FACTORS INFLUENCING CIVIL ENGINEERING PROJECT PERFORMANCE

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Abstract
Civil engineering projects trigger the economic growth by providing infrastructure facilities and job opportunities as well as attracting the attention of foreign investments. Due to their significant contributions towards the nation growth, the performance of civil engineering projects has become the upmost concern by the government. Unfortunately, many civil engineering projects in Malaysia are dominantly associated with unsatisfactory performance in terms of cost, time and quality of the delivered products. Therefore, this paper aims to identify the underlying causes which lead to unsatisfactory performance by determining the factors that affect civil engineering projects. The objective of this paper is to assess the factors i.e the civil engineering project characteristics and the quality of Standard Form of Contract (SFoC) adopted and the contractual behaviour of key participants of civil engineering project which affect the performance. The perceptions of consultant engineers and contractors were compared relatively to a list of these factors derived from the review of literature in construction of project performance. Questionnaires survey were conducted to undertake the research. 214 feedbacks received out of 500 questionnaires distributed to the G7 contractors registered under Construction Industry Development Board (CIDB) and consultant engineer registered under Board of Engineers Malaysia (BEM). The data was statistically analysed using SPSS 21 and descriptive analysis was conducted to determine the rank of factors. It is found that the civil engineering project characteristics namely project complexity, ground uncertainty, ease of site access and design completion before construction starts perceived to have high influence of project performance. Meanwhile, the quality of SFoC factors i.e completeness and clarity and contractual behaviours of key participants' factors i.e delay in making payment and communication skill between engineer and contractor were also ranked as the high-influence factor influencing civil engineering project performance. Thus, as a proactive measure, these factors are paramount to be put more concern in monitoring the performance of civil engineering projects in Malaysia.

Keywords:
Civil engineering, contractual behaviour, project performance, Standard Form of Contract

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INTRODUCTION

Civil engineering structures are undeniable important to a nation. Other than facilitating the human daily businesses, the civil engineering structures such as roads, highways, dams, bridges, airports, ports serve the country's development by underpinning the economic and linking social activities. Realizing the important roles of civil engineering structures towards the growth of the nation, the delivery of project on time and satisfactory quality within a reasonable cost have become the expectation of the public. As the tax payers' money is used in order to finance the civil engineering projects in Malaysia, the performance of civil engineering projects has become the government concern.

Evidence in literature replete with the relationship between project performance and the project characteristics as well as the effects of the latter on the former mainly focusing in building projects for instance such as Demirkesen & Ozorhon (2016), Cho et al. (2009), Shah Ali et al. (2009). Variety of construction project characteristics have been suggested by previous researchers which can affect the performance of construction projects. Songer & Molenaar (1997) grouped the characteristics of construction projects into the project, the owner and the design-builder. Meanwhile, Kaming et al. (1997) identified change orders, experience and resources as among the factors that affect performance.

On top of that, Cho et al. (2009) identified 17 project characteristics which then were grouped into project environment and project participant. Despite many studies associate project characteristics with project performance, unfortunately, very few studies can be found in literature which attempt to determine the characteristics of civil engineering project that affect the performance as much as studies focusing on building projects.

On the other hand, the quality of the Standard Form of Contract (SFoC) used for the civil engineering project also found to be among the factors that influenced the project performance. Despite of not many studies discussed on the SFoC adopted in a construction project has direct impact on performance, the influence of contractual issues towards project performance cannot simply be ignored. In Malaysian construction industry, the common SFoC adopted for civil engineering projects is PWD 203A especially for government projects. However, other types of SFoC such IEM, FIDIC (Red Book and Yellow Book) also have been adopted especially for private projects and the project which involved international participations. Since the contract is the critical governance of the project, the issue such as lack of clarity, fairness and the level of trust produced by the SFoC will adversely affect the relationship between the contracted parties by making it more adversarial and eventually lead to dispute and trigger undesirable behaviours of the project participants for instance opportunistic behaviour (Williamson 1985; Bresnen and Marshall 2000; Cheung & Yiu 2006; Lu, Zhang, & Zhang 2016; Rameezdeen & Rodrigo 2014) which eventually affects the project performance.

