Risk Identification and Impact Analysis of Early Involvement of Contractors in the Melbourne Construction Industry

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Abstract - A majority of construction projects never get completed on time. Delays and cost overruns are the major problems that construction industry around the world face. Construction delays have big implications on the society and its economy which disturbs the process of development. Australia has not been prone to this problem either. This paper aims to identify critical risk factors responsible for project delays and cost overrun and, explore the possibility of mitigation of risk by Early Involvement of Contractor. A literature review is done to identify common factors of project delays and cost overruns. Based on the common findings of the literature 15 factors were identified and a questionnaire set was designed around these factors. Data was collected from 42 respondents who represent project owners, consultants, contractors and other practitioners in the construction industry in Melbourne, Australia. Data was analyzed using relative importance index (RII) as this tool has been widely used in the literature. The analysis indicates that majority of the delay factors originate from the clients and consultants with few from contractors and external forces. Findings also suggest that Early Contractor Involvement can lead to minimization of risks by huge percentages due to better integration of Design and Construction.

Index Terms - Construction Delays, Risk Factors, Early Contractor Involvement (ECI), Relative Importance Index (RII).

I. INTRODUCTION

Construction industry has always been synonymous with delays and cost overrun. Construction industry in many countries contribute to a large part of the Gross Domestic Product and delays could impact the stakeholders like the clients, contractors, government and end user severely. In construction industry timely completion of a project is a major criterion of project success, Rwelami and Hall (1995) and very rarely projects are completed on time Assaf & Al-Hejji (2006). A good understanding of delay factor is important as this can enable designers, consultants and clients to build up a mitigation plan.

The construction project design developed by the clients/consultants may include unnecessary details and liabilities that would tie the hands of the contractors during the execution phase of project management. Arguably, the contractors cannot add much value in increasing "*buildability*". A "*design and dump*" to the contractor by the client, therefore, is widely argued that it brings little benefit to the client and pose difficulties to the contractors causing project delays and cost overruns. Contractors tendering for the job may, in the rush to sign their contract, fail to realize the extent of the liability for the design they have taken on. It has widely been realized that many projects do not get completed on time or/and on cost due to risk factors. Project delays and time overruns are caused due to several factors, many of which are originating from contractors' side and many from clients' side besides market factors and natural calamities (Hatkar and Hedaoo (2016) and Menon, et al (June 2020). If the factors originating from clients and contractors are identified and mitigation strategies worked out from the initial stage of the project, the delays could be reduced, if not avoided. It has been learned that many clients, contractors and even design consultants believe that rather than following the traditional system where contractors are involved only in bid and construct, involving them from initial planning and design phase of the project could help reduce project risks and minimize project delay. It is in this context the study states "identification the project risk factors and possibility of minimizing them" as the broad research problem.

Although, in the construction literature, the factors causing the project delays and cost overruns is extensively researched, not so much has been found in the Australian construction industry particularly at the specific states and city levels. Melbourne, although is one of the major cities in Victoria with booming construction, it is difficult to find relevant literature when comes to this topic. This paper intends to focus at the construction industry in Melbourne, Australia and tries to find answers to the following questions:

- What factors constitute as project risk in the construction industry in Melborne that result in project delays and where do they originate from?

- Can the risks factors be better managed and delay intensity reduced if contractors are involved from early stage?

II. LITERATURE REVIEW

As it is intended to look at the project delay risk factors and further analyze if these risk factors can be mitigated by involving contractors from early stage of the project management phase, the work published by Adamu and et al (2017) on "Adopting Design and Build (D&B) as an Alternative Construction Procurement System to the Traditional Method in Ghana" throughs light in this direction. The traditional system (design-bid-construct -DBC) is one that has no room for involving contractors from the early stage whereas the (D&B) is a system that gives so much room to the contractors to be involved. They reported that seven risk factors were found to have been minimized due to adoption of D&C system - early involvement of contractors. These factors are: *uncertainty of project completion on time, legal risk is mitigated resulting to clarity on line of legal responsibility, time overrun risk is mitigated, there is better integrity of design and construction, projects start early on site, communication and business relation risk is reduced*. Similarly, Anandahl and et al (2017) did a comparative study between traditional system (where no contractor is involved) and "design and construct" system (where contractors are involved from an early stage) in Norwegian road projects. They argued that Norway has shown increasing preference for the design-build system as it is viewed to overcome the shortfalls of the traditional system. They explored, how executing agencies (owners and contractors) use the room for maneuver if contractors are involved from the planning stage of the project. Their findings suggest that D&B system in Norway has improved the *level of conflict management* between owners and contractors and the system is supported by the government since it is believed to have resulted in *cost and time efficiency*. In a similar manner, Ghadamsi and Braimah (2016) expressed that the traditional system is often blamed for poor project performance because it is not able to meet the requirement of modern construction projects that are more complex with numerous uncertainties. Design consultants with whom the clients separately enters into the contract for preparation of project documents, cost and time estimates are not always up to date about the local conditions which results into design errors that pose project risks. They argued that these risks can be minimized if contractors were allowed to comment on the design/project planning works done by the consultants.

