Original article

CRITICAL DELAY FACTORS AFFECTING CONSTRUCTION PROJECT PERFORMANCE – A CONTEMPORARY PERSPECTIVE

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Received: 9 January 2024
Revised: 17 June 2024
Accepted: 10 October 2024

Abstract: The construction industry plays a crucial role in India's fiscal targets amid a growing emphasis on infrastructure development. Despite extensive project management knowledge, persistent delays afflict 33% of projects, averaging a 47-month setback as of August 2021. This study seeks to pinpoint Critical Delay Factors (CDFs) in contemporary construction projects, drawing from 59 attributes identified through literature and expert input. A questionnaire survey gauged expert opinions on the impact of these attributes. Factor analysis unveiled underlying constructs, revealing seven CDFs, and the Relative Importance Index (RII) ranked factors by significance. Across professional roles and regional distinctions, ANOVA demonstrated consistent CDF evaluations. These findings are anticipated to guide project stakeholders in prioritizing factors for effective delay management, promoting successful project outcomes.

Keywords: Critical delay factor; Construction; India; Project.

1. INTRODUCTION

The construction industry is a vital part of India's economy, making a significant contribution to the GDP. As of 2022, the industry was valued at over 3.3 trillion INR, representing nearly 9% of the GDP (Statista, 2022). Despite substantial investments, including Rs. 10 lakh crore allocated in the 2022-23 budget for infrastructure development, the industry faces persistent challenges. It's noteworthy that about 33% of infrastructure projects experience delays (MOSPI, 2014).

Project delays are a critical issue in the Indian construction sector, impacting the timely delivery and cost-effectiveness of projects. Although numerous studies have identified various factors causing these delays, there is a lack of comprehensive research addressing the evolving nature of these factors in the contemporary Indian context. Conventional project management metrics often fall short of adequately assessing and controlling these complexities (Gwaya et al., 2014).

This research aims to bridge this gap by identifying and analyzing Critical Delay Factors (CDFs) specific to the current Indian construction industry. By focusing on these factors, this study provides valuable insights for project managers and stakeholders to improve project outcomes and performance.

2. LITERATURE REVIEW

Project delays occur when completion extends beyond the estimated timeline due to various reasons. Delays negatively impact project timelines, budgets, quality, and stakeholder satisfaction (Baldwin et al., 1973; Chan & Kumaraswamy, 1997; Lovering, 1972; Shebob et al., 2012). Despite efforts to mitigate delays, construction projects rarely finish on schedule (Trauner et al., 2009).

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ISSN 2560-4961 (online)

https://doi.org/10.56889/fwfq7392

Considerable research is focussed on identifying the causes of delays in construction projects. Early studies, such as J. Baldwin et al., (1971), surveyed 1400 professionals and identified sixteen causes of delay, with weather, labour supply, and subcontractors' scheduling being the top three.
Assaf et al., (1995) in Saudi Arabia identified fifty-six delay causes in large building projects, categorizing them into nine groups, including materials, workforce, and financing. A follow-up study by Assaf and Al-Hejji, (2006) expanded to all large construction projects in Saudi Arabia, identifying seventy-three delay factors, with owner-related factors consistently ranked highest.

In Jordan, Battaineh, (1999) highlighted delays due to inadequate design and owner neglect, while Odeh and Battaineh, (2002) focused on traditional contracts, identifying inadequate contractor experience and owner interference as top causes. Alzara et al., (2016) examined delays in public educational projects, emphasizing the "Best Value Approach" and "Performance Information Procurement System".

Iranian studies by Pourrostam and Ismail, (2012) and Samarghandi et al., (2016) identified delay causes such as delay in progress payments and change orders, and categorized them into groups related to owners, contractors, consultants, and legal factors.

Chan and Kumaraswamy (1997) in Hong Kong found unforeseen site conditions and poor risk management as principal causes of delays. In Norway, Zidane and Andersen (2018) identified universal delay factors and compared them to those specific to the Norwegian construction industry.

