Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

CRUCIAL CAUSES OF DELAY IN COMPLETION AND PERFORMANCE MANAGEMENT OF THE CONSTRUCTION WORK: STUDY ON THE BASE OF RELATIVE IMPORTANCE INDEX

UMAIR BAIG
Department of Commerce, Benazir Bhutto Shaheed University, Lyari, Karachi 75660, Pakistan

ABDULLAH AYUB KHAN
Departemnt of Computer Science, Sindh Madressatul Islam University, Karachi, Sindh, Pakistan
Faculty of Computing Science and Information Technology, Benazir Bhutto Shaheed University, Lyari, Karachi, Sindh, Pakistan

MUHAMMAD GHAZANFAR ABBAS
Lasbela University Agriculturere, Water, and Marine Sciences, Balochistan, Pakistan

ZAFFAR AHMED SHAIKH
Faculty of Computing Science and Information Technology, Benazir Bhutto Shaheed University, Lyari, Karachi, Sindh, Pakistan

ALEXEY MIKHAYLOV
Research Center of Monetary Relations, Financial University under the Government of the Russian Federation, Moscow, Russia

ASIF ALI LAGHARI
Departemnt of Computer Science, Sindh Madressatul Islam University, Karachi, Sindh, Pakistan

BATOOL MUHAMMAD HUSSAIN
Faculty of Management Sciences, Mohammad Ali Jinnah University, Karachi, Pakistan

Abstract

Construction delays are a relentless issue for the world. The majority of construction projects retrograde due to construction delays. However, the construction sector possesses the most essential priority among various sectors as it enables the economy to flourish. This study aims to explore the most crucial causes that highly affect construction projects and delay their completion in the Pakistani construction industry, comparing explored factors with other countries in Asia. This study identified forty-nine factors after reviewing past literature and redefining them through interviews with Pakistani field experts. Later, categorized into eight groups, such as investor perspective, constructor perspective, advisor perspective, financial issues, planning and budgeting, coordination with stakeholders, determinants of construction projects, and miscellaneous factors, to interrogate public and private contractors and consultants through a structured questionnaire. The relative importance index (RII) approach empirically validated the study objectives with an aggregate sample of 330 responses. Statistical analysis of the accumulated data through the survey revealed ten major factors based on constructor and consultant perception that cause delays and affect the on-time completion and performance of the construction work. Thus, this study presents recommendations for the practitioners and parties associated with the construction sector of Pakistan to minimize the influence of the observed factors on construction projects.

Keywords: Construction, contractors, consultants, performance management, perception, relative importance index

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

1. Introduction

The construction industry is the backbone of any nation and contributes substantially to economic growth [1, 2, 3, 4]. Construction delays are serious challenges and threats suffered by all stakeholders in the construction sector. However, the construction sector in Pakistan strengthens other sectors by providing infrastructure and reducing unemployment. It also contributes 2.53% to the GDP of the country. Correspondingly, there are numerous reasons for delays in construction projects, and they affect not only timing, cost, and productivity but also macroeconomic indicators of the economy [5].

Delays in the construction process are considered as chronic problems globally [6, 7, 8, 9, 10, 11, 12] and mostly all developed and developing countries are suffering due to construction delays [13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23]. Similarly, the Pakistani construction industry also comes across many challenges that prevent sound performance in the construction process. In light of these barriers, the construction sector of Pakistan also experiences delays in most of its projects [24]. Therefore, Pakistan's construction organizations need to persistently improve the performance of their construction activities. Scholars have highlighted multiple reasons for delays and time extensions in various developing and developed countries [25, 7, 26, 27, 1]. Existing literature in this domain of the construction industry has highlighted a number of categories to comprehend the issues that have been discussed by previous scholars. Generally, factors that cause delays in construction are accompanied by high cost, poor quality, and sometimes insecurity. Consequently, these delays result in a cash flow problem, distrust, and adverse relationship [20]. Thus, it is essential to complete the assigned tasks of construction on time by using advanced innovative methods like [28] tested and implemented Last Planner System (LPS) to ensure on-time project completion. Moreover, the outcomes of this study have contributed to improving the traditional planning system through achieving the scheduled target and collective planning among the construction parties.

Abundant literature has agreed that the construction sector contributes a significant portion of the revenue in the engineering industry worldwide [20, 25, 7, 26]. It requires the smooth execution of a construction project. For instance, planning, proper budget estimation, construction processes, value engineering, and development methods. In general, the construction process comes across different problems in carrying out and completing the projects within the scheduled time. Therefore, it is important to identify the most significant factors that cause delays in the construction process in Pakistan.

For this purpose, we are using a structured questionnaire to explore several critical factors that cause delays and hinder Pakistani construction practitioners from completing the entire construction process on time. This study would help the Pakistani construction industry and real-estate sector to control and reduce critical delay factors and lead to the on-time completion of construction work. Thus, to seek out the issues and accomplish the desired goals, this study aimed to (i) identify the critical factors that cause delays in construction projects through assessing past studies carried out in Asian countries and interview experts for pilot testing the survey before presenting the final draft. (ii) implement the relative importance index method to assess major factors of delay in the Pakistani construction industry, keeping in view

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

the stakeholders of construction companies through a structured questionnaire survey (iii). Finally, analyze the contractor's and consultant's perceptions through Spearman rank correlation to assess the degree of concurrence.

2. Literature Review

The gratification of successful construction projects is achieved when defined objectives in the project specification are met [16]. A successful project refers to when a project is executed within a pre-defined time frame, within the allocated budget, maintains standards and quality demanded by the client, and assures the safety condition of the construction workforce [29, 30]. Delays in the construction industry are of crucial concern and have been considered a wide scope of research for decades. Previously, studies in this scope were broadly categorized into two main streams, such as (i) delay analysis and identifying factors causing delays and (ii) assessing factors causing delays.

Initially, research was conducted to survey contractors, architects, and engineers to provide evidence regarding the causes of delays in US construction projects. The authors highlighted seventeen crucial factors affecting the construction process, such as changes in design, sub-contracting, late approvals, financial issues, jurisdictional disputes, construction errors, labor supply, contracts, inspections, failures in equipment, shop drawings, shortages of material, foundation conditions, manufactured items, coding of building, permits, and weather. Among these, the most important were labor supply, sub-contracting, shop drawings, foundation conditions, design changes, and weather [31]. This was followed by a study conducted by several past studies on the causes of delays and analysis techniques in the construction industry in both developed and developing countries. This study focuses on the comparative analysis of different Asian countries with Pakistan.

[32] discussed the classification of delays as three essential types. They highlighted compensable as a delay to the contractor if it is caused within their control, by a mistake, or because of the owner's negligence. Excusable delays befall when incidences are attributed to neither the contractor nor the owner because of unforeseen events that refer to events in the future, not prevailing causes. Contrarily, situations that the contractor is aware of and does not regard as unforeseeable. Similarly, events beyond the control of the contractor, which is unpractical in legal consideration, occur at an excessive and irrational cost. Finally, events without mistakes or negligence in which the contractor is not blamed because the event is caused due to an act of nature. Unfortunately, labor and materials were found to be in short supply at the time of the contract. Excusable delays are given extra time, but non-excusable delays hurt both the owner and the contractor.

