A preliminary investigation on the effects of characteristics and contractual behaviour on civil engineering project performance

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Abstract: The significant role of civil engineering project is not only to make the lives of people easier and secure but also to trigger the economic growth by providing infrastructure facilities as well as job opportunities. As it is dominantly initiated by government sectors, performance of the civil engineering projects is always observed. This study aims to investigate the characteristics of civil engineering project and the contractual behavior of the key participants and how do these two factors affect civil engineering projects performance. Literature reviews, content analysis and questionnaires survey were conducted to undertake the research. A total of 50 questionnaires were distributed and 10 questionnaires were returned, resulting in a 20% response rate. The research unveiled that performance of civil engineering projects are influenced greatly by the ability to handle the unpredictable character of the civil engineering projects and adequate behavioral management. Apart from that, balancing the factors with high quality of workmanship, avoidance or well managed conflicts and high satisfaction level will ensure performance in projects.

1. Introduction
Civil engineering structures such as roads, highways, dams, bridges, airports, ports etc. are the bloodlines to a progress of a country. Infrastructures improve transportation, communication and services, thus serve the country’s development by underpinning the economic and linking social activities. A well-structured nation helps to generate higher economic activities and attracting local and foreign investment. Civil engineering structures have always been a traditional responsibility of the public sector. Expectation for delivery of work on time, satisfactory quality and responsive customer services is putting the public sector responsible for the works under the microscope.

In literature, there are many researchers who focus their study on the general building construction. Very few studies can be found research on the characteristics of civil engineering projects. Coincidentally, it is found that the research recently done by [1 – 3] and [4] are focusing on civil engineering projects. However, research by [1] is focusing more on the management of risk in major infrastructure projects, meanwhile [2] narrow down their research on the case of cost overrun in Dutch transport infrastructure projects. Meanwhile, [4] focus on the impact of irreversibility and uncertainty on the timing of civil engineering projects. None of the studies have established the characteristics of civil engineering projects. Hence, other than difficult in management and implementation, the characteristics of civil engineering projects which has numerous attribute that
different from general building project also can lead to undesired behavior of project participants where eventually affect the performance of civil engineering projects.

On the other hand, the impacts of contractual behavior of the key participants on civil engineering performance also important to be explored. In fact, [5] and [6] found that most of the problems in construction projects were related to the contractual behavior of individual key participants in the project. The contractual behavior of the key participants i.e delay in paying interim payment, late in giving possession, architect’s behavior, adversarial relationship, poor communication are among other things that affect the project performance [7] and [6]. Unfortunately, none of the study done by the mentioned authors differentiates by the types of project and mostly focus on the general building projects. The findings for the civil engineering project might be different from the general building project due to their distinctive characteristics. This is due to the assumption that the more uncertainty element exist in the project, the more unpredictable behavior of the key participants will occur [8]. Hence, it is important to investigate the common contractual behaviours of key participants since they are among the critical factors that will determine the success and the failure of civil engineering projects.

2. Literature review

[9 – 11] are among the researchers have explored and identified the characteristics of different types of construction projects. However, most of them have done the study focusing on the building projects. For general building project [11] explain the project characteristics 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. From the perspectives of civil engineering works, [10] have determine 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. Unfortunately, the focus given only on the characteristics that influence on the time performance. Very few research can be referred to in order to determine the characteristics of civil engineering project performance. Due to lack of evidence in literature on the characteristics of civil engineering that influence the project performance, this study will identify 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 establish nine (16) project size; procurement method; type of Standard Form of Contract; contractual arrangement; type of design and supervision; project location; construction complexity; design completion before construction start; clear definition of project scope; tight project milestone; ease of site access; variety of stakeholders; environmental uncertainties; technological advances; multicultural team; resources availability.

Meanwhile, the contractual behavior of key participants is referring to the extent the responsibility stated in contract is implemented by the people who makes decision by the contract. In other words, it is related to the action as well as the commitment of the participants towards their task and responsibility as stipulated in the contract. [5] Observed that most of the problems in the construction project are not because of technical, financial, contract or environmental issues where most of them are due to the behavior of the participants. Therefore, the behavior of the participants in complying the responsibility as stipulated in Standard Form of Contract important to be investigated in the present study. This study would explore the behavioral of the participants towards the task and responsibility stipulated in Standard Form of Contract for instance in the aspects of giving instructions; obeying instructions; communication; making decision; making payment; variation; site possession.