Toor & Ogunlana (2009) found that most of the problems in construction projects were related to the contractual behaviour of individual key participants in the project. The contractual behaviours of the key participants i.e delay in paying interim payment, late in giving possession, architect's behaviour, adversarial relationship, poor communication are among other things that affect the project performance (Jaffar et al. 2011; Sambasivan & Soon 2007; Chini & Valdez 2003; Ling et al. 2013). Unfortunately, none of the study done by the aforementioned authors differentiate the types of project and mostly focus on the general building projects. None of them focus on civil engineering projects. Thus, the contractual behaviours of the key participants viewed by many previous researchers are as important factors that affect project performance. Therefore, the objectives of the study are to assess the influence of the the factors i.e the characteristics of civil engineering project and the quality of SFoC adopted in civil engineering project and the contractual behaviours among the key participants on project performance based on consultant engineers and contractors' perceptions

LITERATURE REVIEW

Civil engineering project performance criteria

Basically, time, cost and quality are the common performance variables and have been extensively used for decades in determining the construction project performance. These variables which is called 'The Iron Triangle' concept up to this moment are still considered as the central to measuring project performance (Papke-Shields, Beise, & Quan, 2010). By using this 'The Iron Triangle' concept, the construction projects are generally considered as successful once they meet those criteria. Due to no project performance variables specifically meant for determining the civil engineering project performance, this study adopted the 'Iron Triangle' concept to determine project performance variables. Thus, the project performance variables considered in this study are cost variance, time variance and quality of workmanship.

Cost variance is referred as the extent to which the planned cost corresponds to the actual cost. Cost overrun might be incurred if the actual costs are exceeded than the planned cost. Prevalently, in civil engineering project, cost overrun is predominant as opposed to under run. In a study on large transportation project in Denmark, Skamris and Flybjerg cited in Shehu et al. (2014) concluded that cost overrun of 50-100% is common for large transportation infrastructure and that overruns above 100% are not unusual. On the other hand, Pickrell (1990) stated that the total capital cost overrun for United State (US) rail transit projects was calculated 61%. This variance in cost indirectly shows the performance of the projects. On the other hand, Rwelamila and Hall cited in Bowen et al. (2012) highlighted that project completion on time is frequently seen as a major criterion of project success. Assaf and Al-Hejji (2006) in their survey on time performance of large construction projects in Saudi Arabia found that 70% of the projects experienced time overrun as similar in civil engineering project.

A study by Frimpong et al. (2003) on groundwater projects in Ghana indicated that 33 out of 47 projects were delayed. The delay of a civil engineering projects also experienced by other countries such as the UK (Nkado, 1995), Indonesia (Kaming et al., 1997), Lebanon (Mezher and Tawil, 1998), Hong Kong (Lo, Fung, & Tung, 2006), Nigeria (Elinwa and Joshua cited in Idoro, 2012), Jordan (Al-Momani, 2000) and many more. This shows that the delay in delivery of civil engineering project is the indicator of bad performance of civil engineering projects.

Other than the cost and time aspects, Bowen et al. (2012) found that quality is perceived by the client as the main concerned over time and cost in construction projects, suggesting that the client may be well prepared to sacrifice construction time to improve quality. Quality means producing a product or service that is of a high standard and is fit for purpose. As found in literature, many researchers have used the quality of workmanship as one of the variables in determining the performance of a construction project for instance Rahmat & Ali (2010) and Masrom et al. (2015). Therefore, the quality of workmanship is considered as one of the important variables in measuring the performance of civil engineering projects.

Characteristics of civil engineering projects

Liu et al. (2012), Othman et al. (2006) and Demirkesen & Ozorhon (2016) are among the researchers who have explored and identified the characteristics of different types of construction projects. For general building project, Liu et al. (2012) explained that the project characteristics are based on a precise cost estimate before contract signing; time reductions; tight project milestones or deadlines; cost savings; project budget; ability to define the project scope; project size; complexity. Abdul Aziz (2012) classified the characteristics of project refurbishment based on project size; building type; procurement system; types of SFoC; contractual arrangement; building occupancy; completeness of design when work commenced on site; design changes made by client during construction; ease of access.