[16] examined factors that influenced the Indian construction process. They identified 45 causes of delay and categorized them into six heads, such as site-related, human-related, project-related, authority-related, technical issues, and process-related.

[17] conducted a survey on the delay factors in the Turkish construction industry and ascertained them according to their importance. The scholars considered 34 delay factors. A questionnaire was administered to 71 construction companies in Turkey. The study revealed that changes in the design and materials are the most serious factors, followed by payment delays and cash flow issues.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

[33] assessed the causes of delays in projects for Iranian gas pipelines. They used a questionnaire survey and 43 items were evaluated from the literature review. Finally, 24 items were extracted and divided into nine groups after interviews with Iranian experts. The result implied ten major causes of delay, such as imported material, unrealistic duration of projects, client-related material, expropriation of land, alteration orders, licensing, contractor payment, contractor selection procedures, suppliers, and contractor cash flow.

A questionnaire survey in the United Arab Emirates (UAE) was also used to determine the factors causing the delay.They surveyed 500 respondents, but only 208 responses were collected. The scholars generated 180 factors and categorized them into 11 groups. Their findings revealed five major causes of delay: unrealistic contract duration imposed by the client, scope and order changes, incomplete design at tender time, insufficient scheduling and planning, and poor project control and planning.

[34] ascertained major delays and factors that affected Chinese grain-bin construction. The authors did an in-depth literature review and conducted 15 semi-structured interviews. They administered a structured questionnaire to 108 field practitioners with experience in the field of constructing grain bins. They identified 20 critical factors and categorized them into five groups. Their study identified the top five delay factors.

[35] also examined the causes influencing the Pakistani construction industry. They surveyed 130 respondents, but they considered 113 responses for statistical analysis. They divided their selected causes into four categories and used the mean importance rating (MIR) method to assess the factors of delay.

Similarly, [36] also examined a comparative analysis between Malaysia, Indonesia, Thailand, and Vietnam to find suitable protective and mitigating methods to complete construction projects on time. The author suggested that construction delays can be reduced by having stable meetings of projects with consultants, owners, and contractors. According to them, the progression of consultants' proficient standards must be an ongoing endeavor for professionals and tertiary organizations. The author emphasized the need to upgrade the registration system for contractors in order to minimize construction delays that are caused by incompetent contractors.

Correspondingly, [37] investigated that a project is considered successful when it efficiently manages the constraints such as time, budget, and cost. Currently, in a developing country like Pakistan, the construction industry has attracted a lot of stakeholder attention. According to them, project-based organizations work hard to achieve success by practicing the best stakeholder management and engagement practices.

In contrast, [38] discussed the meta-analytical method for recognizing global or domain design. According to them, meta-analysis integrates the outcomes of various research projects currently taking place in order to establish global problems. The benefit of meta-analysis is its translucency in extracting and examining information for more perfect decisions and policy formulation. The authors demonstrated a narrative summary that has been attained internationally on the grounds of construction delay. As a result, they looked for the most important and relevant studies by following a set of rules. Then, they investigated for numerical facts in the papers they chose.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

In this study, major causes of delay are identified and classified into eight major groups, such as investor perspective, constructor perspective, advisor perspective, financial issues, planning and budgeting, coordination with stakeholders, determinants of construction projects, and miscellaneous factors. Identification of causes and effects alone does not support the project managers to take appropriate remedial or preventive steps. Project managers need to understand, for example, what causes or factors result in time overruns or cost overruns. Once these factors become clear, the managers can take preemptive steps to avoid such circumstances. For instance, if it is known that time overruns are primarily caused by factors related to the client, the project manager can ensure that payments for the finalized work are timely paid, owner interference is reduced, speedy decisions are made, and impracticable contract duration and requirements are avoided. Despite several studies on construction delays all over the world, only a few studies have been conducted in Pakistan to explore the factors causing the delayed completion of construction work. Therefore, this study has created a link between the causes and effects of delays that need to be established, along with the recommendations for future prospects.

3. Research Methodology

A holistic overview is provided in this study regarding the critical factors that cause delays in the Pakistani construction industry through a questionnaire-based survey method. The rationale behind employing this method was to accumulate broad views from potential individuals to better understand research outcomes, spread the word to population respondents, and for its cost-effectiveness [39]. Moreover, this method best fits deductive research that equally supports the test data statistically and helps better interpret the subject matter of the survey [40]. A conventional method was adopted for the survey, as depicted in Figure 1.

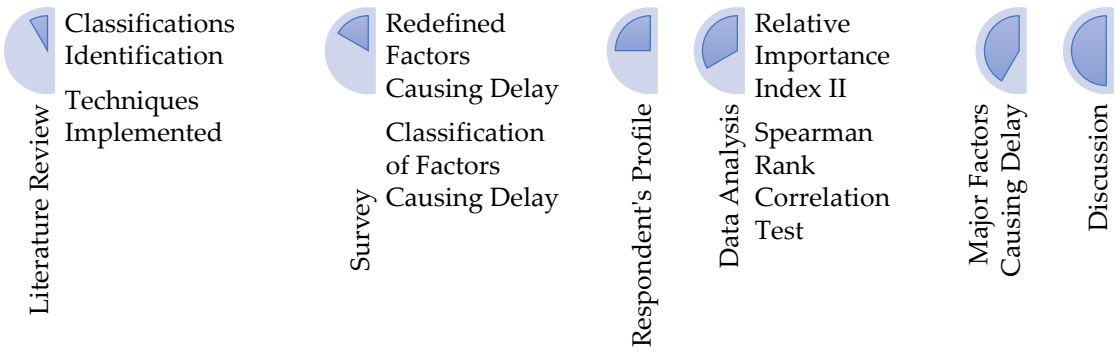

Figure 1. Procedure for Conducting Research

In the first step, classification and techniques implemented to evaluate factors causing delays were identified by reviewing the literature thoroughly. Semi-structured interviews with experts were conducted before the final draft of the questionnaire to ensure its reliability and validate the appropriateness of the causes of delay reported in the past literature with respect to the Pakistani context. The survey tool encompasses two main sections. First, gather the respondent's profile. In the second section, respondents' perceptions were asked to know the relative importance of each

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

of the 49 causes of delays in the Pakistani construction industry. A five-point Likert scale was used to rate how important each factor was: "1–not important, 2–slightly important, 3–moderately important, 4–very important, and 5–extremely important."

