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Abstract

This Meta-Analysis has examined the past ten years' studies concerning the causes of construction project delay. It aims to update the subject area and investigate critical causes of project delay in three different conditions of the external environment. The data from 50 studies have been analyzed and synthesized to determine the top ten critical causes of delay. The Relative Importance Index (RII) technique was applied to rank the critical causes; subsequently, the Spearman's Rank correlation coefficient was calculated to evaluate the critical causes. The review findings indicate substantial differences between the critical causes of project delay in defined situations. The top ten critical causes of delay in developed countries root in the project's internal environment. The leading causes of delays in developing countries are from the project's internal and task environment. While in countries with various constraints and high-risk, the general environment has a critical impact alongside the project task and internal environment on time overrun of a project. Moreover, this review summarized and categorized the best available studies to propose a systematic approach in identifying critical causes of delay to bridge the existing knowledge gap.

Keywords: project delay; causes of delay; external environment conditions; internal environment; top ten critical causes of delay; Relative Importance Index; Spearman's Rank

1. Introduction

A project in any industry needs a timely and efficient resource utilization plan to achieve the project objective. The goal is typically achieved through a time-scaled program of sequenced activities with a list of essential resources. The primary purpose of creating a schedule is to improve the project's efficiency, effectiveness, and productivity in an anticipated or agreed timeframe. However, in real-world practice, projects often fall behind schedule, causing

unwanted delays and cost overrun. Construction delay is defined as the time overrun of a project's work beyond its approved duration (Hamzah et al. 2011; Behboudi 2008). A project's total delay is the difference between its planned and actual completion date (Anastasopoulos et al. 2012). Project success needs to identify what factors causing project delay to mitigate risk and provide a timely response. Project delay accounts for additional costs and revenue loss (Yates 2014; Ramanathan et al. 2012). Many impacting factors have been identified that result in the project delay, but the identified causes of delay are ineffective in mitigating project undesired time overrun.

Early research has shown that construction projects faced 35% to 84% of the time overrun in various construction projects (Arditi et al. 1985; Al-Gafly 1995). Recent studies suggest that construction project delay percentages have not yet changed significantly compared to the past four decades globally. Ellis and Thomas (2003) and Anastasopoulos et al. (2012) specified that highway construction in the US, on average, 44% to 80% of the projects experienced time overrun. In United Arab Emirates, UK, and India, more than 40% of the projects had an extension of time from its planned duration (Lowsley & Linnet 2006; Iyer & Jha 2006; Falqui 2004). Likewise, Assaf and Al-Hejji (2006) concluded that 70 percent of the construction projects in Saudi Arabia experienced 10 to 30 percent of the time extension. Lack of consensus about the causes of delay and inadequate application of research outcome by the industry practitioners are critical shortcomings to keep construction projects on schedule. However, researchers have been studying the causes of project delays for many years. Baldwin et al. (1971) studied causes of delay in the US construction industry and identified 17 critical delay causes; Behboudi (2008) developed a model to predict the impact of excusable and non-excusable delays on construction projects. Alkhalid (2011) suggests an integrated project delivery system to

mitigate project delay causes; Gonzalez et al. (2014) studied delay causes and their impact on project progress. Kazaz et al. (2012) specified critical causes of delay in construction projects in turkey; Srdic et al. (2015) studied causes of delay in the Slovenian construction industry; Choong et al. (2018) studied critical delay causes in Portugal, the UK, and the US construction projects; Chen et al. in China (2019) identified causes of delay in grain bin construction in China. Apipattanavis et al. (2010) and Nguyen et al. (2010) investigated the weather impact on the project delay. Braimah (2014) investigated project programming's effect in delay analyzing and claim resolution in the UK construction industry. In this paper, the project's internal environment is best defined as the conditions and events resulting from the action or inaction of the key parties of the project "client, consultant, general contractor and the sub-contractors." Those are bonded in a legal business agreement in the form of a contract to complete the agreed work. Nevertheless, there is no standard approach and consensus to assess the causes of delay on a project. Some studies merely have selected a higher-order group of impacting factors or only the responsible party to evaluate the performance without an in-depth investigation of causes for time overrun. Moreover, the abundance of causes and variations in the general and task environment of construction projects from region to region have negatively impacted existing knowledge's applicability. A summary of frequently studied topics on the project delay is presented in Fig. 1.