From the perspectives of civil engineering works, Othman et al. (2006) have determined the project characteristics based on contract size; tender type; bid ratio; percentage difference between awarded bid and estimate; extra project cost; number of bidders; size of contractor; project complexity; type of design and supervision; experience of contractors; project regional location. Nevertheless, the focus of their study only relates the project characteristics with time performance. Very few researches associate the characteristics of civil engineering project with overall project performance. Due to lack of evidence in literature on the characteristics of civil engineering that influence the project performance, this study identified project characteristics variables gained from literature that are appropriate to be utilized to describe the characteristics of civil engineering project. Therefore, this study refines the project characteristics from the aforementioned previous studies and establishes nine (9) characteristics of civil engineering project that might influence the project performance i.e project size; procurement system; types of SFoC; project complexity; environment uncertainty; completeness of design when work commenced on site; design changes made by client during construction; ease of access; variety of stakeholders.

Quality of SFoC adopted in civil engineering project

SFoC is a printed form of contract containing standard conditions which are applicable to the wide range of project (Pena-Mora et al., 2003). Since the construction project participants work together only up to the completion of the project, the SFoC is more preferable to specially drafted contract because they are comprehensive and ready-to-use, thus can minimize the time and cost of negotiating contracts (Chan, 2006). Unfortunately, there are many debatable issues concerning on the quality of the SFoC used in construction project. Many researchers argued that SFoC is incomplete (Singh, 2011), lack of clarity and disregards modern principles of risk allocation (Nasirzadeh, Khanzadi, & Rezaie, 2014), trust issues among the contracting parties and many punitive clauses in the SFoC (Hughes et al., 2002) as well as the fairness issues (Jin & Zhang, 2011). All of these issues indirectly could lead to dispute and conflict among the contracting parties. As evidence in literature, many construction projects ended up with unsatisfactory performance if conflict incurred in the project (Jaffar et al., 2011, Mitkus & Mitkus, 2014, Shehu et al., 2014). Therefore, the quality of SFoC in governing the project implementation must be taken into account as the factors contributing project performance. In this study the quality of SFoC adopted in civil engineering projects was investigated based on the completeness, level of trust produced, clarity and fairness

aspects.

Contractual Behaviour of Key Participants of Civil Engineering Projects

Key participants of a construction project will vary based on the types of construction project as well as the size of the construction project. Due to many key participants with their respective organisations are involved in a construction project, the need for a contract is paramount to ensure the well integration and cooperation among themselves in implementing the project. Prevalently, instead of the contract lead to project success, many construction projects eventually ended up unsuccessful with variety of conflicts which have been occurred among the participants.

The contractual behaviour of the key participants refers to the extent of the contract which is implemented by the people who make decision by the contract. Toor & Ogunlana (2009) observed that most problems in construction were associated with human related problems in individual organisations, not technical in nature. In addition, Lim and Zain (2000) revealed that most of problems in construction projects can be considered as 'management problems'. Toor & Ogunlana (2009) concluded that problems related to participant organisations had been given higher ratings as compared to problems related to other issues such as site and environment, finance and contract. The behaviours of key participants who failed to comply with the contract will create conflict and eventually affect project performance.

Delay in making payment and non-payment issues replete in construction industry. This contractual behaviour has long been discussed by many scholars as among the important factors contribute to unsatisfactory project performance for instance Judi et al. (2017), Mohamed et al. (2014), Ye et al. (2010) and Chia, (2012). Besides, other contractual behaviours of key participants mentioned by scholars that could affect project performance are the usage of Standard Forms of Contract in making decision (Mohd Danuri et al., 2006), giving unauthorised instruction and obeying unauthorised instruction by the contractor (Chappel et al., 2005), giving direct instruction by the client and obeying direct instruction by the contractor (Rahmat & Ali, 2010) and communication skills of contractor and consultant (Jaffar et al., 2011).

Not only in Malaysia, the undesired contractual behaviours of key participants also have been argued by many researchers which could affect project performance for instance Assaf and Al-Hejji (2006) in Saudi, Mezher and Tawil (1998) in Lebanon and Lo, Fung, & Tung (2006) in Hong Kong. Thus, this study explored the contractual behaviours of key participants in civil engineering project such as usage of SFoC in making decision, unauthorised instruction, obeying the unauthorised instruction, communication skills of engineer and contractor and the delayed in making payment.