3. Methodology and analysis

The study focused on civil engineering projects in Malaysia. The focus of research was limited to the roads projects in Malaysia including their associated structures such as bridges and tunnels. A specific
area and locality is determined to ensure that the research would be covered within the limited time of study. 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). In addition, to provide better analysis of the project characteristics that influence civil engineering project performance, the study would cover civil engineering projects with the contract value of more than RM10 million.

In order to achieve the objectives of the study, a mixed-method approach was adopted. The study started with an intensive literature review to identify the characteristics of civil engineering project and the common contractual behaviour of the key participants towards the project which have the possibility in affecting the project performance. Since there are very few studies can be found focusing on civil engineering projects as well as to incorporate the scenario of civil engineering projects problems in Malaysia, content analysis method was adopted. The National Audit Reports and construction report prepared by G7 contractors was used to investigate the common contractual behaviour of key participants in civil engineering projects. This is an appropriate solution to overcome the shortage of information available in literature.

Next, based on the variables gain from literature reviews and content analysis, preliminary questionnaire was developed and the distributed to the G7 contractors and professional engineers. The purpose is to ensure the validity of variables gained from literature reviews and report content analysis. Besides, since the study involves large number of respondents, the adoption of questionnaire survey is appropriate because it capable to approach respondents regardless of their location and answer the same set of questions effectively.

A total of 50 preliminary questionnaires were distributed. However, only 10 questionnaires were returned by the cut-off date, resulting in a 20% response rate. The views were therefore predominantly those of contractor. Majority of all respondents have more than 3 years of working experience in procuring construction projects with 50% of their companies’ revenue comes from civil engineering projects.

3.1 Project characteristics variables affect the performance of civil engineering works
Civil engineering projects are complex and difficult to manage. Hence, this study attempts to investigate the level of influence of project characteristics towards performance. As indicated in Table 1, all respondents are very certain that construction complexity and environmental uncertainties are the main characteristics that give impacts on performance. This is followed by design completion before construction start and clear definition of project scope. Meanwhile procurement method, project location, and resources availability were rated as the characteristics that give low influence on performance. This result is in contrast with building project characteristics where project size is the most critical factors that influence project performance [12].

3.2 Contractual behaviour of key participants
Human factors are prevalent and always a major factor. In an industry where involvement from numerous parties is common, behavioural factors are always predominant. The following results examine the contractual behaviour among the parties. The data observed the most frequent behaviour practiced by the parties. The listed behaviours are alleged to be the factors of disputes in civil engineering works where eventually affect the performance.