This study employed a random sampling technique to target Pakistani construction specialists from different locations in Pakistan. This technique allowed for the acquisition of representative samples and reduced biases in the selection process [41]. According to [42], a random sampling technique is applied when a list of potential respondents is available. Therefore, a list of 850 potential respondents was selected, and these members were comprised of the following: owners, contractors, architects, consultants, and suppliers. The authors established a few standards to determine the accuracy of the sample. It was then that the following criteria were used to choose samples: (i) contractors and consultants; (ii) the location of Pakistani construction companies in any specialized field; (iii) a valid postal address, email address, and phone number; and (iv) the ability to send a letter or send an e-mail.

Companies that did not meet the set standards were eliminated, and the seluting number of sample was 540. Multiple distribution techniques have been employed to ensure the spread of the survey among Pakistani construction experts and professionals. Initially, e-mails were sent to private and public construction companies. Then, hard copies of the questionnaires were dispatched to several contractors and consulting agencies. Finally, the survey tool was faxed. A total of 380 questionnaires were sent through e-mail, 70 were delivered in person, and faxed questionnaires totaled approximately 90. The survey commenced in April 2020 in Pakistan. The respondents were assured of their confidentiality and anonymity during the survey process to raise the response rate. In return, providing a summary of the research outcomes was promised to the respondents. Over a period of five months, 353 questionnaires were received, and of those, 23 were rejected due to incomplete or invalid information provided. Hence, 330 valid surveys were utilized for analyzing the data, representing a response rate of 61%. This response rate was relatively high because of COVID-19, and it was enough for consistent and reliable statistical testing.

3.1 Reliability

Reliability refers to the extent to which a questionnaire, observation, or any measurement process produces the same results on reiterated tests [43]. It allows measurement of the consistency of the responses on repeated application of the same measuring tool [44]. Therefore, a reliability indicator, Cronbach's alpha coefficient, was computed to test and confirm the internal reliability of the responses collected. Cronbach's alpha coefficient is computed as follows :

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum {\sigma_i}^2}{\sigma_X}\right) \quad (1)$$

Where, variance score of each factor is ${\sigma_i}^2$, variance of the total observed test score is $\sum {\sigma_i}^2$ and k is the number of factors [45]. Cronbach's alpha coefficient ranges from 0 to 1. Higher value implies strong linear internal consistency. Cronbach's alpha coefficient (α) mean value for all characteristics was observed at 0.963, which was considered outstanding as it was above the threshold value. The outcomes indicated that each respondent who chose a particular likert-scale score for one of the factors

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

causing delays in the Pakistani construction industry would probably give a similar score to the associated factors.

Similarly, external reliability was also measured by the initial questionnaire being sent to ten experts, such as four project managers, four managers on-site, and two academicians, all of whom had working experience of more than 10 years. They accurately verified the selected factors that reflected the proposed constructs, assessed the validity of the content, and checked the technical accuracy. Several amendments were made to the final draft of the survey questionnaire to determine the most important delay caused in the context of Pakistani construction. Some causes were combined with one another, and a few causes were added, adapted, changed, or excluded because of recurrence and ambiguity. This analysis of interviews with experts and a thorough review of the previous literature enabled us to generate an ultimate list of 49 critical factors causing the delay. These factors were classified into eight major categories as investor perspective, constructor perspective, advisor perspective, financial issues, planning and budgeting, coordination with stakeholders, determinants of construction projects, and miscellaneous factors as summarized in Table 1. Software called Statistical Package for Social Sciences (SPSS) version 25.0 for Windows was used to figure out how each factor and the total factors were linked. Thus, a significant p-value (which is less than 0.1) was found that ensured the reliability of the results outside of the study. As a result, it can be said that the 49 factors that caused the delay are valid and consistent.

Table-1. Redefined factors of delay causes and classification

Classification	No.	Factors Causing Delay
Investor Perspective		Investor enforces impractical contract duration
		Material type and specification frequently change during the construction process
		Vague and confusing requirements
		Lack of proactive participation of the investor
		Delay in allotting adequate site to contractors
Constructor Perspective		Inadequate experience of construction
		Poor supervision and management of the site
		Failure of management commitment
		Ineffectual construction methods
		Difficult instructions for work
		Absence of waste management strategy

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

	Inadequate use of man energy on account of construction inaccuracies
	Defected quality
	Frequent repairing of work
	Unorganized spare time
	Accidents during construction work
	Poor qualification technical staff
	Replacement of sub constructor during the construction stage
	Unnecessary subcontracting
Advisor Perspective	Design changes
	Preparing and approving the design
	Absence of skills to use advanced engineering design software
	Lack of quality control of finished works
Financial Issues	Liquidity issues faced by contractors
	Deferral of progress payment
	Price instabilities
Planning and Budgeting	Ineffective Planning and budgeting
	Inadequate collective planning
Coordination with Stakeholders	Lack of coordination between the concerned authorities
	Slow flow of information between stakeholders
	asymmetry information
	Disputes amongst participants
Determinants of Construction Project	Delay in material delivery
	Inferior materials used
	Inadequate handling of materials on site
	Improper warehousing of materials
	Scarce material
	Unskilled workforce
	Low capacity level of workers
	Insufficient experience of workmen
	Unnecessary transfer of labors
	Untrained employees
	Right staff not provided with the right position
	Shortage or damaged equipment

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

Miscellaneous Factors	Unpleasant weather
	Selection of inappropriate construction sites
	Robbery or theft
	Delay in receiving governmental agency's permission
	Shortage or delay of transportation

3.2 Validity

To validate the test, face validity was performed to assess the transparency or relevance [46]. Therefore, the initial questionnaire was sent to six external advisors for review. They were talented at designing an adequate questionnaire. Furthermore, they evaluated the survey instrument for transparency, completeness, and readability. Their feedback enabled us to make the necessary changes to the survey. In addition, the questionnaires were sent out in English, based on the advice of outside advisers and the preferences of the people who answered them, as well.

Correspondingly, the validity of the construct compares the actual measure of a questionnaire with the measure it was supposed to have [47]. It allows us to check and test whether a single factor is unearthed for each test. Moreover, Bartlett's test of sphericity and the Kaiser–Meyer–Olkin (KMO) test were also performed. The KMO coefficient for the 49 factors of delay was > 0.7 (KMO = 0.94), indicating enough intercorrelations. whereas Bartlett's test of sphericity = 7423.2 and significant p-value = 0.000, Therefore, H_0 was rejected, justifying that the data is suitable to ensure the validity of the construct and that variables can be further used to perform factor analysis.

4. Results

4.1 Sampling and compilation of data

Private and public stakeholders allied with the Pakistani construction industry were circulated about 540 questionnaires. The purpose of this survey involves several fields of specialization, for instance, roads, building, flyovers, bridges, and other technical engineering projects. A random sample was chosen from each field of specialization. In all, 330 professionals participated, of which 190 were contractors and 140 were consultants. Table 2 illustrates descriptive statistics and briefly summarizes respondents' profiles. Surprisingly, most of the respondents were found to be highly experienced, having more than 10 years of experience (51.51%), while most of them had a diploma (36.36%) and a bachelor's degree (33.33%). Although people with masters' (18.18%) and Ph.D. (12.12%) degrees possessed less quantity, they possessed sufficient knowledge, which to an extent validated the results obtained in this survey.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

Table-2. Description of the respondent's profiles.