Aljohani, Dagbui and Moore (2017) reviewed several literatures for seventeen nations covering countries in Asia, Africa, Middle East and a case of Australian highway construction project to find out what are the major project delay factors. They reported that generally in all the projects the following have been identified as the common project delay risk factors:

> *Delayed payment for completed work by the client, Inadequate project preparation and planning, Change in work scope and work orders, Inaccurate time estimation, Increase in material and labor cost, Shortage of skilled labor, Lack of project monitoring and Contractors' poor experiences.*

Venkatesh and Venkatesan (2017) also conducted an extensive literature review covering construction projects in both the developing and developed countries and they argued that the causes of project delays in developing countries mostly originate from clients and contractors (mostly internal to the project) however, in the developed countries the delay are governed by the external causes besides having some effect of the internal factors. The most frequently appearing delay factor, more so with developing countries, was identified to be the finance related. It was reported that the project implementing agencies and the contractors lack sufficient and timely fund and absence of financial discipline. Hatkar and Hedaoo (2016) collected primary data on seventy-six potential risk factors and ranked them using Relative Importance Index (RII). They identified the top ten risk factors based on the ranking. These were considered as the most critical risk factors that contribute to project delays.

> *Local political interference, Inadequate fund allocation by clients, Improper project planning and scheduling, Delay in progress payment by clients, Cost escalation of materials, Weather conditions, Delay payments by contractors to sub-contractors and suppliers, Insufficient equipment, Incomplete drawings by consultants and Natural disasters.*

They argued that the causes of delay originate mostly from all the three group of stakeholders (clients, consultants and contractors) and indicated that if all three work together in a coordinated manner from the early stage of the project, most risks can be minimized. Similarly study by Johnson and Babu (2018) covered construction projects in Dubai, UAE and applied RII ranking procedure for risk responses collected from 53 respondents inclusive of contractors, clients and consultants and identified *design variation from client and consultants* as the number one cause for project delays followed by *delays in decision making by the client*. On the other hand, *poor cost estimates, financial constraints of the clients, lack of risk management* were found to result in cost overruns.

A very recent study in this area by Menon, et al (June 2020) gathered data for fifty-five variables commonly reported from the earlier studies and tried to identify which among them are attributing to cost overrun in the construction industry in Pakistan. Having collected the data from thirty-three respondents, they calculated average index (AI) which is not much different from RII except or a common denominator throughout. Conclusion from both AI and RII in any case remains undisputedly the same. They found out that the following key risk factors have caused delays and cost overruns in Pakistan.

> *Delay in obtaining permits from the government agencies, financial difficulties faced by the contractors, delay in material procurement, high cost of machinery and maintenance, inaccuracy in cost estimation, delay in progress payment by owners and inadequate planning and scheduling.*

Wong and Vimonsatit (2012) published on "factors affecting construction time" representing a Western Australian case. They reviewed literature of several countries and identified 48 potential project delay factors. Based on these risk factors they developed a questionnaire, administered with 32 respondents covering contractors, consultants and clients from Perth, Western Australia. They ranked these factors using RII. Their findings suggest that the most important causes for project delays are *skill shortage, financial difficulties, unrealistic time estimates, unforeseen ground*

conditions, poor communication between project parties, poor organizational capacities of contractors and consultants, delayed decision making and design errors.