Review Objective

Available construction management (CM) literature implies a slow onset in mitigating causes of project delay. Causes of construction project delay have been the topic of interest from way back. Baldwin et al. (1971), Arditti et al. 1985, and Al-Gafly 1995 conducted studies on project delays and their causes, and currently, numerous studies have been done to addressed causes of project

delay. Yet, many projects experience time overrun. Chen et al. (2019) argue that there is no consensus in the literature on project delay causes. Ambiguity in the definition and analysis of causes leads to the time overrun of the projects. The purpose of this review is to provide an update on the subject area. Furthermore, to assess the causes of project delay in three different conditions of the external environment defined in section 2.1, "developed and developing countries conditions, and countries with various constraints and high risk." To this end, the objective of this review is outlined as follows:

- Provide an updated list of factors and causes of project delay in an organized format;
- Identify critical causes of project delay considering the project general, task environment, and internal environment; and
- Recommendation for future studies on how to enhance the applicability of study findings to minimize project delay.

1.1. The Scope of Review

This paper reviewed the available literature of the past ten years "2010-2020" to provide a comprehensive and up-to-date review of the topic "critical causes of construction project delay." A critical review is conducted to analyze and synthesize qualitative and quantitative data from 50 primary studies selected out of 172 published papers. To accomplish a quality review, the data for review should come from a systematic search; Xiao et al. (2019) suggest three effective literature search techniques:

- Database search using keywords;
- Backward search to explore the references list of the article for earlier publications; and
- Forward search to find out publications that cited the article.

In consideration of proposed techniques, the Purdue University library database, the engineering village database, and other open-access databases and peer-reviewed journals were searched to collect the data. The compiled papers are chosen from different countries published between 2010 to 2020. Fig. 2&3, and Fig.S1 &2 illustrate the characteristics of the selected articles.

2. Methodology

Bearing in mind the systematic literature review fundamental elements, the review compiled data is assessed for quality, analyzed, and synthesized in the subsequent steps.

2.1. Refining Data and Criteria for Inclusion

Primary and secondary criteria were established to screen available literature. It is essential to establish criteria for data inclusion and exclusion based on the study objective (Kitchenhand et al. 2009; Xiao et al. 2019). A total of 172 papers were initially selected, and after screening for quality, 50 articles were chosen, shown in Tables 2, 3, and 4. Selected papers satisfied all primary and at least one secondary criteria. Table 1 shows the inclusion criteria.

Furthermore, Considering Dess and Beard (1984) and Amarkhil (2019) studies that generalized external environment** impacting variables on organization performance in three groups" *dynamism, munificence, and complexity*". Three conditions of the external environment are identified using the World Bank (2020) report Doing Business "DB" score and the United Nations (2018) report Human Development Index "HDI" score. The cut-off score is selected as follows: developed countries ($DB \text{ score} * HDI \text{ score} \geq 69$), developing countries ($40 < DB \text{ score} * HDI \text{ score} < 69$). Countries with high political and security risk or countries with various constraints and high business risk ($DB \text{ score} * HDI \text{ score} \leq 40$). Selected studies are shown in Tables 2, 3, and 4.

**Project external environment is best defined as "*the conditions and events outside a company that affects the way it operates*" (Cambridge online dictionary 2020).

2.2. Data Analyzing and Synthesizing

Researchers identified an abundant number of causes of delay in various conditions, and it is found that numerous factors lead to the project delay. Al-Kharashi et al. (2009) identified 112 factors of project delay in Saudi Arabia, Zidane et al. (2018) identified 45 causes of project delay in Norway, and Bekr (2015) identified 65 causes of project delay in Iraq. The most critical cause of delay in Saudi Arabia was the lack of a qualified and experienced workforce. In Iraq, the inappropriate tendering system was the primary cause. In Norway, ineffective project planning and programming were the primary causes of delays in building construction projects. While in road construction projects in Egypt, Aziz et al. (2016) listed equipment as the primary cause of time overrun, and Santoso et al. (2016) determined adverse weather (rain and flood) the critical causes of the project delay in Cambodia. To this end, the causes of project delay are many and fragmented; for instance, it depends on the project characteristics and the project's internal and external environment.

