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Research paper

A review of causes of delay in construction projects

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Abstract

Time is one of the keys by which project success can be measured. However, delay in construction projects remains a common occurrence. This paper attempts towards reviewing past literature on causes of delay in different types of construction. The most common methods adopted by researchers for causes of delay identification were presented. This review also discussed the groups causing delay based on the source of delay. The top five delay factors related to contractor, owner and consultant have been discussed within each category. This paper revealed that previous researches are regarded as the main source for causes of delay identification. Moreover, questionnaire and the relative importance index are the most frequent methods for collecting data and ranking delay factors, respectively. Contractor, owner and consultant groups are the highest frequent groups utilized for categorization. Furthermore, causes of delay related to contractor and owner are of great importance. While consultant group and its relevant causes have shown lesser importance relatively.

Keywords: *Causes of Delay; Construction Projects; Risk Management; Time Overrun.*

1. Introduction

It is generally known that time is one of the key indicators by which the project success is examined [1]. However, regardless the location, type of construction and ownership, delay in project completion remains a common occurrence [2]. Delay is the time that exceeds contract duration or the agreed time between project parties [3]. When delay takes place, several adverse consequences may appear such as extra cost, profit loss reaching to disputes between project parties [4]. The evidence of that comes from variety of studies conducted in different countries. For instance, it has been found that more than half of public construction projects in Jordan were completed beyond planned completion period [5]. While the percentage increases considerably in Ethiopia reaching to 80% in road projects field [2]. Furthermore, almost the same percentage as previous has been recognized in bridge construction in Nepal where 16 of them out of 82 exceeded the contract period by more than 100% [6].

Late time completion can be generated from variety of reasons. Some causes are related to individuals in the project , others related to resources and few are beyond control such as weather conditions [7]. It is believed that construction projects have more risks due to multiplicity of stakeholders involved [8]. Although each party seeks to make great profits through completing the project in a timely manner, many causes of delay are always attributed to them. In fact, contractors, owners and consultants have the greater influence on project delay [9, 10]. For this reason, causes of delay related to contractor, owner and consultant were reviewed.

2. Causes of delay identification

Risk identification is regarded as starting point of risk management where risks that could affect the project and their characteristics are recorded [11]. Risks may appear at any time, especially for those beyond control, that is why risk identification is an iterative process and repeated through the project [12]. However, when risks are identified during the third part of project duration, they can be managed better for contractors [13]. In contrast to this, it has been argued that the estimation of cost and time overrun can be performed more effectively when identifying risks in the bidding stage [14].

Seeking for understanding construction delays, contractors, owner and consultant are commonly targeted in a purpose of analysing their perceptions about risks. Most of reviewed publications examined risks causing delay through all project phases from different perspectives. However, in a study in Sri Lanka, the causes of delay in construction phase have been considered and a total of 51 factors have been analysed [15]. In Saudi Arabia, the researchers examined delay factors from owner point of view only [16], [17]. While the emphasize was placed on public projects in another [18].

The tools and techniques for identifying risks are varied. Adopting a certain method depends on the availability of the relevant sources, historical data and the nature of the study. That what makes researchers follow a certain method. In this regard, two practical approaches for causes of delay identification have been adopted more frequently. The first approach depends heavily on the literature if available where initial factors could be listed. Since each study has different scope, the confirmation of the list needs to be conducted by qualified persons in the field. Based on expert comments, a list of delay factors is then established. The second approach is undertaken when the literature is not sufficiently available. It begins with reviewing similar past projects, records and their documents. Subsequently, a comparison with available literature or expert evaluation is made. Finally, a theoretical framework could be established and prepared for the next stage. It is worth mentioning that some researchers seek to conduct both case studies and project documents review to address delay factors. This is similar to a university case study conducted in Saudi Arabia and the most important factors were outlined in parallel with literature [17]. In such cases, the resulting factors could be location and project specific.