As stated earlier, there are many studies in the literature that have looked into the project risk factors, not much has been found in the Australian construction industry, particularly representing Melbourne construction sector. Further, the earlier studies are mostly qualitative and the few that followed quantitative approaches have used average index (AI) or/and relative importance index (RII) in estimating the project risk factors that cause delays and cost overruns. However, the differences in RII and AI for "with and without" involving contractors from the early stage have rarely been studied although there is general perceptions that the project risk factors can be minimized if contractors are involved and consulted from the initial project phase rather than following the *design and dump* approach. This paper aims at identifying the main project delay risk factors for both with and without involvement of contractors from the initial project phase in the Melbourne construction industry.

III. RESEARCH OBJECTIVES

Given that not many studies are found on causes of project delays at the state and city levels in Australian construction industry this paper sets the following objectives for investigation.

3.1 identifying the project delay risk factors and their sources and rank them using relative importance index (RII) to see which factors pose greater risk for project delays and cost overruns.

3.2 analyzing if the project delay risk factors can be minimized with involvement of contractors from the early stage of project planning.

IV. RESEARCH METHODOLOGY

For this study, a structured questionnaire is designed carefully selecting 15 main statements that represent potential risk factors. These statements are to be rated by the respondents in the scale of 1 – 5 where 1 stands for not a potential risk factor at all, 2 for somewhat a potential risk, 3 for moderate risk, 4 for strong risk factor and 5 for very strong potential risk factor. Each statement is to be rated twice once for a situation where contractors are not involved from the early stage of project planning and the other where contractors are involved. Finalized questionnaire after pilot testing was mailed to 150 respondents covering contractors/their representatives in the field, clients/their representatives in the field, architect/design consultants and others who represent professional group in the construction discipline. However, not many would like to spend time to fill up the questionnaire. Fourty-two validly filled in forms were received back and the sample distribution by category of respondents is presented in Table # 1.

Table # 1 Sampling Distribution

Respondent Category		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	ContractorsContractors' Representatives/	16	38.1	38.1	38.1
	ClientsClients' Representatives/	9	21.4	21.4	59.5
	ArchitectDesigners/	8	19.0	19.0	78.6
	Others representing professional group in the industry	9	21.4	21.4	100.0
	Total	42	100.0	100.0	

In order to identify the main project risk factors from amongst the 15 potential factors that were included in the questionnaire, RII approach was applied in ranking the risk factors. Overall average risk of all the factors was used as benchmark. Any factors with higher than the overall average risk was considered as the key risk factors. RII for each risk factor is calculated once for the scenario "with involvement of contractors from the early stage and without involvement. Risk reduction percentages were calculated using differences between two scenarios.

$$RII = \Sigma W/(A \times N) \quad (1)$$

Where,

W = Weightage given to each factor by the respondents

A = Highest weight (i.e., 5 in a scale of 1 - 5)

N = the total number of respondents

∑ = sum.

V. FINDINGS AND DISCUSSIONS

In this section, the research results are placed sequentially based on the research objectives. Firstly, the report presents the findings on identification of main risk factors followed by factors ranking based on RII and their sources. This is followed by result presentation and discussion on magnitude of risk reduction when contractors are involved at the early stage of the project.

5.1 Identification of Main Project Risk Factors

The table # 2 is produced based on the risk ratings on 15 risk factors assuming that there is no involvement of contractors from the early stage. The overall RII average of 15 risk factors that are perceived to be causing project delays and cost overruns is found to be 0.73. Of the fifteen factors, the paper identified nine factors whose RIIs are greater than or equal to the overall average. This paper considers these nine factors with

greater than 0.73 RII as the main risk factors. The top nine risk factors have RII ranging from 0.73 to 0. 86. *Improper analysis of project risk and mitigation measures by consultants and clients* has the highest RII at 0.86 among the top nine and *underestimation of cost by the client* stands at ninth place with 0.73 . They are placed in descending order table.

