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Evaluating Risk Impacts on Design and Build Projects in Malaysia

[1]Sabihah Saaidin, [1]Intan Rohani Endut, [2]Siti Akmar Abu Samah and
[1]Ahmad Ruslan Mohd Rizduan
[1]Faculty of Civil Engineering, [2]Academy of Language Studies,
Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

Abstract: One of the challenging tasks in Design and Build (DB) project is how to identify and assess the risks that impact on the project objectives. The impact of the risks can cause the increase in the project cost, delay in time and lack of quality expectation from client. Design and build project is widely associated with high degree of risk and uncertainty due to the nature of the project itself. The objective of this study is to identify and asses the occurrence of risk impact in design and build projects in Malaysia. A total of one hundred seventy usable questionnaires were received from respondents (client, consultants and contractors) that were involved in DB projects and analyzed using descriptive statistics and Spearman's rank correlation test. The results revealed the top 10 risk factors impacting the DB projects observed. Armed with this information, stakeholder may be better able to provide complete information on the influence of design and construction related to risks in DB projects and consequently, the client's cash flow position.

Key words: Design and Build (DB), risk impact, descriptive statistics, spearman's correlation test, client, consultants and contractors

INTRODUCTION

Design and Build (DB) project has been implemented and demonstrated with an effective delivery method in recent years. The selection of DB project is to take an advantage of the shortened project delivery time and to reduce project cost. However, DB is still perceived to be subjective and complicated. It is because the client is still skeptical and hesitant (Saaidin *et al*., 2016a, b; Saaidina *et al*., 2016). Design and build project is considered as the most risky project for both client and contractor unless appropriate identification, analyzing, controlling and monitoring for the project are essential to minimize the risk impact in DB project. Adoption of risk management process during design stage will help to minimize the risk impact of construction project. Thus, risk can be observed with two events: the likelihood of something happening and the degree of the severity consequence of risk occurring.

Construction industry mostly involves high risks, starts with initial phase of designing to execution of construction phase. Generally, risk is associated with every activity of the construction work but if these risks are not properly managed, usually result on the project objectives like cost overrun, time overrun and lack of quality satisfaction. According to dada, most contractors in developing countries are not familiar with these risk factors and insufficient experience and knowledge in managing risk effectively and could lead to failure of the project (Saaidin *et al*., 2016a). Likewise, contractor tends to mark up risk by putting additional price for contingency sum to cover the risk impact on the project (Saaidin *et al*., 2016b). By execution of risk management process, it will help the ability to identify potential risks and steps to be taken to avoid them are important aspect of project management. Therefore, the objective of this study is to identify and assess the risk impact on DB project in Malaysia.

Definition of risk: Risk is defined as a probability of miscarriage, loss and jeopardy. Risk is identified as chances or arguments that create an impact to possibility of deprivation or wound in terms of cost, time quality of probability (Ogunsanmi *et al*., 2011). Risk is categorized as a factor that causes the problem to progress work and achieve objective project success. Risks cannot be eliminated but it can be shared and transferred to minimize impact on the project. However, it needs to be identified, quantified and understood first before it can be managed properly.

Risk assessment is complex and depends on the degree of discernment and professionalism of individual

Corresponding Author: Sabihah Saaidin, Faculty of Civil Engineering, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

interpreted risk. Project team view risk from the technological perspective, head of department or institution's interpretation risk from the economic stability and financial side, safety and health organization views it in terms of a safety and environmental perspective (Baloi and Price, 2013).

The construction industries are wide-open to high risk such as costing, time constrains, quality expectation and contractual disputes. Thus, mills describes construction industry as an interesting, risky and changeable field. Construction industries are critical because of the difficulty in the activities involved. Thus, each project is unique and regularly integrated with new techniques and procedures (Modupe *et al*., 2012).