3. Data collection and analysis

After identifying causes of delay based on previous steps, data collection stage begins. In this stage, the proper instrument with respect to research objectives is selected. Apart from few countable studies, all the remaining adopted questionnaire as the main instrument. The targeted population commonly recognized in previous works to fill out the questionnaire comprises three main parties, namely: contractors, owners and consultants. This is the general case when the main objective is to explore causes of delay from party's perspectives combined or separately. In other cases, however, it depends on the expected outcomes of each research. For example, in two studies owners were targeted only since the main goal was to assess delay factors according to their opinions [16], [19]. While the focus was on developer's and contractor's point of view in Malaysia and Palestine, respectively [20], [21].
The analysis stage is curried out after receiving answers from targeted sample. Since the agreed objectives through all reviewed publications are to identify and rank factors causing delay, the importance of each factor is assessed based on the responses obtained. Several methods and techniques have been utilized for achieving this goal. These methods normally lead to a set of factors that should receive more attention than the others. It has been realized that the relative importance index (RII) is regarded as the favourite method for ranking causes of delay followed by importance index technique in which the frequency and severity for each risk are multiplied. The use of the remaining techniques was considerably smaller. Data analysis methods and their descriptions are shown in Table 1. All the methods discussed and presented in the table are basically preceded by conducting a questionnaire survey.

Table 1: Data Analysis Techniques and Their Descriptions

Technique	Equation	Description
Relative importance index	$RII = \frac{\sum W}{A*N}$	W: Weight given to each cause by respondent ranges from 1 (not significant) to 5 (extremely significant) A: The highest score i.e. 5 in this case N: Total No. of respondents
Frequency index	$FI\% = \sum \frac{a*n*100}{5*N}$	a is the constant expressing weight given to each response ranges from 1 (never happen) to 5 (always) n: Frequency of the response N: Total No. of respondents
Severity index	$SI\% = \sum \frac{a*n*100}{5*N}$	a is the constant expressing weight given to each response ranges from 1 (no influence) to 5 (very high) n: Frequency of the response N: Total No. of respondents
Importance index	$IMP.I. = FI * SI$	
Mean score	$MS = \frac{\sum W*n}{N}$	W: Weighting number n: total score of frequency N: Total No. of respondents

4. Groups causing delay in construction projects

Most often, researchers attempt to organize delay factors within categories by which the analysis becomes much easier. The purpose of this process is to explore the main source and responsible for delay. These groups are not fixed but vary from study to another. They can be referred to professionals in the project, resources and other external factors. However, some studies were conducted without grouping risk factors into any category. More than 20 names of delay groups have been recognized through literature. Usually, according to the source of delay, delay groups can be established [1]. For instance, delay factors in Sudanese roads were divided into 7 groups, namely: contractor, consultant, owner, material, labour and equipment, project and external [22]. While four groups has been established in another (contractor, owner, consultant, external) [20]. Within Kenyan road sector, a total of 141 delay causes were classified into 25 groups [23]. In private sector in Jordan, equipment, labour and materials were treated as a major group and named as production elements [24]. Similarly, on a study in Thailand, causes of delay related to site and environment were formed and analysed as one category [25]. This indicates that the groups can be fairly created based on researchers view proportional with literature review. In principle, the name of the group reflects the nature of the factors involved in each one whether financial-related, design-related, contractual-related or others. Other potential groups in addition to above-mentioned ones used for classification are: contract, rule and regulation, scheduling and controlling, managerial, construction, government, communication, logic, interface, process and authority. Fig. 1 shows the most frequent 10 delay groups utilized for classification.

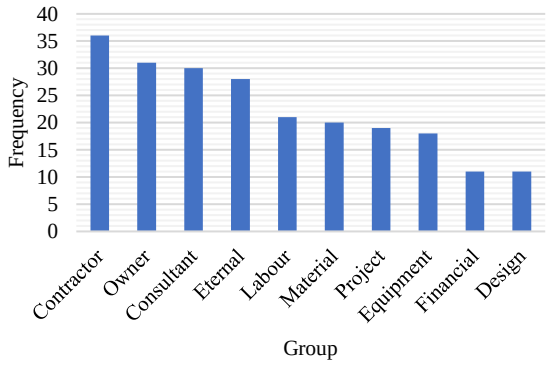

Fig. 1: Most Frequent 10 Delay Groups Utilized for Classification.