Table # 2 Project Delay RISK Factors

Risk Factors	RII	Ranks
Improper analysis of project risks and mitigation measures by consultants and clients	0.86	1
Frequent changes in the scope of work from clients' sides	0.84	2
Misleading drawings and project information by consultants	0.83	3
Delay in decision making by the client	0.82	4
Lack of skilled professionals	0.80	5
Underestimation of project duration by clients & consultants	0.76	6
Poor project risk management by the contractors	0.74	7
Failure of contractors to mobilize project resources such as labour, material and technology	0.73	8
Under estimation of costs by contractors to get the award	0.73	9
Delays in decision approving work variations by the consultants	0.69	10
Frequent conflicts between the clients and contractors due to lack of communication	0.68	11
Lack of materials in the local market	0.67	12
Poor fund management by the contractors	0.61	13
Unpredictable weather conditions	0.59	14
Delays in payment for completed works by client to contractors	0.58	15
Overall Average RII	0.73	

Even those factors that have lower than 0.73 range between 0.58 – 0.69 RII. It has been found that the top nine factors pose greater than the average risk. Based on the RII ranking, as *improper analysis of project risks and mitigation measures by consultants and clients* seems to have the highest potential risk, it is closely followed by *frequent changes in the scope of work from clients* and *misleading drawings and project information by the consultants at (RII =0.84) and misleading drawings and project information by consultants at (RII =0.83)*. Of the 15 risk factors assessed, delays in payment for completed works by the clients, poor fund management by the contractors and unpredictable weather conditions are found to be comparatively less frequently experienced by the actors in the construction industry in Melbourne. This finding is quite similar to Venkatesh and Venkatesan (2017) who argued that the project finance related risk factors are less of a problem in the developed countries in comparison to projects in developing countries.

5.2 Sources of Project Risk Factors

The top four risk factors that have much higher than the average RII are found to be have their sources either with consultants or/and clients. These are *Improper analysis of project risks and mitigation measures by consultants and clients, Frequent changes in the scope of work from clients' sides, Misleading drawings and project information by consultants and Delay in decision making by the clien*t. Although, there are three risk factors originating from contractors' side, these are at the lower risk ranks among the top nine factors. The main risk factors that have sources with contractors are *poor project risk management, underestimation of cost to get the work award* and *failure to mobilize project resources*. These risks, originating from contractors, have comparatively lower RII, very close to overall average of 0.73. *Unavailability of skilled manpower* which has the origin at the labour market (external) also poses quite a high risk to the project, (RII= 0.80). The analysis on the sources of risk finds that among the top nine main factors, five originate from the clients or/and consultants' side, three from the contractors' and one from the external source. The table # 3 presents the result.

Table # 3 Risk Factors and Sources

Risk Factors	RII	Ranks	Sources of Risk
Improper analysis of project risks and mitigation measures by consultants and clients	0.86	1	Clients and Consultants
Frequent changes in the scope of work from clients' sides	0.84	2	Clients and Consultants

Risk Factors	RII	Ranks	Sources of Risk
Misleading drawings and project information by consultants	0.83	3	Consultants
Delay in decision making by the client	0.82	4	Clients
Lack of skilled professionals	0.80	5	External
Underestimation of project duration by clients & consultants	0.76	6	Client and Consultant
Poor project risk management by the contractors	0.74	7	Contractors
Failure of contractors to mobilize project resources such as labour, material and technology	0.73	8	Contractors
Under estimation of costs by contractors to get the award	0.73	9	Contractors
Delays in decision approving work variations by the consultants	0.69	10	Consultants
Frequent conflicts between the clients and contractors due to lack of communication	0.68	11	All three project parties
Lack of materials in the local market	0.67	12	External
Poor fund management by the contractors	0.61	13	Contractors
Unpredictable weather conditions	0.59	14	External
Delays in payment for completed works by client to contractors	0.58	15	Clients
Overall Average RII	0.73		

5.3 Risk Reduction with Involvement of Contractors from the Early Stage of Project

The other objective of this research was to find out the percentage differences in the risk between two scenarios, *with and without involvement of contractors* from the early stages. In Table # 4, the percentage difference in RII has been calculated. A huge gap between with and without involvement of contractors have been noticed. The perception of respondents on risk ratings is much higher when for a situation where there is no involvement of contractors from the initial stage (see column RII-A) in the table. Figures under RII-B column indicates the risk index for a scenario where contractors are involved from the early stage of the project. In all the nine risk factors that pose above average risk to the project, it is found that there is huge scope for risk reduction in contractors are involved. It is also seen that the factors with higher RII also has greater possibility of risk reduction with involvement of contractors. The highest risk reduction is seen with Improper analysis of project risk and mitigation measures by consultants and clients at 43% followed by frequent changes in the scope of work by the clients and misleading drawings and project information by the consultants at 40% and 41 % respectively. These are also the factors that are experienced to have posed the highest risk for project delays and cost overruns in Melbourne. If 21% to 43% of the perceived risk can be minimized among the top nine factors, the remaining factors also have risk reduction scope between 9% to 21%. On the whole, substantial risk reduction is possible in all the risk factors if involvement of contractors is practiced in the project planning and implementation process from the initial phase of the project rather than involving them only from the bidding stage.