The clients, contractors and consultants should rethink their approach to treat risks in the organizations. Common risks involved in construction projects include scope of work changes, financial issue, material and labour disputes, equipment and material availability, quality and safety issue, geotechnical issue, political uncertainty, changes in government regulation, permits and ordinances, delays in resolving litigation/arbitration disputes, inflation, cost of legal process and force majeure (Modupe *et al*., 2012).

However, the construction industry is plagued with the most amount of risk compared to other industries. The inability to complete project on time and within budget continues to be a chronic problem worldwide and is worsening.

Risk impact on design build project: Modupe *et al*. (2012) identified in their finding the most prominent of risk factor and risk impact in DB project in terms of time, cost and quality. There are 19 risks which impact in terms of time namely changes in quality/scope of work, inflation, exchange rate fluctuation, owner and contractor experience, contract award and method, error or omission revealed during construction, owner delay (lack of payment/delay progress payment) and catastrophes. The level of risk impact in term of time on DB project is changes in quantity/scope of work, permit and approval. While, the level of risk impact on quality is quality control and assurance, constructability of design, construction defects, inadequate of specification, etc.

Ogunsanmi *et al*. (2011) concluded 35 risk impacts to DB project mainly classified with three categories, 19 risks related to cost, 21 risks related to time and 10 risks related to quality. Saloka (2010) categorized in their finding as the most risky impact to the DB projects are combination of design activities on site supervision and participation in the actual construction project by the contractor that lead to the high degree of risk over the entire project.

MATERIALS AND METHODS

This study captured the opinions of Malaysian construction industry practicing in DB projects on the issues of the identification and assessment of risk impacting on DB projects. A research questionnaire was designed to elicit information from respondents namely client, consultant and contractor. A comprehensive list of 64 risk factors was identified in literature review and used in the questionnaire survey. The first section of the questionnaire solicited demographic information about the respondents. The second section consists of two parts of 64 risk factors. The two parts were related to the probability and impact of each risk factor in DB project on a five-point Likert scale. The scale for risk probability ranged from (low), (slightly low), (medium), (slightly high) and (high). Meanwhile, the scale for risk impact ranged from (insignificant), (minor), (Moderate), (Major) and (catastrophic). A total of one hundred seventy questionnaires were received from the clients, consultants and contractors. The results were analyzed by using descriptive statistics and Spearman's rank correlation test.

RESULTS AND DISCUSSION

Spearman's correlation analysis is a bivariate analysis that is to evaluate the strengths between two different variables. The risk probability and risk impact were ranked separately, indicating the "degree of risk" values. The statistical package for the social science software was used to carry out Spearman's correlation analysis. The Equation 1 indicates that 0.97 ($p>0$ and p close to 1) is the value of Spearman's correlation coefficient. The value of Spearman's correlation analysis indicates a positive and strong agreement from three parties (client, consultant and contractor) in their discernment on each of the risk factors and positive and perfect correlations among the ranks of risk factors impacting in DB projects. Hence, the top 10 risk factors are reliable for predictive modeling. The Spearman's correlation coefficient (p) is calculated using Eq. 1 and detailed as in Appendix 1:

$$\text{Spearman's correlation coefficient (p)} = 1-\frac{6\sum d^2}{n(n^2-1)}$$

$$\frac{1-6\times1490}{64(64^2-1)} = 0.97 \quad (1)$$

Based on the overall results, the risk factors in DB project were shown in Table 1 all 64 numbers of risk factors perceived by respondents were analyzed and

Table 1: Impact of risk factor in design and build project perceived by respondents