Respondent's Profile	Frequency	Percentage (%)
Concerned Respondent		
Contractors	190	57.58
Consultants	140	42.42
Education		
Diploma	120	36.36
Bachelor's degree	110	33.33
Master's degree	60	18.18
Ph.D. degree	40	12.12
Experience		
≤ 5 years	115	34.84
5 to 10 years	45	13.64
≥ 10 years	170	51.51
Fields of specialization		
Building	150	45.45
Road, flyovers, and bridge projects	112	33.94
Technical engineering projects	68	20.61
Size of company		
Small (≤ 50 employees)	166	50.30
Medium (50 to 200 employees)	88	26.67
Large (≥ 200 employees)	76	23.03
Sector of construction		
Public	145	43.94
Private	185	56.06

4.2 Ranking of delay causes

Previously, several scholars specifically in Asia have performed a set of techniques to rank factors causing delays, such as MIR, AI, PLS-SEM, ANOVA, BVA, and PIPS, mean score value, MICMAC, IAA, and RII. Below, Table 6 shows that many of the literature from 2010 to 2021 (10 out of a total of 21) have adopted the RII technique. Thus, this study also used the RII (Relative Importance Index) technique to ascertain the relative importance of all the 49 factors individually in accordance with the level of importance perceived by contractors and consultants. The RII was calculated by applying the below equation:

$$\text{RII } \% = \frac{\sum_{i=1}^{5} a_i \times x_i}{A \times N} \times 100 \qquad (2)$$

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

The response classification index is denoted by i in the above equation, such as "1—not important, 2—slightly important, 3—moderately important, 4—very important, and 5—extremely important." The numerator consists of an a_i implies the numerical value given to the ith response, ranging between 1 and 5, and, x_i represents the frequency of the ith response in all answers given to i. In this study, denominator A indicates the maximum weight, such as 5. N refers to the total number of respondents. Here, the factors causing delays are identified, evaluated, and classified into nine categories in accordance with the Pakistani construction industry, for instance, investor perspective, constructor perspective, advisor perspective, financial issues, planning and budgeting, coordination with stakeholders, determinants of construction projects, and miscellaneous factors. Thus, the RII of each of the 49 factors causing construction delays is calculated and ranked based on the responses of individual group contractors and consultants. Moreover, the overall RII of every factor is ascertained through the replies of all survey respondents (combined view of contractors and consultants). Hence, the ranking of all factors causing delays in the Pakistani construction industry can be viewed in Table 3.

Table-3. Relative importance index of factors causing delay

No.	Factors Causing Delay	Contractor		Consultant		Overall	
		RII (%)	Rank	RII (%)	Rank	RII (%)	Rank
1	Investor enforces impractical contract duration	62.44	17	70.00	6	61.91	19
2	Material type and specification frequently change during the construction process	59.14	33	57.18	37	58.16	35
3	Vague and confusing requirements	50.00	48	49.44	48	49.72	48
4	Lack of proactive participation of the investor	62.02	20	61.56	25	61.79	21
5	Delay in allotting adequate site to contractors	63.30	14	62.82	22	63.06	16
6	Inadequate experience of construction	57.44	38	57.32	36	57.38	38
7	Poor supervision and management of the site	51.60	46	48.18	49	49.89	47
8	Failure of management commitment	60.86	26	59.30	32	60.08	29
9	Ineffectual construction methods	60.74	27	61.40	26	61.07	26
10	Difficult instructions for work	51.80	45	50.98	45	51.39	45

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

11	Absence of waste management strategy	62.98	16	73.20	1	62.70	18
12	Inadequate use of man energy on account of construction inaccuracies	61.60	21	68.46	8	59.26	33
13	Defected quality	64.04	12	65.50	16	64.77	12
14	Frequent repairing of work	63.20	15	66.62	11	64.91	13
15	Unorganized spare time	54.68	43	56.76	38	55.72	40
16	Accidents during construction work	52.34	44	52.54	44	52.44	44
17	Poor qualification technical staff	63.84	13	61.84	23	62.84	17
18	Replacement of sub constructor during the construction stage	60.54	28	58.02	35	59.28	32
19	Unnecessary subcontracting	65.42	11	64.94	17	61.58	22
20	Design changes	55.86	40	53.66	43	54.76	43
21	Preparing and approving the design	73.84	1	72.28	2	73.06	1
22	Absence of skills to use advanced engineering design software	59.78	32	59.30	32	59.54	31
23	Lack of quality control of finished works	60.22	29	63.24	20	61.73	23
24	Liquidity issues faced by contractors	61.18	24	61.70	24	61.44	25
25	Deferral of progress payment	66.38	8	66.28	15	66.33	8
26	Price instabilities	61.18	25	59.57	30	60.38	28
27	Ineffective planning and budgeting	68.40	5	68.26	9	68.33	5
28	Inadequate collective planning	62.34	18	66.34	13	64.60	11
29	Lack of coordination between the concerned authorities	72.88	2	72.22	3	72.55	2
30	Slow flow of information between stakeholders	66.18	9	66.35	14	66.27	9
31	asymmetry information	61.50	22	59.72	29	60.61	27
32	Disputes amongst participants	65.00	12	63.66	18	64.33	14
33	Delay in material delivery	65.96	10	63.52	19	64.74	10
34	Inferior materials used	57.56	36	60.56	27	59.06	34

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

35	Inadequate handling of materials on site	57.98	35	58.60	34	58.29	36
36	Improper warehousing of materials	55.54	41	55.64	41	55.59	41
37	Scarce material	58.72	34	56.34	39	57.53	37
38	Unskilled workforce	68.20	6	66.52	12	67.36	6
39	Low capacity level of workers	68.72	4	69.68	7	69.20	4
40	Insufficient experience of workmen	62.34	19	60.42	28	61.38	24
41	Unnecessary transfer of labors	59.90	30	59.59	31	59.74	30
42	Untrained employees	59.78	31	71.26	5	63.35	15
43	Right staff not provided with the right position	67.56	7	66.96	10	67.26	7
44	Shortage or damaged equipment	61.28	23	62.96	21	62.12	20
45	Unpleasant weather	56.28	39	55.22	42	55.75	39
46	Selection of inappropriate construction sites	49.26	49	50.14	47	49.70	49
47	Robbery or theft	50.74	47	50.56	46	50.65	46
48	Delay in receiving governmental agency's permission	69.78	3	72.14	4	70.96	3
49	Shortage or delay of transportation	55.00	42	56.06	40	55.53	42

Based on the above-mentioned ranking, ten major factors were extracted from the perception of contractors and consultants, individually illustrated in Table 4 as under:

Table-4. Ranking ten major factors of contractors and consultants individually

Contractor			**Consultant**		
Factors Causing Delay	**RII %**	**Rank**	**Factors Causing Delay**	**RII %**	**Rank**
Preparing and approving the design	73.84	1	Absence of waste management strategy	73.20	1
Lack of coordination between the concerned authorities	72.88	2	Preparing and approving the design	72.28	2

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

Delay in receiving governmental agency's permission	69.78	3	Lack of coordination between the concerned authorities	72.22	3
Low capacity level of workers	68.72	4	Delay in receiving governmental agency's permission	72.14	4
Ineffective Planning and budgeting	68.40	5	Untrained employees	71.26	5
Unskilled workforce	68.20	6	Investor enforces impractical contract duration	70.00	6
Right staff not provided with the right position	67.56	7	Low capacity level of workers	69.68	7
Deferral of progress payment	66.38	8	Inadequate use of man energy on account of construction inaccuracies	68.46	8
Slow flow of information between stakeholders	66.18	9	Ineffective planning and budgeting	68.26	9
Delay in material delivery	65.96	10	Right staff not provided with the right position	66.96	10

Similarly, Table 5 demonstrates the overall ranking of the ten major factors that caused delays in the Pakistani construction project. These ten factors belong to the following six groups being classified: advisor perspective (one factor), coordination with stakeholders (two factors), miscellaneous factors (one factor), determinants of construction projects (four factors), planning and budgeting (one factor), and financial issues (one factor). Thus, it is essential for both the contractors and consultants to focus on these factors, causing delays arising from the mentioned classifications. Analysis of the outcome also revealed that the top ten major factors based on the contractor's perceptions belonged to the overall ten major factors that caused the delay. In contrast, seven factors that caused delays were based on the perspective of the consultant.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

Table-5. Ten major factors of delays in the Pakistan construction industry

Classification	Ten Major Factors Causing Delay	Rank	RII (%)
Advisor Perspective	Preparing and approving design	1	73.06
Coordination with Stakeholders	Lack of coordination between the concerned authorities	2	72.55
Miscellaneous Factors	Delay in receiving governmental agency's permission	3	70.96
Determinants of Construction Project	Low capacity level of workers	4	69.20
Planning and Budgeting	Ineffective planning and budgeting	5	68.33
Determinants of Construction Project	Unskilled workforce	6	67.36
Determinants of Construction Project	Right staff not provided with the right position	7	67.26
Financial Issues	Deferral of progress payment	8	66.33
Coordination with Stakeholders	Slow flow of information between stakeholders	9	66.26
Determinants of Construction Project	Delay in material delivery	10	65.74

Kendall's W, also known as "Kendall's coefficient of concordance," was calculated to examine consistency in the ranking of the 49 delay factors among different groups of respondents.The value of Kendall W ranges between 0 and 1. Value 1 indicates full consensus, 0 implies no consensus, and if the value is 0.05, it is considered significant, which means general consensus among respondents [48]. Hence, Kendall's W value was calculated at 0.08, whereas the level of significance at 1% was 0.000, indicating significant agreement among 330 respondents on the ranking of 49 factors, respectively.

4.3 Spearman rank correlation

This study used a non-parametric test known as the Spearman rank correlation. The coefficient of spearman rank correlation, r-s, was computed to measure the relation, the intensity, and the direction of the association among the rankings of two parties, considering the delay caused by disregarding the third party [49, 33]. The equation for calculating the coefficient is highlighted by [50] as follows:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \quad (3)$$

Here, spearman's rank correlation coefficient is represented by p, difference in ranking of two respondents for every individual factor is referred to as d and N implies rank

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

pairs. Spearman's rank correlation coefficient lies between ±1, where −1 refers to disagreement or negative relation, 0 indicates no correlation, and +1 means agreement or positive relation. Thus, to determine the strength of the correlation between the contractor's and consultant's perceptions; a spearman rank correlation was performed to ascertain the level of concurrence between them. The r_s value was 0.94 for all individual factors and 0.98 for the classifications made for the factors causing the delay. The results showed that the contractors and the consultants agreed on a lot of things.

5. Discussion

The ten major factors causing delays discussed in the discussion above were based on the combined perceptions of both contractors and consultants in the Pakistani construction industry.

The first major factor, preparing and approving the design, causes delays because a change in design requires a revision of the project that results in claims by contractors and sometimes creates disputes between consultants and clients. The reasons behind this delay may be errors in design resulting from the inadequate preliminary study; limited field information; lack of adaptability; negligence of design staff; incomplete efforts in design; insufficient or incompetent recruitment of the design team; and lack of a quality control plan. It wastes time and money as the structure is rebuilt. Consequently, costs increase, and time is wasted, causing delays in the construction.

The second major factor is the lack of coordination between the concerned authorities, which causes failures in construction projects. It creates conflicts and disturbs work schedules. Poor coordination leads to insufficient resource allocation for assigned activities and increases the possibility of work schedule delays. Adequate communication between all stakeholders with clear technical instructions to the management on-site makes construction activity successful. [51] suggested using advanced cloud technology to improve the mode of communication. Building this model of information will make the environment digital and allow for dynamic interaction at all stages, which will help to avoid disputes and conflicts.

The third major factor, a delay in receiving permission from a governmental agency, also causes a delay because government agencies hold the authority to begin the construction process, which unfortunately adds to the overall schedule. It is very important for the Pakistani government to speed up administrative procedures and remove barriers so that the construction process can start on time.

The fourth most important factor is the low capacity level of workers. This causes delays because, usually, the owners provide an award to the lowest bidder for executing the construction project, and these are mostly unqualified contractors with limited resources and low capacity and capabilities. Hence, this leads to low performance and causes delays in completing the scheduled work.

Planning and budgeting are also the keys to successful construction projects. Pakistan's construction industry faces delays in work because of the fifth most important factor (ineffective planning and budgeting). As the traditional system of planning and budgeting is carried on, it eventually takes more time to complete work on time. Ineffective planning and budgeting refer to assigning tasks to the main contractor and its subcontractors to perform the strategic tasks according to the master

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

plan without considering factors that affect the execution of the work on time, for instance, the absence of materials and workers when required, insecure working environment, and lack of essential financial resources. In addition, the planning team must keep an eye on things and deal with problems quickly to avoid long delays.

The sixth major factor, an unskilled workforce, is a crucial obstacle that influences the timely fulfillment of the construction process. Unskilled and poor workmanship promote other problems such as defects in quality, errors in construction, and low levels of worker productivity. This greatly affects the overall performance of the construction process. Recruiting an unskilled workforce is inevitable. The Pakistan contractors of construction must mitigate this effect by ensuring proper supervision of their workforce on construction sites. Besides, workshops and training programs must be held to enhance their technical knowledge and make them familiar with new advanced construction technologies.

The seventh major factor, right staff not provided with the right position, refers to the inadequate qualification of the staff according to their position. This eventually leads to inefficiency on the part of the workforce and may cause mishaps during the construction process.