Another challenge is the lack of validity of the findings. A suitable research method and data analyzing technique adds to the study outcome validity and its applicability. In 172 selected papers of this review, many studies have inquired qualitative data presented in Tables 2 to 4, and a few studies have applied the quantitative research method. The compiled 50 papers indicate that the prevalent data collection method to identify causes of delay through the survey questionnaire technique. Moreover, the extensively used data analyzing tools to identify and rank causes of delay were the Relative Importance Index (RII), frequency index (FI), severity index (SI), and the Spearman's Rank correlation coefficient shown in Tables 2 to 4. Thus, considering all the criteria above, the review analyzed obtained data in three different conditions of the project's external environment. To identify critical causes of delay in every situation: Firstly, critical causes of the project delay from 50 studies were organized and indexed. Secondly, the Relative Importance Index (RII) was calculated to determine substantial causes of delay in all three identified

conditions; thirdly, the Spearman's Rank equation has been used to assess the relationship between the critical causes of delay in specified three identified external environment conditions.

2.2.1. Major causes of delay in Developed Countries and Business-Friendly Environment

The major causes of the delay from 50 chosen studies have been organized into 12 major groups of causes plus two groups of causes for countries with high risk and various constraints shown in Table 5. Furthermore, 42 attributes of causes of delay were extracted from 11 studies conducted in developed countries, presented in Table S1. In this review, delay factors are weighed on a scale of 1 to 10, where one shows the weight of cause ranked ten or higher, and 10 shows the cause ranked 1 in the primary study. Critical causes of delay shown in Tables S1, S2, and S3 are indexed as follows: *Indexed Cause = "Group of Cause Initial + A number Specifying the Attribute of Cause • Weight of Factor from 1 to 10 Based on the Primary Study Ranking."*

2.2.2. Major Causes of Delay in Developing Countries

Studies listed in Table 2 were investigated to identify and weight critical causes of delays in developing countries. Critical causes of project delay from all 24 articles in Table 2 are summarized under 45 attributes. Table S2, illustrates the critical causes of delay in developing countries.

2.2.3. Major Causes of Delay in Post Conflict Condition & Countries with High Business Risk

The external environment significantly impacts construction project performance in post-conflict countries and countries with various constraints and uncertainties (Amarkhil & Elwakil 2019).

The data analyzed in this review revealed that the macro or general environment has a more critical impact on construction project time overrun in countries with high political and security risk. Two more groups of causes were added to the earlier 12 Identified groups of causes in developed and developing countries' conditions to take in all impacting factors. In this section, a total of 40 attributes of causes of delay were identified in 14 groups. Three identified causes are

not listed in Table S3 (3.RI1.7, and 7. W1.7 & 14. W1.6) but included in the calculation to determine the top ten critical causes of delay as shown in Table S3.

3. Results and Discussion

The Relative Importance Index (RII) technique is applied to weigh the identified causes to determine the top ten critical causes of delay. Equation (1) calculates the Relative Importance Index (RII) in all three conditions.

$$RII = \frac{\sum_i^{10}(W_i * X_i)}{N} \dots\dots\dots (1)$$

Where:

- 0< RII ≤ 1
- W_i = the assigned weight of the ith cause
- X_i = the frequency of the ith cause
- N = the total number of tabulated causes in a distinct condition
- i = the attribute of causes ranging from 1 to 10

Tables, 6,7, and 8 show the top ten critical causes of delay in the identified environmental situations. The obtained data were also analyzed to determine the individual group of causes relative importance in different conditions. Fig. 4 illustrates the percentage of each group's contribution to the time overrun in different situations. The study results for the top ten critical causes of delay predicate: causes of delay varies in distinct environments. Investigating the literature in the subject area reveals differences in the causes of delay in different external environmental situations. However, many researchers and practitioners do not appreciate it to distinguish the critical causes of project delay according to the project characteristics, internal and external environment conditions presented in Tables 2, 3, and 4. Based on the review findings, most of the identified causes of project delay in developed countries were caused by the contracting

party refer to Table, 6; owner, contractor, and consultant were responsible for more than 90% of the top ten critical causes of delay. In developing countries, 60% of the project delay top ten critical causes of delay were rooted in the contracting parties' action and inaction "internal environment of the project." The remaining 40% of causes of delay were related to third-party influence, such as resource suppliers and competency of the technical staff and skilled labor "project task environment" presented in Table 7. While in countries with various constraints and uncertainties, 30 % of critical causes of delay were descended from the general environment impacting factors. The other 30% of the causes of delay were from the project task environment. Only 40 % of the causes of the project delay were the contracting party responsibilities "internal environment of the project" shown in Table 8. The equation 2 Spearman rank coefficient is used to determine the correlation between these three identified situations statistically.

$$r_s = 1 - \frac{6\sum d^2}{(N^3 - N)} \dots\dots\dots 2$$

Where:

r_s = Spearman rank correlation coefficient (r_s value ranging from 1 showing the robust direct relationship, and -1 showing strong inverse correlation)

d = difference in causes ranking of the identified conditions

N = number of variables, Table 9 illustrates the relationship between ranked causes in three identified external environment conditions.