Descriptive statistics	Risk probability (P)	Risk impact (I)	Degree of risk (P×I)	Rank
Inadequate cash flow by contractor	4.029	4.188	16.876	1
Client financial capability	3.871	4.165	16.120	2
Delay in commencing work because under-estimated time needed to obtain statutory	4.035	3.924	15.833	3
Mistake during construction	3.859	4.071	15.708	4
Lack of payment (delayed progress payment by owner to the contractor)	3.894	4.029	15.691	5
Lack of design/build knowledge/experience/competency	3.800	4.094	15.558	6
Insufficient time for completion date	3.818	4.012	15.316	7
Lack in quality control and assurance	3.812	3.953	15.068	8
Lack of project manager competency and authority	3.782	3.971	15.018	9
Contractors lack of staffs knowledge/experience	3.747	3.994	14.966	10

ranked accordingly to fulfill the objective of this study. The result only shows the top 10 most important risks that impact on DB project as indicated below. Inadequate cash flow by contractor was ranked first with 16.876. Inadequate cash flow is mainly contributing to the risk impact in DB projects. Besides having an experience in DB project, clients also have good insights during selection of contractor for DB project and choose main criteria on financial capability by contractor are important (Saaidin *et al*., 2016a).

Client financial capability was ranked second with 16.120. Clients play important roles in contributing to the success of the DB projects. Besides having clear definition information about design and construction in DB projects, clients are also required to have a strong financial capability for each project involved. DB project is normally large and complex which require large capital scale. The clients are required to provide sustained capital supply for the DB project with less risk transfer to the contractor. Otherwise the contractors will markup the higher price in contingency sum and additional profit to compensate the extra risk that occurs during construction stage (Saaidin *et al*., 2016).

Delay in commencing work because of under estimating time needed to obtain statutory was ranked third with 15.833. The importance of discussion and communication among the stakeholders during design phase is to prevent the delay of commencing work. The contract planning department is responsible to calculate the duration for the entire project by considering all the circumstances based on previous experience (Saaidin *et al*., 2016).

Mistake during construction was ranked fourth with 15.708. Design change or mistake of original design that contributed to the mistake during construction. Effective of communication on design in between client and contractor will reduce of occurrence the risk impact to DB projects. It is because in DB projects, normally at the beginning stage of the project the design document are often change and a lot of decision making are makes during execution of the project. The important of closely coordination client with contractor are also avoiding misunderstanding or conflict occurred during construction stage of the project. The good relationship developing in between both parties will bring additional benefit to the project (Adafin *et al*., 2016).

Lack of payment (delayed progress payment by owner to the contractor was ranked fifth with 15.691. Delayed progress payment by client to the contractor is the main problem for contractor to run project smoothly. With this situation that is reflect to the sub-contractor for them to purchase the material from supplier and it causes of slow progress of work and effect to projects (Ren *et al*., 2008).

Lack of design/builder knowledge/experience competency was ranked sixth with 15.558. Knowledge/ experience/competency of design builder are most difficult to achieve. Only with big company and capital are experiences of the DB projects. This is because DB project involves unique and complex matters of the project itself. Meanwhile, Malaysia is also facing the difficulty to retain the client's experience in DB project. If the client has sufficient experience, the implementations of DB project become easier and they have sufficient information of the design ability. The experience of consultants or advisors should be employed at the initial stage of the DB projects to help contractor gain knowledge and experience.

Insufficient time for completion date was ranked seventh with 15.316. Delay of project contributed from insufficient time for completion. It is due to several reasons namely lack in design approval, lack of project manager competency, lack of resources and labour productivity. To mitigate this risk impact the stakeholders need to apply knowledge management and project learning among stakeholders. Lack of quality control and assurance was ranked eighth with 15.068. Quality control and assurance are important and should be the concern of project managers. Quality control must start during the design and planning phases rather than during construction. It is during these initial stages that the design and material specification performance are

decided. Therefore, the conformance of quality control during construction largely consists of these original design and planning decisions at the early stage of the projects. Lack of project manager competency and authority was ranked ninth with 15.018. Project manager competencies and authorities are most important in DB projects to achieve in managing on project cost, managing in project time and managing in project quality. The clients need to focus on these issues when selecting the project manager as they would have minimal effect on the project outcomes.