METHODOLOGY

This study involved three (3) steps. It was started with an intensive literature review to identify the project performance variables to be used in this study i.e the characteristics of civil engineering project, the quality of SFoC and contractual behaviours of key participants which have the possibility in affecting the project performance. Various project characteristics, the quality of SFoC, contractual behaviours of key participants and performance variables from variety types of construction projects have been intensively reviewed in order to select the most suitable variables for this study. It was found that nine (9) civil engineering project characteristics i.e project size; procurement system; types of SFoC; project complexity; environment uncertainty; completeness of design when work commenced on site; design changes; ease of access; variety of stakeholders. Meanwhile, four (4) quality aspects of SFoC i.e the completeness, level of trust produced, clarity and fairness and five (5)contractual behaviours of key participants i.e the usage of SFoC in making decision, unauthorised instruction, obeying the unauthorised instruction, communication skills of engineer and contractor and delay in making payment were found to have possible effect on civil engineering project performance.

Next, to ensure the validity of variables gained from literature reviews, preliminary questionnaire survey has been distributed to G7 contractors and consultant engineers. The respondents have selected the criteria for instance, designated in the position of professionals; current, recent or direct involvement in constructing civil engineering projects particularly in public funding projects; as well as obtain at least five years' working experience. This phase has formed the foundation for subsequent phase and assisted in the design of the main survey. Twelve (12) responses were returned by the cut-off date given and then the Realiability Test using a Cronbach's coefficient alpha test was performed. Reliability Test showed internal consistency with value of the test was 0.745, which was more than 0.7. This indicates that the 5-point Likert scale measurement

was reliable, and the main questionnaire survey could be carried out to all respondents.

After that, the collection of main data for the study was conducted. Since this study involves large sample of population, questionnaire survey is appropriate where it requires respondents to answer the same set of questions effectively. The data for this study was obtained from G7 of CIDB's listed contractors and certified professional engineers registered under The Boards of Engineers Malaysia (BEM). Total population of this study which comprising of Grade G7 contractors who carried out civil engineering projects and certified professional engineers registered under BEM was 4151. The sampling method used in this study was non-probability convenience sampling due to difficulty in acquiring responses from statistical sampling. This is based on Sambasivan & Soon (2007) and Denscombe (2010) who stated that this method is preferred in the event to which responses from statistical sampling is difficult to be acquired.

The simple multiple choice and Likert-type questions was used in collecting data on respondents' opinions. In responding to the questionnaire, respondents were requested to indicate the level of significance of each factor. The level of influence was measured on a 5-point Likert scale where 5=Very high; 4= High; 3=Moderate; 2=Low; 1=Very low. Out of 500 numbers of questionnaire distributed, only 214 numbers were returned before cut-off date given representing 43% of response rate. The data gathered was analysed using statistical software SPSS version 21. This study adopted Descriptive analysis where mean values were used to rank the level of influence of the factors on civil engineering project performance. The interpretation of the level of influence of the factors was based on the mean values i.e more than 4.63 = Very high; 3.64 – 4.63 = High; 2.64-3.63 = Moderate; 1.63-2.63 = Low; less than 1.63 = Very low.

RESULTS AND DISCUSSION

Respondent's demographic

The demographic background of respondents participated in this survey are summarised in Table 1, Table 2 and Table 3.

Table 1: Types of respondent's organisation

Types of organisation	Respondents	
	No	%
Consultant Engineer	100	47%
Contractor	114	53%
Total	214	100%

Table 2: Respondents' length of experience in civil engineering works

Length of experience in civil engineering projects	Respondents	
	No	%
1 - 5 yrs	33	15%
5 - 10yrs	160	75%
> 10yrs	21	10%
Total	214	100%

Table 3: Respondents' status in their respective organisations

Position	Respondents	
	No	%
CEO/ Director	0	0%
Engineer	124	42%
Quantity Surveyor	45	48%
Supervisor	0	0%

Project manager	45	8%
Total	214	100%

As shown in Table 1, Table 2 and Table 3, the respondents of this study consist of 53% contractors and 47% consultant with 100% of their positions at their respective organizations are at executive level. Furthermore, the 10% of the respondents have more than 10 years of working experience in civil engineering while 75% have experienced working in civil engineering between 5 to 10 years. These indicate that the respondents of this study were capable and competent enough to participate in this study.