The Spearman rank result indicant that there is a weak inverse association between the identified critical causes of delay in countries with high risk and developed countries. The correlation between the critical causes of delay in developing countries and countries with high uncertainties has also been low. However, the relationship between developing and business-friendly states was at a medium level, which means there is somewhat agreement on the major causes of delay

in these two distinct environments. To this end, it has been statistically validated that the major causes of the project delay in the identified three external environment conditions are different and should be considered according to the project environment. Fig. 5 illustrates the critical causes of the project delay in identified external environment conditions by the RII value.

4. Conclusion, Recommendations, and Future Research Work

This study examined the studies conducted since 2010 concerning the causes of construction project delays in various situations. Fifty studies were analyzed and synthesized by categorizing and determining the critical causes of project delay in different external environments. The review findings acknowledge the heterogeneity of delay causes and the lack of a standardized approach in identifying causes of delay. The obtained data have been analyzed in the context of a systematic review technique. In this review, the main responsible party for the cause of delay and the situation leading to the project time overrun is differentiated. Because it is essential at the first step to know what circumstances resulting in the project delay and then to know who is responsible for that cause, as it is presented in Table 5. Moreover, the identified causes of a delay from primary studies have been categorized and indexed since some researchers used synonymous phrases to identify critical causes of delay. It was behooved to be indexed as a single phrase presented in Tables S1, S2, and S3. A summary of the key findings of this review are presented in the following sequence:

- A total of 14 main groups of causes of delay have been generalized from the opted studies applicable to various situations shown in Table 5. About 50 factors are realized that impact construction project time. The word Bank (2020) report Doing Business "DB" score and the United Nations (2018) report HDI score were used to categorize studies in three identified conditions of the external environment.

- The Relative Importance Index (RII) technique has been applied to determine the top ten critical causes of delay in the external environment's identified conditions. The Spearman Rank Correlation coefficient result shows an insignificant association between the major causes of delay in different specified conditions.
- The top ten critical causes of delay in developed countries indicate that 90% of the causes of delay are the responsibility of the project contractor, consultant, and client (internal environment of the project). Ineffective planning, slow decision making, and poor communication have been the most critical causes of project delay in developed countries presented in Table 6.
- The critical causes of delay in developing countries are the delay in progress payment by the owner, ineffective planning and scheduling, and poor site management by the contractor. Moreover, 60% of the project delay has been rooted in the contracting party's action and inaction "internal environment of the project." The remaining 40% of the causes of delay are related to the third party, such as resource suppliers, market and competency of the technical staff, and skilled labor "project task environment."
- In countries with various constraints and high risk, multiple factors impact the project progress, and some of them are not in direct control of the project stakeholders. Delay in progress payment by the owner, political instability and insecurity, poor management and supervision by contractor, inflation, and price fluctuation have been the most critical causes of project delay among the top ten critical causes of delay shown in Table 8. In countries with high risk, 30 % of critical causes of delay arise from the general environment impacting factors, the other 30% of causes of delay result from the project task environment, and only

40 % of causes of the project delay are the contracting party direct responsibility "project internal environment."

4.1. Recommendations and Future Research Work

There is a lack of a standardized approach, and vague phrases in the survey questionnaire lead to an abundant, heterogeneous, and erroneous ranking of causes. Some of the existing studies identified 10 to 20 causes of project delay, while other studies identified over a hundred causes of project delay presented in Tables 2,3, and 4. There is no standard method to identify and categorize the minimum and the maximum number of causes of the project delay. Lack of a systematic approach in phrasing causes of the project delay is another challenge in identifying causes of project delay. For instance, Doloi et al. (2012) phrased a cause of delay as "inefficient site management." Sanni-Anibire et al. (2020) stated that cause as "poor site organization"; Jalal and Shoar (2017) worded it "Error in execution"; and Durdyev et al. (2017) phrased that "Poor site management"; while all these phrases were used to ask the study participant about the site management by the project contractor. Therefore, differences in phrasing of causes of delay have been creating ambiguity, and it has reduced the objectivity of the study findings.