Contractor lack of staff knowledge and experience was ranked tenth with 14.966. Contractors should have sufficient staff in knowledge and experience to handle design and construction works. If the contractor does not have existing experience and knowledge staff for the DB projects, new recruitment should be employed. Otherwise, the contractor will face with the same problem which is cost overrun, time overrun and lack of quality expectation to occur. Contractors are advice to engage proficient technical staff for effective during construction project.

CONCLUSION

In developing countries which are involved in DB project, there are still many clients and contractors that are not familiar and not ready with DB projects. It will increase the risk factors that contributed to the impact of the project objectives in terms of cost, time and quality. The research finding indicates that the top 10 most important risk factors impacting on DB project should emphasize the following: inadequate cash flow by contractor, client financial capability, delay in commencing work because under-estimated time needed to obtain statutory, mistake during construction, lack of payment (delayed progress payment by owner to the contractor) lack of design/builder knowledge/experience competency, insufficient time for completion date, lack of quality control and assurance, lack of project manager competency and authority and Contractor's lack of staff knowledge/experience. By identifying the risk factors that impact on DB project will help the clients and contractors to evaluate and be cautious on the risk occurrence by considering them during the design stage.

APPENDIX

Appendix 1: Spearman's correlation coefficient

Descriptive statistics	Degree of risk (P×I)	Rank	Risk Probability (P)	Rank	Risk impact (I)	Rank	Spearman's correlation $d_1 = (P-I)$	Spearman's correlation d_2
Inadequate cash flow by contractor	16.876	1	4.029	2	4.188	1	1	1
Client financial capability	16.120	2	3.871	4	4.165	2	2	4
Delay in commencing work because under-estimated time needed to obtain statutory	15.833	3	4.035	1	3.924	12	-11	121
Mistake during construction	15.708	4	3.859	5	4.071	4	1	1
Lack of payment (delayed progress payment by owner to the contractor)	15.691	5	3.894	3	4.029	5	-2	4
Lack of design/build knowledge/experience/competency	15.558	6	3.800	8	4.094	3	5	25
Insufficient time for completion date	15.316	7	3.818	6	4.012	6	0	0
Lack in quality control and assurance	15.068	8	3.812	7	3.953	10	-3	9
Lack of project manager competency and authority	15.018	9	3.782	10	3.971	8	2	4
Contractors lack of staffs knowledge/experience	14.966	10	3.747	12	3.994	7	5	25
Lack of payment (delayed progress payment by contractor to the sub-contractor)	14.862	11	3.782	9	3.929	11	-2	4
Incompetent sub-contractors	14.718	12	3.718	14	3.959	9	5	25
Lack of teamwork	14.505	13	3.759	11	3.859	14	-3	9
Contractor's detailed design does not meet owner's expectation	14.413	14	3.729	13	3.865	13	0	0
Lack of coordination with sub-contractor	14.143	15	3.671	16	3.853	15	1	1
Complexity of the project	13.754	16	3.671	15	3.747	22	-7	49
Lack of communication of design/builder with end users to meet their requirements	13.752	17	3.653	17	3.765	20	-3	9
Lack in effectiveness of communication in design	13.729	18	3.635	18	3.776	18	0	0