Table # 4 RII Reduction Percentages

Risk Factors	**RII-A**	**RII-B**	**% of Risk Reduction**
Improper analysis of project risks and mitigation measures by consultants and clients	0.86	0.50	43%
Frequent changes in the scope of work from clients' sides	0.84	0.51	40%
Misleading drawings and project information by consultants	0.83	0.49	41%
Delay in decision making by the client	0.82	0.64	22%
Lack of skilled professionals	0.80	0.58	28%
Underestimation of project duration by clients & consultants	0.76	0.48	37%
Poor project risk management by the contractors	0.74	0.53	29%
Failure of contractors to mobilize project resources such as labour, material and technology	0.73	0.58	21%
Under estimation of costs by contractors to get the award	0.73	0.58	21%
Delays in decision approving work variations by the consultants	0.69	0.55	21%

Risk Factors	RII-A	RII-B	% of Risk Reduction
Frequent conflicts between the clients and contractors due to lack of communication	0.68	0.62	9%
Lack of materials in the local market	0.67	0.53	21%
Poor fund management by the contractors	0.61	0.54	11%
Unpredictable weather conditions	0.59	0.52	11%
Delays in payment for completed works by client to contractors	0.58	0.48	17%

VI. CONCLUSION

Of the 15 risk factors analyzed a total of nine factors that have risk RII scores of above the overall average (0.73) are identified as key risk factors in Melbourne construction industry. The key ones that originate from the clients and consultants are "*improper analysis of project risks and mitigation measures by consultants and clients followed by frequent changes in the scope of work from clients' sides, misleading drawings and project information by consultants, underestimation of project duration by clients and consultants, and "delay in decision making by the client"* . All these factors that originate from the clients and consultants have higher risk magnitudes. From the contractor's side there are three factors: *poor project risk management by the contractors, underestimation of costs by contractors to get the award, failure of contractors to mobilize project resources such as labor, material and technology* in the group of top nine . The findings are quite similar to what the earlier researchers have found. Of the eight factors identified by Aljohani, Dagbui and Moore (2017), four of them that are very similar the ones identified by this paper, had the source with consultants and clients. Hatkar and Hedaoo (2016) and, Wong and Vimonsatit (2012) who employed the similar research methods as this paper also reported very similar factors originating from the consultants and clients group. The risk originating from the contractors, although varied from researchers to researcher in terms of their magnitude, more or less, the types of risk factors were similar to the findings of this research. Shortage of skilled manpower in the market was reported by most of the researchers as one of the market-risk that tallies with this paper.

When the paper attempted to analyze if these risks can be mitigated or reduced with involvement of contractors from the initial stage of the project, the findings suggests that percentage of risk reduction in each risk factor will be substantial, as high as 21% to 43% among the top nine. As it is noticed that the more probable and more frequently experienced risk factors in Melbourne construction projects have higher possibilities of risk minimization.

While one question may arise as to why would the risk be reduced when contractors are involved from the initial stage as against the scenario of engaging them only at the construction phase. Ghadamsi and Braimah (2016) had reported that when contractors are engaged only at the construction phase, *the parties land up negotiating for design rectifications, additional scope of works, project schedule and cost corrections.*

Obviously, given the findings of this paper backed by the available literature, one could reason out that if they are engaged from the beginning, misunderstanding that could arise at a later stage could be discussed, each party's views and comments incorporated and the risk mitigation measures put in place so that the project delay is reduced.

Finally, this paper recommends involvement of contractors from the beginning as opposed to the traditional approach where they are engaged only for the construction phase after bidding is complete. Since this research is based on the data from Melborne area alone with limited samples, the future researches could expand the study with larger sample to validate the findings. To generalize the findings for Australia or for that matter even for Melbourne construction industry, one has to keep in mind that this study is based on convenience sampling, basically sending questionnaire through mails and as such it is difficult to confirm that the respondents had given serious thoughts while filling up the forms.

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