Influence of project characteristics on civil engineering project performance.

As a reference to overall opinion from all respondents, four factors have been seen as high influence on the civil engineering project performance. Based on Mann-Whitney U test conducted, both types of respondent have consensus that the four factors included construction complexity (M=4.01), ground uncertainty (M=4.00), ease of site access (M=3.82) and design completion before construction start (3.81) would significantly influence the project performance. The highest factor influencing project performance ranked by Engineer was construction complexity followed by ground uncertainty and design completion before construction start. In contrast, ease of site access was ranked by Contractor as the highest influencing factor on project performance followed by design completion before construction start and ground uncertainty.

Table 4: The ranking of project characteristic factors that influenced project performance

Influence of project characteristics on project performance	Overall			Engineer		Contractor		Mann-Whitney U Sig.*p*
	N	Mean	Rank	Mean	Rank	Mean	Rank	
Project complexity	214	4.01	1	4.03	1	3.72	4	0.008
Ground uncertainty	214	4.00	2	3.98	2	3.74	3	0.021
Ease of site access	214	3.82	3	3.80	4	3.95	1	0.122
Design completion before construction start	214	3.81	4	3.87	3	3.82	2	0.799
Procurement method	214	3.55	5	3.66	5	3.53	5	0.004*
Design changes	214	3.44	6	3.53	6	3.36	6	0.075
Project type	214	3.35	7	3.39	8	3.33	7	0.081
Type of standard form of contract	214	3.34	8	3.44	7	3.25	9	0.007
Variety of stakeholders	214	3.19	9	3.10	9	3.27	8	0.001*

In overall, project complexity was found to be the highest factor influencing civil engineering project performance. Indeed, civil engineering projects dominantly associated with project complexity for instance as highlighted by He et al. (2015) and Favari (2012). The complexity was not only in the construction process but also including technological complexity, organizational complexity, goal complexity, cultural complexity, environmental complexity and information complexity which could direct or indirectly affect project performance (He et al., 2015).

Meanwhile, ground uncertainty also ranked as one of the highest factors affecting the civil engineering project performance (M=4.00). In previous researches, many researchers argued that uncertainty affects project performance for instance Rahmat & Ali (2010) on refurbishment projects, and Nasirzadeh et al. (2014) on general building projects. This study has proven that civil engineering project performance also was influenced by the unpredictable ground condition because mostly civil engineering projects are full of uncertainty and most of the time quite complex, difficult to manage and replete with unpredictable behaviours of project key participants.

Influence of the quality of SFoC on civil engineering project performance.

Based on Mann-Whitney U test shown in Table 5, all respondents have consensus on each of the quality of SFoC variables have moderate-to-high influence on civil engineering project performance. As depicted in Table 5, both Engineer and Contractor respondents agreed that the completeness of SFoC ranked as the highest factor which influenced project performance. This finding was in lined with many scholars who questioned whether the SFoC used in construction projects are completed to govern all aspects of construction implementations for instance Lu et al. (2016), Bubshait & Almohawis (1994) and Mansor & Rashid (2016). Since contract is the governance of overall project implementation, the completeness of SFoC is important because it does not only detailed out the contracting parties rights and obligations but also capable to reduce opportunistic behaviours among them (Lu et al., 2016).

On the other hand, the clarity of SFoC ranked as the second most affecting factor towards civil engineering project performance by both engineer and contractor respondents. This is very true because the SFoC plays an important role in governing all aspects of civil engineering projects. Therefore, the clarity of SFoC adopted in terms of content, wording and roles of contracting parties are paramount. This is because different interpretation could denote a dispute regarding the contractual obligations and expectation between the contracting parties (Chong & Zin, 2010). Bubshait & Almohawis (1994) argued that ease of language structure and the conciseness of clauses which is free from unnecessary information is important to avoid misinterpretation. According to Rameezdeen & Rodrigo (2014), lack of clarity in standard form of contract is mainly attributable to long sentence length, poor layout and the presence of many redundant legal expressions. The same argument is also shared by other researchers for instance (Ali & Wilkinson, 2010), (Chong & Zin, 2010) and (Wright & Fergusson, 2009). Thus, the clarity of SFoC is very important as a good governance in civil engineering projects. Wrong interpretation could lead to dissatisfaction among the contracting parties which eventually affects the civil engineering project performance