Appendix 1: Continue

Descriptive statistics	Degree of risk (P×I)	Rank	Risk Probability (P)	Rank	Risk impact (I)	Rank	Spearman's correlation $d_1 = (P-I)$	d_2
Supplies of defective materials	13.679	19	3.594	23	3.806	16	7	49
Lack in availability of skilled labour	13.663	20	3.624	20	3.771	19	1	1
Errors of original design	13.661	21	3.612	21	3.782	17	4	16
Unforeseen site condition	13.621	22	3.629	19	3.753	21	-2	4
Lack of training on safety at site	13.318	23	3.582	24	3.718	24	0	0
Lack on supervision of labour and works	13.299	24	3.600	22	3.694	26	-4	16
Insufficient communication between team member to meet project success	13.189	25	3.559	29	3.706	25	4	16
Late deliveries of materials	13.185	26	3.535	31	3.729	23	8	64
Lack of information on safety at site	13.170	27	3.582	25	3.676	29	-4	16
Scope of work is uncertainty	13.127	28	3.565	28	3.682	27	1	1
Unidentified utilities	13.043	29	3.571	27	3.653	31	-4	16
Insufficient of original design	13.002	30	3.576	26	3.635	32	-6	36
Team members are not participating in technical discussions with owners	12.874	31	3.553	30	3.624	33	-3	9
Lack in availability of equipment	12.651	32	3.441	34	3.676	28	6	36
Difficulties in availability of materials	12.483	33	3.412	38	3.659	30	8	64
Delay in design approval from client	12.470	34	3.447	33	3.618	34	-1	1
High current workload to contractor	12.451	35	3.453	32	3.606	35	-3	9
Insufficient information in	12.205	36	3.429	36	3.559	36	0	0
Inadequate specification in contract document	12.084	37	3.429	35	3.524	38	-3	9
Insufficient information of site access/right of way	12.040	38	3.400	39	3.541	37	2	4
Lack of suitable organizational structure	11.815	39	3.359	43	3.518	39	4	16
Insufficient time to evaluate tenders from sub-contractor	11.781	40	3.412	37	3.453	43	-6	36
Change of original design from client	11.757	41	3.371	40	3.488	42	-2	4
Legal disputes during the construction phase among the parties of the contract	11.694	42	3.341	45	3.500	41	4	16
Lack in preparing method statement or shop drawings by contractor	11.539	43	3.365	42	3.429	46	-4	16
Exchange rate fluctuation/devaluation	11.497	44	3.335	47	3.447	44	3	9
Slow approval permit by BOMBA department	11.457	45	3.335	46	3.435	45	1	1
Lack of information in drafting request for proposals to sub-contractor	11.360	46	3.365	41	3.376	50	-9	81
Insufficient time in preparing tender documents to sub-contractor	11.242	47	3.347	44	3.359	53	-9	81
Actual quantities differ from the contract quantities	11.182	48	3.324	48	3.365	52	-4	16
Slow approval permit by local authorities	11.162	49	3.306	49	3.376	51	-2	4
Slow approval permit by town planning department	11.120	50	3.276	52	3.394	48	4	16
Redesign because of over budgeted	11.062	51	3.271	53	3.382	49	4	16
Owner lack of knowledge and experience	11.060	52	3.259	54	3.394	47	7	49
Insufficient time during request for proposal to sub-contractor	11.005	53	3.288	50	3.347	56	-6	36
Bureaucracy in government agencies	10.966	54	3.276	51	3.347	54	-3	9
Slow approval permit by public work department	10.790	55	3.235	55	3.335	57	-2	4
Catastrophes (Act of God)	10.741	56	3.059	60	3.512	40	20	400
Poor supervision by the client	10.710	57	3.200	56	3.347	55	1	1
Inflation	10.445	58	3.176	57	3.288	59	-2	4
Lack of standardised systems during tender evaluation	10.180	59	3.129	58	3.253	60	-2	4

Appendix 1: Continue

Descriptive statistics	Degree of risk (P×I)	Rank	Risk Probability (P)	Rank	Risk impact (I)	Rank	Spearman's correlation $d_i = (P-I)$	d_2
Tax rate exchange	10.174	60	3.094	59	3.288	58	1	1
Change in government policy	9.8570	61	3.041	62	3.241	61	1	1
Change in government regulations and law	9.8010	62	3.029	63	3.235	62	1	1
Rigid specifications in contract document	9.6250	63	3.047	61	3.159	64	-3	9
Political uncertainty	9.6210	64	3.018	64	3.188	63	1	1
Total $\sum d_i^2 =$	-	-	-	-	-	-	-	1490

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