According to Fig. 1, it can be noticed that professional's groups are the most preferable groups utilized for causes of delay categorization.
It has been realized that the same factors can be placed in different groups, for example, the cause " low productivity of labour" placed in contractor group [26] can be placed in labour group [3], the cause "inadequate experience of contractor" placed in technical group [27] can be placed in contractor group [28]. Therefore, in most cases, the ranking of delay groups depends number of factors involved in each group, that is, calculating the overall scores of all factors in each group and considering the average. As a second approach, the ranking can be obtained by evaluating these groups directly and separately from their causes.

Table 2 presents the number and importance of delay groups according to overall result where available.

From the sample presented in

Table 2, it can be observed that the causes of delay are divided into 7 to 10 groups. Therefore, it is fair to make comparison between them. The overall results indicate that contractor and owner groups are the most important groups causing delay. Both tow groups were prioritized among the first four most of the time. Consultant was given the least importance within professional's groups. In fact, this group was ranked between third and seventh in all studies. In Arabic countries such as Egypt, Iraq and Palestine, the situation is slightly different where equipment-related problems obtained higher significance. However, contractor and owner groups remaines in a critical position. Comparatively with other countries, equipment group gained lower importance. As mentioned earlier, two groups could be merged forming one group.

For instance, labour and equipment were regarded as a single group and ranked second and third in Egypt and Malaysia, respectively.

For the remaining groups the ranking was inconsistent through studies presented in the table.

Table 2: Overall Ranking of Delay Groups

	Arabic countries					Others							
Reference	[1]	[12]	[29]	[30]	[31]	[11]	[18]	[32]	[33]	[10]	[7]	[25]	[34]
Group\ No of groups	8	15	7	9	10	8	8	8	9	7	7	10	8
Contractor	4	3	3	1	2	3	4	3	5	2	-	4	1
Owner	2	10	1	3	3	6	3	-	1	1	4	1	4
Consultant	7	6	6	6	4	6	-	7	3	3	-	3	7
External	5	14	7	8	9	8	2	-	9	7	-	-	8
Labour	3	12	2	9	7	2	8	8	8	4	3	5	3
Material	1	4	5	8	8	7	6	5	2	6	-	-	2
Project	6	13	4	4	6	-	1	-	-	-	7	-	-
Equipment	1	1	2	2	5	3	5	8	8	5	-	-	3
Financial	-	7	-	-	-	1	-	-	-	-	4	6	-
Design	8	2	-	5	1	-	7	4	-	-	-	-	-

4.1. Contractor-related causes of delay

Completing the project on time, within the budget and in accordance with the specifications is the desired goal for project's professionals. However, lots of barriers that may lead to late delivery of works are attributable to the contractor [11]. Although many causes are interconnected between project parties, it is believed that more responsibility lies on the contractor for project delay [20, 35]. During the review of previous works, more than 45 different delay factors related to contractor have been observed. Some of these causes can be mainly summarized by mismanagement, poor resource handling and appointment of unqualified staff [26]. This would result in poor performance and affect the completion of works in a timely manner. In addition, many delays fall on subcontractors because of inadequate work. But they claim that late payment by contractor causes this negative consequence [36]. Therefore, contractor should have enough capital as well as expertise in construction so that appropriate methods of construction can be implemented. In conjunction with project resources, it has been found that factors linked to labour are pivotal in this category [37]. In addition to that, shortage in materials and equipment and late delivery could affect the execution progress [38].

Table **3** presents the top five important delay causes related to contractor. The ranking of these factors, as well as those related owner and consultant, were presented when they were ranked among the highest twenty, otherwise, the symbol "*" indicates the existence of these causes in certain study but out of this rang.

Table **3**, the clear majority of previous researches identified at least two or three factors mentioned above. The first three causes were prioritized among the important ten repeatedly. Generally, different ranking can be seen through literature, but some similarities can be found. For example, poor contractor's management was in the highest six frequently in different types of construction. This factor was given second and third place three times and fifth place four times. The table indicates the importance of scheduling and controlling risk where it was pointed in second position twice as well as the first once. Financial issue was the highest risk causing delay in Egypt, Pakistan and Malaysia despite of being out of top-ten-rang four times in other countries. Although contractor experience factor was of crucial importance to some extent, it comprises with the last cause lesser significant than the causes discussed earlier.