Based on the result tabled in Table 2, most of the respondents rated very high frequency for the late of client in delivering interim payment. This is followed by the S.O give unauthorised instructions to the contractor and the contractor obey them. This is accord with the study by [7] and [13] who state that delay in paying progress payment to contractor is the most critical factors contributing to conflict among them and eventually can reduce the project performance.
| Item | Civil engineering project characteristics | Frequency | TR | MR | Ranks | Freq |
|------|------------------------------------------|-----------|----|----|-------|------|
|      |                                          | Not certain | Neutral | Very certain |       |      |
|      |                                          | 1 | 2 | 3 |       |      |
|      |                                          | No | % | No | % | No | %       |      |      |
| 1    | Project size                             | 0 | 0% | 3 | 30% | 7 | 70% | 10 | 2.70 | 5     | Very certain |
| 2    | Procurement method                       | 2 | 20% | 6 | 60% | 2 | 20% | 10 | 2.00 | 16    | Neutral |
| 3    | Type of Standard Form of Contract        | 0 | 0% | 5 | 50% | 5 | 50% | 10 | 2.50 | 7     | Very certain |
| 4    | Contractual arrangement                  | 3 | 30% | 1 | 10% | 6 | 60% | 10 | 2.30 | 12    | Neutral |
| 5    | Type of design and supervision           | 3 | 30% | 1 | 10% | 6 | 60% | 10 | 2.30 | 10    | Neutral |
| 6    | Project location                         | 6 | 35% | 4 | 24% | 7 | 41% | 17 | 2.06 | 15    | Neutral |
| 7    | Construction complexity                  | 0 | 0% | 0 | 0% | 10 | 100% | 10 | 3.00 | 1     | Very certain |
| 8    | Design completion before construction start | 0 | 0% | 2 | 20% | 8 | 80% | 10 | 2.80 | 4     | Very certain |
| 9    | Clear definition of Project scope        | 0 | 0% | 1 | 10% | 9 | 90% | 10 | 2.90 | 2     | Very certain |
| 10   | Tight project milestone                  | 0 | 0% | 5 | 50% | 5 | 50% | 10 | 2.50 | 7     | Very certain |
| 11   | Ease of site access                      | 0 | 0% | 4 | 40% | 6 | 60% | 10 | 2.60 | 6     | Very certain |
| 12   | Variety of stakeholders                  | 0 | 0% | 5 | 50% | 5 | 50% | 10 | 2.50 | 7     | Very certain |
| 13   | Environmental uncertainties              | 0 | 0% | 0 | 0% | 10 | 100% | 10 | 3.00 | 1     | Very certain |
| 14   | Technological advances                   | 0 | 0% | 6 | 60% | 4 | 40% | 10 | 2.40 | 11    | Very certain |
| 15   | Multicultural team                       | 0 | 0% | 5 | 50% | 5 | 50% | 10 | 2.50 | 7     | Very certain |
| 16   | Resources availability (material, labour, plants) | 2 | 17% | 6 | 50% | 4 | 33% | 12 | 2.17 | 14    | Neutral |
Table 2. Contractual behaviour of key participants in civil engineering projects

| Contractual behavior among the parties in civil engineering works | Frequency |  |  |  |  | Rank | Freq |
|---|---|---|---|---|---|---|---|
|  | Low | Neutral | Very high | TR | MR | s | |
|  | 1 | 2 | 3 | | | | |
| How frequent did the client give direct instruction (without going through the S.O) | 2 | 20% | 5 | 50% | 3 | 30% | 10 | 2.10 | 4 | Neutral |
| How frequent did the S.O give unauthorised instruction to the contractor | 2 | 20% | 2 | 20% | 6 | 60% | 10 | 2.40 | 2 | Very high frequent |
| How frequent did the contractor obeyed to the unauthorised instruction from the S.O | 2 | 20% | 4 | 40% | 4 | 40% | 10 | 2.20 | 3 | Neutral |
| How frequent the client fail to pay the interim payment within the stipulated time | 1 | 10% | 3 | 30% | 6 | 60% | 10 | 2.50 | 1 | Very high frequent |

Table 3. Communication between contractor and S.O

| Contractual behavior among the parties in civil engineering works | Agreement on effectiveness |  |  |  |  | Rank | Freq |
|---|---|---|---|---|---|---|---|
|  | Not agree | Neutral | Very agree | TR | MR | s | |
|  | 1 | 2 | 3 | | | | |
| How do you rate the effectiveness of communication between the S.O and the contractor | 0% | 6 | 60% | 4 | 40% | 10 | 2.40 | 1 | Very agree |

Concisely, communication between parties is rated from neutral to any positive scale, indicating that parties accept the communicational relationships within civil engineering works environment. Even though there is a preconceived notion that communicational problems are predominant in the industry, it is not observed here.

4. Conclusions

The performance of civil engineering projects influenced greatly by the ability to handle the unpredictable character of the civil engineering projects and adequate behavioural management of the key participants. Construction complexity and environmental uncertainties are the main characteristics of civil engineering projects that give big impact on performance. In Malaysia, the PWD203a Standard Forms of contract series are prevalent as most civil engineering projects are government initiated. The documents provided sufficient details to resolve conflicts, even though the contents are not generally favoured by the parties. An improvement to suit the characteristics of the civil engineering works would be advantageous. Most behavioural issues are induced by communication problems. There is a preconceived notion that communicational problems are predominant in the industry, but performance is observed to prove otherwise. This is probably due to the acceptance towards the current communicational practice. Evidently, performance is also influenced by high quality of workmanship, avoidance or well managed conflicts and satisfaction level. A balanced in the aforementioned factors will ensure performance in the civil engineering projects.

5
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