Correspondingly, the eighth major factor, deferral of progress payment in construction activity, refers to not funding the project on time. It leads to several financial issues for the main contractor and its respective sub-contractors. Moreover, they encounter difficulty in meeting their daily expenses too. This causes delays, and mostly Pakistani construction companies, which are not financially strong, face this issue because their payment period exceeds the time period, which hinders the progress compared to the duration of the contract.

The ninth major factor is the slow flow of relevant information between stakeholders. This exists because there are multiple levels of sub-contractors, which constitute a barrier to proper communication channels in developing countries like Pakistan. Here, major construction processes are sub-contracted and companies work in the informal sector, which becomes a severe problem for project execution, which is not considered a legitimate business.

Finally, the tenth major factor, delay in material delivery, also creates a problem for the construction process. Late delivery of materials will ultimately delay the construction process. In contrast, the contractors will incur costs earlier than planned if the delivery of material is earlier than scheduled. Consequently, this will generate cash flow problems. In addition, contractors won't be able to get time extensions if they get their orders late.

6. Comparison with other countries

This study aims to provide an overview of the factors that cause delays among Asian countries by examining ten major factors of delays. These studies in Asian countries have been carried out in the past 10 years, from 2010 to 2020. Although the scholar’s purpose and investigation methodologies were different, it is essential to understand the issues that arise in the construction industry in the context of Asia. After a survey of several factors, it was revealed that the most critical delay factor in the Pakistani

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

construction industry has also occurred in other countries in Asia. For instance, Malaysia, Iran, India, and Afghanistan are all significant past studies that have been summarized in Table 6 to compare the construction industry with Pakistan. Past researchers also talked about how important it is for construction projects to be finished on time, and they came up with categories for policymakers in the countries where these projects took place.

Table-6. Comparison with the construction industries of emerging countries

Authors	Regions	Causes Identified	Categories of Delay Factors in Construction Projects	Techniques Implemented
[13]	Taiwan	35	Planning Phase Design Phase	Relative Importance Index (RII)
[14]	Iran	28	Client Contractor Consultant Material Labour and equipment Contract Contract relationship External	Relative Importance Index (RII)
[52]	Iran	27	Consultant Contractor	Relative Importance Index (RII)
[17]	Turkey	34	Excusable delay Non-excusable delay	Mean Importance Rating (MIR)
[16]	India	45	Project related Site related Process related Human related Authority related Technical issues	Relative Importance Index (RII)
[33]	Iran	43	Client Consultant Contractor Material External issues Communication Interface	Relative Importance Index (RII)

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

			Contract Labour and equipment	
[24]	Malaysia	35	Contractor's Site Management related factors (CSM) Design and Documentation related Factors (DDF) Financial management related factors (FIN) Information and Communication related factors (ICT) Human resource (workforce) related factors (LAB) Non-human resource related Factors (MMF) Project Management and Contract Administration related factors (PMCA)	PLS-SEM
[53]	India	50	Financing related Scheduling and controlling technique Material related Plan related Contractual related Equipment related Governmental action related Labour related Design related Contractor related Consultant related External factor related Owner related Project related Engineer related Client related Operation related	Mean Score Value Ranking in SPSS
[15]	Bangladesh	35	Materials Manpower and equipment Owner Consultant Contractor	ANOVA and Pearson's Coefficient of

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

			Construction External cause	Rank Correlation
[54]	Turkey	83	Consultant Related Contractor Related Design Related Equipment Related External Related Labour Related Material Related Owner related Project related	Relative Importance Index (RII)
[55]	Pakistan	53	Project related Owner related Contractor related Consultant related Material related Equipment related Design related Labour related	Relative Importance Index (RII)
[56]	Sri Lanka	52	Client Contractor Consultant Materials Equipment Labour External factors.	Relative Importance Index (RII)
[57]	Bangladesh	79	Rules and Regulation Contractor Managerial Financing Owner Project Consultant Manpower and resource Environmental	Spearman's Rank Correlation
[18]	Saudi Arabia	28	Owner Contractor Other	Best Value Approach (BVA) and

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

				Performance Information Procurement System (PIPS)
[30]	Afghanistan	69	Client Contractor Consultant Labour Material and equipment External	Relative Importance Index (RII)
[20]	UAE	180	Factors related to clients Factors related to designers Factors related to project managers Factors related to contractors Labour related labour Problems of finance Factors related to contractual matters Problems of communication and information Problems of site and environment Problems of government and local authorities Other factors	Relative Importance Index (RII)
[34]	China	20	Contractor-related causes (CORC) Client-related causes (CLRC) Designer-related causes (DERC) Managerial-related causes (MARC) External-related causes (EXRC)	PLS-SEM
[35]	Pakistan	24	Design and documentation related issues Labour related issues Procurement related issues Site operation related issues	Mean Importance Rating (MIR)

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

[21]	Saudi Arabia	50	Factors before the award of tenders Factors during the award of tenders Factors after the award of tenders General factors	Average Index (AI)
[58]	India	56	Driving factors Dependent factors	Matriced' Impacts Croise's Multiplication Appliquée a UN Classement (MICMAC) analysis
[59]	Malaysia	52	Client Contractor Consultant Labour and equipment Material Other	Index Analysis Approach (IAA)

Table 6 of the study also revealed that the most critical delay factors in the Pakistani construction industry have occurred in other countries of Asia as well. For instance, Malaysia, Iran, India, and Afghanistan. So, contractors in Asia's newer countries should make sure their finances are safe and set up an effective planning system with qualified sub-contractors to deal with the difficulties of the construction process.

7. Conclusions and recommendations

To assess contractors' and consultants' perceptions regarding major factors causing delays in the construction industry of Pakistan, it was essential to conduct and analyze a questionnaire survey. Thus, this study determined those key factors that affect the construction process and ranked them accordingly by using the RII approach. The factors of delay were extracted from other countries' findings along with socio-economic factors pertinent to Pakistan, which were ascertained through semi-structured interviews with Pakistani experts. The findings of this study revealed high agreement between contractors and consultants, who assigned ranks to all factors or classified groups of factors after performing Spearman rank correlation. Results also show that the main causes of delays for both the builder and the consultant, as shown in Table 5, are not working together, not getting permission from the government, not

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

having enough workers, not planning well, and not giving the right people the right jobs at the right time.