4.2. Owner-related causes of delay

As far as owner is concerned, more than 50 different risk factors have been realized. Delays from owner side are attributed to financial status considerably. Deficiency in funding the project impacts individuals especially the contractor who is the main affected person by this issue [39]. If payment procedures adopted by owner are not smoothly performed, they would impact the ability to deliver the works on time. Furthermore, frequent change order made by owner disrupt contractor's schedule negatively [3]. In India, it has been reported that that low speed of decision making occurs due to poor communication between owner and other parties. Moreover, interface and change of scope by owner causes were found of great importance in the same country [27]. In addition, insufficient feasibility studies and contract modification during execution stage by owner contribute to project delay significantly [3].

According to **Table 4** presents the top five important delay causes related to owner.

Table 3: Ranking of Top Five Causes of Delay Related to Contractor

Reference	[40] [30]	[18] [31]	[41] [5]	[42] [33]	[32] [9]	[43] [10]	[12] [4]	[21] [22]	[7] [16]	[17] [27]	[26] [1]	[11] [28]	[44] [19]	[45] [38]	[35] [25]	[20] [47]	[29] [34]	[46] [3]	[37] [48]	[39] [49]
Delay causes\ Type of construction	H[a] C[b]	B[c] C	C C	RE[d] P[e]	C C	IN[f] T[g]	R R	R R	C IN	C C	R R	C C	R R	C B	C C	C C	C C	R C	C R	C C
Poor site management & supervision	- 5	14 3	* -		* -	* 5	10 -	- *			6 *	6 3		* -	- 10	3 5	* 2	* *	5 4	2 2
Ineffective planning and scheduling	- 4	9 2	5 -	12	7 -	4 8		- *		- 19	* 15	9 2				- 10	5 1	* *	- 7	4 14
Financial difficulties/ insufficient cash flow	11 -	1 8	* -	- 10		14 -	- 2	* -	* -	- 3	16 13		* *	* 1	8 7	6 -	6 -	* *	2	3 1

Inadequate contractor experience		7			18		3	-	-	*	13	*		-	-		*		*	5
		-			*		-	*	*	12	-	9		19	2		3		*	*
Improper construction methods implemented by contractor	-	*	*		*	*	*	*			*	11		*	-	-	-	*	*	
	18	9	-		*	-	-	-			*	-		-	*	15	15	*	*	

[a] Highway, [b] Construction, [c] Building, [d] Residential, [e] Pipeline, [f] Infrastructure, [g] Transportation, [h] Road

Table 4: Ranking of Top Five Causes of Delay Related to Owner

Reference	[40] [30]	[18] [31]	[41] [5]	[9] [15]	[43] [33]	[48] [32]	[22] [10]	[12] [4]	[17] [21]	[16] [1]	[26] [28]	[11] [44]	[35] [19]	[46] [25]	[20] [38]	[29] [34]	[47] [37]	[27] [39]	[49]
Delay causes\ Type of construction	HC	BC	CC	CB	INP	RC	RT	RR	CR	INR	RC	CR	CR	RC	CB	CC	CC	CC	C
Change order by owner/ client	-	*	-	*	17	-	-	*		-	*	4		-			1		
	17	*	2	-	-	2	4	*		*	-	-		*			*		
Delay in progress payments by owner	-	2	-	-	7	-	-	-	*	-	9								8
	1	12	19	*	-	6	6	4	-	4	-								-
Slowness in decision making	-	*	-	*	*	*	-	*	-	-	*	19	*	*	-	-	3	7	18
	*	11	18	*	-	1	17	*	*	6	14	-	-	-	8	20	3	14	
Delay in payment for completed work	-	10	4				*				-		13		-	1			
	*	-	-				-				1		-		4	4			
Delay in payment to the contractor	4	11			-		*		-				13	-	-			14	
	-	-			7		-		*				-	11	2			-	

As can be clearly noticed from

Table 4, three tasks related to financing the project and payment by owner were a major delay causes in construction. These factors were located among the highest six in most types of construction remarkably. Although low speed of decision making placed in the top five causes few times, it comprised the most frequent factor causing delay above the remaining. Change order factor obtained high ranking in many occasions in different countries but was not addressed as critical in the others. Delay in payment for completed work occupied first and fourth place in five different studies but was not even experienced in the same field of construction in the remaining. The first four causes have occupied first place in different countries. Delay payment for completed work appeared in first place twice in both Egypt and Iran in general construction. In principle, consultant-related factors have shown lower importance than those included in contractor group relatively.