Many studies have blended the source of cause for the project delay with the situation leading to the project time overrun. For instance, Kog (2018) identified five major groups of causes of project delay: 1. Factors related to all project participants; 2. Owner-related factors; 3. Contractor-related factors; 4. Consultant-related factors; 5. Other factors. Also, Santoso and Soeng (2016) categorized critical causes of delay into ten groups: 1. Financial; 2.Resource; 3.Technical; 4.Economic; 5.Environmental; 6.Operational; 7.Government and political; 8.Relationship; 9.Security/safety; and 10.Legal. These two approaches are different, arduous, and vague to request the study participant to identify and rank the project delay causes. These discrepancies and lack of a standard

method have resulted in disagreement between studies findings and limited the research outcome applicability. In this review, the author proposed 14 general categories of causes of delay and an indexing method, which can be applied in different situations to reduce discrepancies in the subject area. As a final point, this is crucial to delimit the scope of a study according to the project characteristics, internal and external environment impacting factors to enable construction industry practitioners to convert the research findings into actionable knowledge. The authors highly advise conducting research that combines the meta-analysis of the available research, expert opinion, and construction practitioners. Moreover, a future research to propose a new delay analysis method/technique to assess the effect of the delay on the project outcome.

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Table 1. Data Inclusion Criteria

Primary Criteria	Secondary Criteria
<ul style="list-style-type: none"> • Peer-reviewed scholarly article • Applied a valid data analyzing method • Identified Initial causes/factors of delay • Determined critical causes of delay 	<ul style="list-style-type: none"> • Described data collection method • Introduced study participants • Introduced type of construction • Categorized critical causes of delay

Table 2. Studies Conducted in Developed Countries –Business Friendly Environment

A, YoS	CoS	ToC	SP	DAM	DCM	TP	IC	G	M C	R
Lessing et al., 2017	New Zealand		Contractor Project Manager	Relative Importance Index	Interview, Questionnaire		22	8	7	80
Zidane et al., 2018	Norway	Building construction	Client, Consultant Contractor	Frequency	Questionnaire survey		46	11	10	79
Larsen et al., 2016	Denmark	Building construction	Contractor Architect	Importance Index, (RII)	Survey Xact	Public	26	5	5	79
Agyekum et al., 2017	UK	Multi-Discipline	Owner Contractor Consultant		Interviews 4 Case Studies	Public	32	15	5	77
Adam et al., 2017	Sweden	Multi-Discipline		Kiviat Diagram	Review	Public	25	8	5	77
Choong et al., 2018	Portugal, The UK, The US	Multi-Discipline			Review		42	7	10	77
Tafazzoli et al., 2017	The USA	Multi-Discipline	Owner Contractor, Consultant	Factor analysis AHP	Questionnaire survey	Private Public	30	4	14	77
Durdyev et al., 2019	New Zealand Australia	Multi-Discipline			Review	Public& Private	149		12	76
Kog, 2018	Singapore	Residential	Owner Contractor Consultant			Public	91	5	6	76
Yang et al., 2013	Taiwan	Multi-Discipline			Questionnaire survey	Public	21		4	69
Srdic et al., 2015	Slovenia		Contractor, Consultant, Client		Online Survey		12	5	7	69

A, YoS = Author, Year of Study; ToC =Type of Construction; CoS =Country of Study; SP =Study participant; DAM = Data Analyzing Method; DCM = Data Collecting Method; TP= Type of Project; IC = Total Identified Causes; G = Group of Causes; MC = Major Causes; R= Doing Business Score Human Development Index