The goal of this research is to make a significant contribution to Pakistani construction projects by controlling and preventing time overruns by reducing the critical delay they cause. Although this research specifically discusses Pakistan in the context of Pakistan, its findings would support construction stakeholders to better understand the main causes that adversely affect the productive completion of construction projects. Moreover, factors identified in this study are more or less found in previous studies conducted in Asia, which consolidate current knowledge with new evidence from Pakistan. Thus, to overcome the challenges and reduce the number of factors causing delays in Pakistan's construction industry, the concerned authorities must take systematic steps and are suggested to consider the following recommendations: :

- Preparing, approving, and reviewing the design submittals should be done prior to the construction phase. Furthermore, architecture and engineering must also complete design documents on-onset time and schedule.
- Coordination and communication among the parties related to project sites and work must be clear and transparent. It is important to use digital systems instead of traditional methods to avoid delays in the completion of building work.
- Government entities must well plan and organize their schedules. Their vision should be clear and strategic plans must be established. They must not delay in giving financial rights to contractors that need to be conveyed. Financial aid must be provided on time and if issues occur, they must be resolved with the help of domestic and international financial institutions such as banks or advisory bodies.
- To boost the productive capacity of the labor force, it is required to provide improved management skills to the construction staff. Training workshops and programs must be held to enhance their skills and methods to perform tasks on schedule. This would be cost-effective and help them save time without wasting energy. So, building information modeling (BIM) technology should be used, and enough money and time must be given to workers to finish their jobs on time.
- The Last Planner System (LPS) is an innovative approach that enhances workforce productivity and makes them accountable for well-planned, budgeted, and scheduled work through collaboration with all the project stockholders, such as contractors, sub-contractors, architects, clients, and suppliers. In addition, the planning team should keep an eye on the progress of the project to figure out how to solve any problems that might be causing the project to be late.
- Staff providing services during construction programs must receive adequate training in order to develop and improve their management skills.Moreover, technical supervision departments must also visit to ensure the progress of projects and benefit them through the transfer of informative experience.
- Recruitment must be based on merit, with qualified candidates being chosen for the position that they deserve. This would avoid biases and lead to successful construction projects.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

- Parties associated with different construction projects must duly review the disbursement clauses in the contract. A transparent procedure and timeline should be specified with the consent of everyone. Moreover, the payment process must be checked by the funding agencies at the planning stage to assure that companies are paid on time.
- Smooth information flow is possible if a web-based system of transferring information is adopted. It saves time and is also cost-effective. A system like a virtual private network (VPN) can be used because it allows people to communicate in a way that is limited to people in a certain group of people.
- The use of automation can reduce material delivery times. Although it is expensive to procure automated logistic software, it will help avoid delivery delays. It also makes it easier to figure out which product should be sent out based on when it was ordered.

Supplementary Materials: Not applicable

Funding:

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declear no conflict of intrest.

References

[1] Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of project management*, *25*(5), 517-526.

[2] Toor, S. U. R., & Ogunlana, S. O. (2008). Problems causing delays in major construction projects in Thailand. *Construction management and economics*, *26*(4), 395-408.

[3] Mahamid, I., Bruland, A., & Dmaidi, N. (2012). Causes of delay in road construction projects. *Journal of management in engineering*, *28*(3), 300-310.

[4] Khanh, H. D., & Kim, S. Y. (2014). Identifying causes for waste factors in high-rise building projects: A survey in Vietnam. *KSCE Journal of Civil Engineering*, *18*(4), 865-874.

[5] Enshassi, A., Al-Najjar, J., & Kumaraswamy, M. (2009). Delays and cost overruns in the construction projects in the Gaza Strip. Journal of Financial Management of Property and Construction, 14(2), 126–151. https://doi.org/10.1108/13664380910977592

[6] Arditi, D., Akan, G. T., & Gurdamar, S. (1985). Reasons for delays in public projects in Turkey. *Construction management and economics*, *3*(2), 171-181.

[7] Kaming, P. F., Olomolaiye, P. O., Holt, G. D., & Harris, F. C. (1997). Factors influencing construction time and cost overruns on high-rise projects in Indonesia. *Construction Management & Economics*, *15*(1), 83-94.

[8] Al-Khalil, M. I., & Al-Ghafly, M. A. (1999). Delay in public utility projects in Saudi Arabia. *International journal of project management*, *17*(2), 101-106.

[9] Koushki, P. A., Al-Rashid, K., & Kartam, N. (2005). Delays and cost increases in the construction of private residential projects in Kuwait. *Construction Management and Economics*, *23*(3), 285-294.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

[10] Faridi, A. S., & El-Sayegh, S. M. (2006). Significant factors causing delay in the UAE construction industry. *Construction Management and Economics*, *24*(11), 1167-1176.

[11] Sun, M., & Meng, X. (2009). Taxonomy for change causes and effects in construction projects. *International journal of project management*, *27*(6), 560-572.

[12] Farooqui, R., Ahmed, S., & Lodi, S. (2008). Assessment of Pakistani construction industry–current performance and the way forward. *Journal for the advancement of performance information and value*, *1*(1), 51-51.

[13] Yang, J. B., & Wei, P. R. (2010). Causes of delay in the planning and design phases for construction projects. *Journal of Architectural Engineering*, *16*(2), 80-83.

[14] Khoshgoftar, M., Bakar, A. H. A., & Osman, O. (2010). Causes of delays in Iranian construction projects. *International Journal of Construction Management*, *10*(2), 53-69.

[15] Rahman, M. D., Lee, Y. D., & Ha, D. K. (2014). Investigating main causes for schedule delay in construction projects in Bangladesh. *Journal of Construction Engineering and Project Management*, *4*(3), 33-46.

[16] Doloi, H., Sawhney, A., Iyer, K. C., & Rentala, S. (2012). Analysing factors affecting delays in Indian construction projects. *International journal of project management*, *30*(4), 479-489.

[17] Kazaz, A., Ulubeyli, S., & Tuncbilekli, N. A. (2012). Causes of delays in construction projects in Turkey. *Journal of civil Engineering and Management*, *18*(3), 426-435.

[18] Alzara, M., Kashiwagi, J., Kashiwagi, D., & Al-Tassan, A. (2016). Using PIPS to minimize causes of delay in Saudi Arabian construction projects: university case study. *Procedia Engineering*, *145*, 932-939.

[19] Durdyev, S., Omarov, M., & Ismail, S. (2017). Causes of delay in residential construction projects in Cambodia. *Cogent Engineering*, *4*(1), 1291117.

[20] Mpofu, B., Ochieng, E. G., Moobela, C., & Pretorius, A. (2017). Profiling causative factors leading to construction project delays in the United Arab Emirates. *Engineering, Construction and Architectural Management*, 24(2):346–376.

[21] Alsuliman, J. A. (2019). Causes of delay in Saudi public construction projects. *Alexandria Engineering Journal*, *58*(2), 801-808.

[22] Yaseen, Z. M., Ali, Z. H., Salih, S. Q., & Al-Ansari, N. (2020). Prediction of risk delay in construction projects using a hybrid artificial intelligence model. *Sustainability*, *12*(4), 1514.

[23] Liu, Y., Jarvamardi, A., Zhang, Y., Liu, M., Hsiang, S. M., Yang, S., ... & Jiang, Z. (2021). Comparative Study on Perception of Causes for Construction Task Delay in China and the United States. *Journal of Construction Engineering and Management*, *147*(3), 04020176.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

[24] Rahman, I. A., Memon, A. H., Aziz, A. A. A., & Abdullah, N. H. (2013). Modeling causes of cost overrun in large construction projects with partial least square-SEM approach: contractor's perspective. *Research Journal of Applied Sciences, Engineering and Technology*, *5*(06), 1963-1972.