4.3. Consultant-related causes of delay

Previous studies revealed that more than 40 different delay factors can be linked to consultant. The task of revising and approving documents should be done appropriately by consultant. Therefore, late response and instructions from consultant to other parties may affect work schedule [43]. Appointment of qualified and experienced staff should be considered to meet the proper and desired outcome [10]. The ability of appointing adequate personals leads to better supervision over the project and could minimize delays in construction [7]. The same positive results can be achieved when consultant avoids major changes in design so that no threats to contractor's performance are produced [46]. In Palestinian roads, seven factors were included in this category namely: late design works, mistake in design, inappropriate design, late inspection, late approval, insufficient inspectors and incapable inspectors [44]. Other important factors found in different studies that may pose a threat to project completion are: conflict and poor communication between consultant and other parties, poor experience of consultant and inaccurate site survey. **Error! Not a valid bookmark self-reference.** presents the top five important delay causes related to consultant.

Based on the **Error! Not a valid bookmark self-reference.**, it is obvious that causes of delay related to consultant were ranked in low position comparatively with those involved in contractor and owner groups. In fact, this result has not been realized only for the factors presented in the table, most factors related to the consultant were of low importance. The five factors listed in the table were occasionally ranked critical. Generally, they were placed in significant position six times but still relatively small. However, the inspection and testing risk factor was considerably identified through literature.

Table 5: Ranking of Top Five Causes of Delay Related to Consultant

Reference	[40] [30]	[18] [31]	[41] [5]	[48] [33]	[32] [15]	[10] [43]	[12] [4]	[22] [21]	[27] [1]	[26] [28]	[11] [44]	[35] [19]	[46] [25]	[20] [38]	[29] [34]	[47] [37]	[49]
Delay causes\ Type of construction	HC	BC	CC	RP	CB	TIN	RR	RR	CR	RC	CR	CR	RC	CB	CC	CC	C
Late in reviewing and approving design documents by consultant	16	-	10	*	20	*	*	*		*				-	-	-	10
	*	*	-	-	-	*	-	-		16				17	16	1	
Incomplete documents and design by the consultant				*				-		*	*	7		4		-	13
				-				*		-	*	*		-		15	
Poor qualification and experience of consultant's staff			-	*									-	5			
			12	-									3	-			

Poor project and quality control				-14	* -						- *		3 -	- *		- *	- *		
Delay in performing inspection and testing by consultant	- *	- *	- *	* -	* *	* *	* -	- *	* *	* *	* *	20	- *		- *	- *	- *	*	

5. Conclusion

The review undertaken in this paper covers research studies form many resources associated with construction delay. Moreover, this work has been conducted considering different type of construction namely: highway, residential, buildings, roads, pipeline, infrastructure, transportation and general construction.

It has been found that literature and previous studies are regarded as the main source for researchers by which delay factors can be highlighted. On the other hand, lack of previous works may force researcher to look for other source of information. Private and public sectors can support researchers by providing relevant documents of similar projects completed in the past.

Questionnaire comprises the main research instrument which has been utilized by the vast majority of researchers for collecting data. Contractor, owner and consultant are commonly targeted to examine their perceptions about delay factors and their importance.

The relative importance index is the favourite technique by which respondent's opinions are analysed and causes of delay are ranked according to their importance followed by importance index method.

Professionals groups are the most frequent groups used for classifying delay factors. Contractor group possessed the highest frequency and consultant one relatively the lowest.

The overall ranking resulted from past researches indicates that contractor group is the highest important group causing delay followed by owner's group. Generally, consultant group has shown low importance even comparatively to equipment group. In Arabic countries, equipment group is regarded as the first group affecting project delay in addition to contractor and owner groups.

With respect to the top five causes of delay discussed earlier, causes related to contractor and owner have shown great importance in many types of construction. For consultant's factors, the situation differs since they were rarely placed in high positions through literature.

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