Table 3. Studies Conducted in Developing Countries

A, YoS	CoS	ToC	SP	DAM	DCM	TP	IC	G	M C	R
Ramanathan et al., 2012	Malaysia	Multi-Discipline			Review		11 3	18	5	66
Kazaz et al., 2012	Turkey		Contractor	(RII)	Questionnaire		34	7	5	62
Aynur et al., 2012	Turkey		Contractor	Importance Index, (RII)	Questionnaire survey		34	7	10	62
Gunduz et al., 2015	Turkey		Owner Contractor, Consultant,	(RII) & Fuzzy logic	Interview	Pubic Private	83	9	15	62
Alhajri et al., 2018	Saudi Arabia	Petrochemical projects	Contractor Owner	(RII), (FI),	Survey Questionnaire	Public	23		6	61
Al-Kharashi et al., 2010	Saudi Arabia	Multi-Discipline	Contractor Consultant Owner	(ANOVA)	Survey Questionnaire	Public	11 2	7	3	61
Rahman et al., 2016	Saudi Arabia	Building		PLSSEM	Questionnaire Survey	Public Private	37	7	10	61
Chen et al., 2019	China	Grain Bin	Owner Contractor, Consultant,	PLSSEM method	Structured Interviews Questionnaire		20	6	5	59
Wang et al., 2018	China	Building	Client, Consultant Contractor	Expected Risk Factor	Questionnaire Survey		37		9	59
Castillo et al., 2019	Qatar	Multi Discipline	Owner Contractor, Consultant,	(SPSS) Regression (RII) Index	Survey Questionnaire	Public	50	5	9	58
Soliman, 2017	Kuwait	Building	Consultant Contractor	Absolute Ranking		public	25	5	6	54
Asmi et al., 2019	Indonesia			(SPSS)	Questionnaire Survey		10		10	49
SanniAnibir et al., 2020	Global Const.	Multi-Discipline		(RII)	Review		36		5	48
Baloyi et al., 2011	South Africa	Building	Client Contractor Consultant	(RII)		Public	34	4	10	47
Mbala et al., 2019	South Africa	Multi-Discipline			Review		20		6	47
Jalal et al., 2017	Iran		Client, Consultant Contractor	(SD) & (DEMATEL) method	Questionnaire		58	6	9	47
Pourrostamet al., 2011	Iran	Building	Contractor, Employer, Supervisor	(SPSS) Index (RII)	Questionnaire Survey	Public	27		4	47
Durdyev et al., 2017	Cambodia	Residential	Contractor Consultant	Spearman's Rank, (RII)	Survey Questionnaire		31	6	10	46
Santoso et al., 2016	Cambodia	Road	Contractor Consultant	(FI), (SI) & Importance Index	Questionnaire Survey	Public	64	5	10	46

Doloi et al., 2012	India	Building	Owner Contractor, Consultant,	Regression & (RII)	Questionnaire & Interviews		45	6	7	46
Mau et al., 2017	Brazil	Building		Factor analysis	Survey	Public	18	8	5	43
Aziz et al., 2016	Egypt	Road	Contractor Consultant Eng.	Relative Importance Index (RII)	Questionnaire & personal Interviews	Public	29 3	8	20	42
Ezeldin et al., 2013	Egypt		Employer Consultant Contractor	Frequency Index (FI)	Questionnaire Survey		31	5	12	42

Table 4. Post Conflict and Countries with High Uncertainties (Low DB score and HDI)

A, YoS	CoS	ToC	SP	DAM	DCM	TP	IC	G	M C	R
Gardezi et al., 2014	Pakistan		Client, Consultant Contractor	(RII), (FI) & (SI)	Questionnaire	Public	27		8	34
Rahsid et al., 2013	Pakistan			Factor Analysis Regression	Questionnaire survey		30	7	10	34
Fugar et al., 2010	Ghana	Building	Owner Contractor, Consultant,	Importance Index, (RII)	Field survey		32	9	10	33
Lundin et al., 2015	Ghana	Building	Contractor Consultant Professional	(RII)	Survey		37	10	6	33
Mahamid et al., 2012	Palestine	Road	Contractor Consultant	(SI) Spearman's Rank	Questionnaire Survey	Public	52	8	5	32
Muhwezi et al., 2014	Uganda	Building	Client, Consultant Contractor	Importance Index, (RII)	Interview, Questionnaire		81	4	5	32
Alinaitwe et al., 2013	Uganda		Client, Consultant Contractor	RII, (FI) & Severity Index	survey Questionnaire	Public	22		5	32
Bekr, 2015	Iraq		Client Contractor Consultant	Frequency, Severity & Importance Index	Survey Questionnaire	Public	65	4	7	31
Sunjka et al., 2013	Nigeria	Multidiscip line	Client, Consultant Contractor	ANOVA & t-test	Survey	Public	38	5	11	30
Sambasivan et al., 2017	Tanzania		Client, Consultant Contractor	(SEM), RII	survey Questionnaire	Public Private	42	7	11	29
Mohammad et al., 2015	Bangladesh	Building	Owner Contractor, Consultant,	RII, Frequency Index (FI)	Survey Questionnaire	Private	79	9	10	28