[25] Sullivan, A., & Harris, F. C. (1986). Delays on Large Construction Projects. *International Journal of Operations & Production Management*, *6*(1), 25–33. https://doi.org/10.1108/eb054752

[26] Long, N. D., Ogunlana, S., Quang, T., & Lam, K. C. (2004). Large construction projects in developing countries: a case study from Vietnam. *International Journal of project management*, *22*(7), 553-561.

[27] Lo, T. Y., Fung, I. W., & Tung, K. C. (2006). Construction delays in Hong Kong civil engineering projects. *Journal of construction engineering and management*, *132*(6), 636-649.

[28] Hicham, H., Taoufiq, C., & Aziz, S. (2016, July). Last planner system: Implementation in a moroccan construction project. In *Proceedings of the 24th Annual Conference of the International Group for Lean Construction* (pp. 193-202).

[29] Frimpong, Y., Oluwoye, J., & Crawford, L. (2003). Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *International Journal of project management*, *21*(5), 321-326.

[30] Niazi, G. A., & Painting, N. (2017). Significant factors causing cost overruns in the construction industry in Afghanistan. *Procedia Engineering*, *182*, 510-517.

[31] Baldwin, J. R., Manthei, J. M., Rothbart, H., & Harris, R. B. (1971). Causes of delay in the construction industry. *Journal of the Construction Division*, *97*(2), 177-187.

[32] Kraiem, Z. M., & Diekmann, J. E. (1987). Concurrent delays in construction projects. *Journal of Construction Engineering and Management*, *113*(4), 591-602.

[33] Fallahnejad, M. H. (2013). Delay causes in Iran gas pipeline projects. *International Journal of project management*, *31*(1), 136-146.

[34] Chen, G. X., Shan, M., Chan, A. P., Liu, X., & Zhao, Y. Q. (2019). Investigating the causes of delay in grain bin construction projects: the case of China. *International Journal of Construction Management*, *19*(1), 1-14.

[35] Maqsoom, A., Khan, M. U., Khan, M. T., Khan, S., & Ullah, F. (2018). Factors influencing the construction time and cost overrun in projects: empirical evidence from Pakistani construction industry. In *Proceedings of the 21st International Symposium on Advancement of Construction Management and Real Estate* (pp. 769-778). Springer, Singapore.

[36] Kog, Y. C. (2019). A structured approach for questionnaire survey of construction delay. *Journal for the Advancement of Performance Information and Value*, *11*(1), 21-33.

[37] Saad, A., Zahid, S. M., & Muhammad, U. B. (2020). Role of awareness in strengthening the relationship between stakeholder management and project success in the construction industry of Pakistan. *International Journal of Construction Management*, 1-10.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

[38] Sanni-Anibire, M. O., Mohamad Zin, R., & Olatunji, S. O. (2020). Causes of delay in the global construction industry: A meta analytical review. International Journal of Construction Management, 1–13. https://doi.org/10.1080/15623599.2020.1716132

[39] Shang, G., & Sui Pheng, L. (2014). Barriers to lean implementation in the construction industry in China. *Journal of Technology Management in China*, *9*(2), 155–173. https://doi.org/10.1108/JTMC-12-2013-0043

[40] Abawi, K. (2008). Qualitative and quantitative research. *World Health*, *2*(1), 1-10.

[41] Gravetter, F. J., & Forzano, L. B. (2011). Research Methods for the Behavioral Sciences, Cengage. *Learning*.

[42] Saunders, M., Lewis, P., & Thornhill, A. (2009). *Research methods for business students*. Pearson education.

[43] Wragg, C. B., Maxwell, N. S., & Doust, J. H. (2000). Evaluation of the reliability and validity of a soccer-specific field test of repeated sprint ability. *European journal of applied physiology*, *83*(1), 77-83.

[44] Shang, G., & Sui Pheng, L. (2012). The adoption of Toyota Way principles in large Chinese construction firms. *Journal of Technology Management in China*, *7*(3), 291–316. https://doi.org/10.1108/17468771311325185

[45] Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *psychometrika*, *16*(3), 297-334.

[46] Holden, R. R. (2010). Face validity. *The corsini encyclopedia of psychology*, 1-2. https://doi.org/10.1002/9780470479216.corpsy0341

[47] Bagozzi, R. P., Yi, Y., & Phillips, L. W. (1991). Assessing construct validity in organizational research. *Administrative science quarterly*, 421-458.

[48] Siegel, S., & Castellan, N. J. (1988). The case of k related samples. *Nonparametric statistics for behavioral sciences. New York: McGraw-Hill*, 170-4.

[49] Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International journal of project management*, *24*(4), 349-357.

[50] Bajjou, M. S., & Chafi, A. (2020). Empirical study of schedule delay in Moroccan construction projects. *International Journal of Construction Management*, *20*(7), 783-800.

[51] Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). *International journal of project management*, *31*(7), 971-980.

[52] Pourrostam, T., & Ismail, A. (2011). Significant factors causing and effects of delay in Iranian construction projects. *Australian Journal of Basic and Applied Sciences*, *5*(7), 450-456.

[53] Ravisankar, K. L., & Anandakumar, S. (2014). Study on the quantification of delay factors in construction industry, 4(1):105–113.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online): 0493-2137
E-Publication: Online Open Access
Vol:55 Issue:04:2022
DOI 10.17605/OSF.IO/SRCK4

[54] Gunduz, M., Nielsen, Y., & Ozdemir, M. (2015). Fuzzy assessment model to estimate the probability of delay in Turkish construction projects. *Journal of Management in Engineering*, *31*(4), 04014055.

[55] Masood, R., Ali, M., Shafique, F., Shafique, M. A., Zafar, B., Maqsoom, A., & Ullah, Z. (2015). Investigating the delay factors of construction projects in metropolitan city of a developing country. *Journal of Civil Engineering and Architecture Research*, *2*(9), 947-955.

[56] Kesavan, M., Gobidan, N. N., & Dissanayake, P. B. G. (2015). Analysis of factors contributing civil engineering project delays in Sri Lanka. In *6th International Conference on Structural Engineering and Construction Management 2015* (pp. 40-46).

[57] Islam, M. S., Trigunarsyah, B., Hassanain, M., & Assaf, S. (2015, October). Causes of delay in construction projects in Bangladesh. In *The 6th International Conference on Construction Engineering and Project Management, Busan, Korea* (pp. 82-86).

[58] Shrivas, A., & Singla, H. K. (2020). Analysis of interaction among the factors affecting delay in construction projects using interpretive structural modelling approach. *International Journal of Construction Management*, 1-9.

[59] Yap, J. B. H., Goay, P. L., Woon, Y. B., & Skitmore, M. (2021). Revisiting critical delay factors for construction: Analysing projects in Malaysia. *Alexandria Engineering Journal*, *60*(1), 1717-1729.