Table 5: The ranking of SFoC quality factors that influenced on project performance

Influence of quality of SFoC on project performance	Overall			Engineer		Contractor		Mann-Whitney U Sig.*p*
	N	Mean	Rank	Mean	Rank	Mean	Rank	
Completeness of SFoC	214	3.7	1	3.67	1	3.72	1	0.431
Clarity of SFoC	214	3.47	2	3.5	2	3.44	3	0.037
Fairness of SFoC	214	3.35	3	3.36	3	3.33	2	0.390
Trust produced by SFoC	214	3.24	4	3.26	4	3.23	4	0.826

Influence of contractual behavior of key participants on civil engineering project performance.

As depicted in Table 6, there are two factors that possessed high influence on project performance namely delay in making payment and communication skill of contractor and engineer. Delay in making payment ranked as the highest contractual behavior of key participants factor as the performance of civil engineering projects by both engineer and contractor respondents has been affected. As rated by all respondents with 3.85 Mean value (see Table 6), delay in making payment is in-lined with findings by many previous researchers who found that this factor is the most influencing factors which can affect construction project performance for instance (Adnan et al., 2012) and (Nurul, Aminah, Syuhaida, & Chai, 2016). In fact, interim payment can be considered as the 'blood' of the contractor in construction process to maintain the contractor's cash flow and minimising the contractor's cash deficit (Guo et al., 2016). In addition, the payment is also important to contractor due to high investment made by the contractor at the preliminary stage of construction process. Problems in contractor's cash flow will affect the smoothness of construction process. Thus, delay in paying making payment is the undesired contractual behaviour of the client towards the contractor which could give significant impact towards civil engineering project performance.

Table 6: The ranking of contractual behavior of key participants' factors influenced project performance

Influence of contractual behaviour of key participants on project performance	Overall			Engineer		Contractor		Mann-Whitney U Sig.*p*
	N	Mean	Rank	Mean	Rank	Mean	Rank	
Delay in making payment	214	3.85	1	3.88	1	3.82	1	0.280
Communication skill of contractor and engineer	214	3.70	2	3.66	2	3.74	2	0.222
Obeying unauthorised instruction	214	3.29	3	3.36	3	3.23	4	0.243
Usage of SFoC in making decision	214	3.29	4	3.31	5	3.27	3	0.356
Unauthorised instruction	214	3.28	5	3.35	4	3.22	5	0.006

Meanwhile, communication skill between contractor and engineer ranked as the second-high contractual behavior of key participants which has influenced on project performance. Communication skills between engineer and contractor are the ability to conduct effective communication among the project participants for the purpose to smoothen the project implementation (Zhang & Fan, 2013) thus, poor communication among them could create problems and lead to project failure (Sambasivan & Soon, 2007). In the meantime, obeying unauthorised instruction and usage of SFoC in making decision was ranked as the third-high influencing factor by Engineer and Contractor respectively. In dealing with unauthorised instruction issues, the contractor must equip himself with the content of SFoC as well as the scope of works detailed in the contract in order to ensure that only authorised instruction to be obeyed. This is because the contractor is not obliged to comply if the engineer's instruction amounted to cardinal change, namely works not contemplated by the contract and which substantially changes the nature and scope of the contract. If the contractor does comply, not only the contractor is entitled to be paid on a quantum meruit basis (Lim, 2004), but it could create dispute among key participants where eventually affect project performance.

CONCLUSION

Civil engineering project performance in Malaysia is considered unsatisfactory where most projects associated with severe cost and time overruns. Therefore, a mitigating action must be put into civil engineering projects to ensure the future civil engineering projects can be delivered within budget, time and quality required. This study attempts to contribute to this mitigating action by identifying the root cause which dominantly affecting the previous civil engineering project performance. Result of this study found that project complexity, ground uncertainty, ease of site access and design completion before construction starts, the completeness and clarity of SFoC, delay in making payment, obeying unauthorized instruction and usage of SFoC in making decision factors play an important part affecting civil engineering project performance. Therefore, these factors must be given more concern by the government and project participants to ensure we can deliver world class civil engineering project for a better Malaysia.

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