. There were few significant differences between public sector owners and private sector owners, and among owners who developed different types of project, in their approach to constructability.

Project owners improved their project performance by clearly stating their project objectives, project designers improved project performance by interfacing with construction personnel during preparation of design, and contractors improved project performance by providing the designers with timely construction input. Early contractor involvement reduced constructability problems, which led to an improved project performance.

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