Islam et al., 2015	Bangladesh	Building	Client, Consultant Contractor	Importance Index, (FI) & Severity (SI)	Questionnaire survey		30	9	10	28
Kardry et al., 2017	Multi-country	Infrast. Road,	Expert	(DIF), (CIF) & (EV)	Interview & window analysis	Public	31	3	10	28
Shebob et al., 2011	Libya	Building	Contractor Owner Consultant	(RII) T-test	A semi-structured questionnaire		75	8	5	23
Kardry et al., 2016	Afghanistan	Infrast. Power, Road,	Expert	(DIF), (CIF) & (EV)	Interview & window analysis	Public	10	3	6	22
Niazai et al., 2012	Afghanistan		Client, Consultant Contractor	Pearman's Rank, (RII)	survey Questionnaire	Public	83	9	10	22

Table 2. Categorized and Indexed Groups of Critical Causes of Delay

Group of Causes of Delay	Index	Key Responsible Party
Communication & Coordination	C	Contracting Party (Owner, Consultant& Contractor)
Financial & Price Escalation Uncertainty	F	Owner, Contractor, and Market
Management & Performance	M	Contractor and Sub-Contractor
Resources Availability (Mat., Eq., Labor)	R	Third-Party (Supplier), Contractor & Client, Other
Planning & Scheduling	P	Contractor, Sub-Contractor, and Owner
Decision Making & Approving	D	Owner and Consultant
Experience & Knowledge	EK	Contracting Party and Industry
Design & Specification	DS	Consultant and Client
Scope Change & Work Variation	SC	Client and other
Risk Assessment & Uncertainty	RI	Contracting Party
Regulation & Contract Requirements	RC	Government and Contracting Party
Weather & Climate	W	External (Climate)
Political & Security Problem	PS	External (Government and Business Environment)
Corruption & Bureaucracy	CB	External (Government and Business Environment)

Table 6. Top Ten Critical Causes of Delay in Developed Countries

Index	RII Value	Cause of Delay	Rank
P1	0.367	Ineffective planning and scheduling by the contractor	1
D1	0.367	Slow decision-making process	2
C1	0.347	Poor communication of the contracting party	3
SC1	0.347	Changes of scope & variation order by owner	4
M1	0.296	Poor site management and supervision	5
C2	0.286	Poor coordination of the contracting party	6
W1	0.255	Inclement weather	7
F1	0.224	Delay in progress payments by the owner	8
DS1	0.224	Design error and discrepancies by consultants	9
RI2	0.216	Unforeseen conditions by contractor	10

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Table 7. Top Ten Critical Causes of Project Delay in Developing Countries

Index	RII Value	Cause of Delay	Rank
F1	0.721	Delay in progress payments by the owner	1
P1	0.626	Ineffective planning and scheduling by the contractor	2
M1	0.480	Poor site management and supervision by the contractor	3
R1	0.369	Delay in delivery and shortage of materials on site	4
R2	0.302	Shortage of skilled labor	5
EK1	0.291	Lack of experience and knowledge of contractor stuff	6
R3	0.212	Shortage and delay in equipment delivery	7
C1	0.207	Poor communication of the contracting party	8
D1	0.201	Slow decision-making process by owner & consultant	9
SC1	0.201	Changes of scope & variation order by owner	10

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Table 8. Top Ten Critical Causes in Countries with External Environment High Risk

Index	RII Value	Cause of Delay	Rank
F1	0.673	Delay in progress payments by the owner	1
PS1	0.527	Political instability and insecurity	2
M1	0.382	Poor management and supervision by contractor	3
F3	0.327	Inflation and price fluctuation	4
P1	0.300	Ineffective planning and scheduling by the contractor	5
SC1	0.300	Changes of scope and variation order by owner	6
R1	0.264	Delay in delivery and shortage of materials on site	7
DS1	0.245	Design error and discrepancies by consultants	8
EK1	0.236	Lack of experience and knowledge	9
CB2	0.236	Corruption and Issues clearing customs	10

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Table 9. Correlation of The Major Causes of Delay in Identified Conditions

Spearman rank	High-Risk Countries Developed Countries	Developing Countries High-Risk Countries	Developed Countries Developing Countries
$6 \sum d^2$	5820	3684	2940
$N^3 - N$	4896	4896	4896
$r_s = 1 - \frac{6 \sum d^2}{(N^3 - N)}$	-0.2	0.2	0.4

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