In Turkey, Kazaz et al., (2012) and Gündüz et al., (2013) provided lists of delay factors, emphasizing managerial, financial, and labour-related factors. Gunduz et al., (2014) proposed a delay analysis model using fuzzy set theory, highlighting design-related factors as the most influential.

In India, Iyer and Jha, (2006) identified seven critical failure factors impacting schedule performance, including conflicts among project participants and indecisiveness. Doloi et al., (2012) extracted seven critical delay factors, such as a lack of commitment and inefficient site management.

These studies reveal that while there are shared delay factors globally, local conditions and project-specific variables significantly influence delays. As project management evolves, previously identified delay factors may no longer apply in contemporary settings.

This research focuses on identifying and prioritizing the key factors causing delays in the contemporary Indian construction industry. By examining current conditions alongside previously recognized factors, this study aims to offer a thorough analysis of the contributors to project delays specific to the Indian context.

3. RESEARCH METHOD

The objective of this research requires an analysis of perception-based responses from professionals in the construction sector, given that data on delay factors or attributes of delay in construction projects are rarely documented in official project records. Therefore, the primary research process is empirical quantitative research, and the research design is essentially a factor analysis design using a cross-sectional survey methodology. Hence, a general sample survey was best suited for capturing such details because it provides first-hand primary data that is reliable, accurate, and applicable to the research goals and is considered a good tool for investigating the perceptions based on the experience of the targeted population (McCombes, 2022).

4. DATA COLLECTION AND ANALYSIS

4.1 Survey design

Initially, a comprehensive list of 59 delay attributes was curated through an exhaustive review of literature and in-depth discussions with 'subject matter experts'. These consultations ensured the inclusion of attributes that accurately reflect the contemporary construction landscape.

The initial segment of the questionnaire was dedicated to gathering detailed information about the project participants, encompassing personal demographics and their extensive experience within the construction industry. This approach was taken to ensure a diverse and representative sample. Subsequently, respondents were tasked with assessing the impact of attributes of delay on the project, utilising a five point Likert scale. Additionally, an open-ended question was included to solicit suggestions for any supplementary attributes relevant to project delay.

After conducting a pilot survey involving 20 construction experts, modifications were made to the questionnaire in line with the inputs received, incorporating an additional demographic question and removing redundant attributes. The final questionnaire ultimately consisted of 45 delay attributes.

4.2 Sampling method, adequacy and response

Traditional random sampling turns out to be resource and time-intensive for a study that targets respondents spread nationwide. Accordingly, in such cases, employing snowball sampling for precision and efficiency is deemed appropriate (Leighton et al., 2021). Initial respondents from diverse organisations like CPWD, NBCC, and various PMCs were identified and asked to share the questionnaire with their network as well. The online survey was conducted using Google Forms and garnered 213 responses, meeting the recommended sample size criteria for Exploratory Factor Analysis (EFA) (Hogarty et al., 2005; Velicer & Fava, 1998) and also met the recommended N:P ratio of 5 for EFA (Gorusch, 1983). Data analysis in SPSS version 27 demonstrated high internal reliability (Cronbach's Alpha > 0.9) and moderate correlations (0.3 < r < 0.7) (George & Mallery, 2003; Nunnally & Bernstein, 1994). Therefore, the sampling size of 213 responses seemed adequate and fit for further analysis.

Table 1: Reliability analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
0.972	0.973	45

4.3 Data screening

An exploratory factor analysis (EFA) requires scrutinising the data beforehand for potential biases that might influence the outcomes (Hair et al., 2019; Tabachnick and Fidell, 2019). These biases may arise from factors such as limited score variability, type of data distribution, outliers, and missing data.

Limited score variability, meaning values lie within a narrow range, can hinder various statistical analyses, including correlation assessments and EFA (Lorenzo-Seva & Ferrando, 2020). The study employs a comprehensive survey approach that includes a wide array of construction professionals across different roles, ensuring balanced representation within the expert construction community and mitigating limitations in response diversity.

Table 2: Distribution of representative experts

Role	Nos	Percent	Experience	Nos	Percent	Project size	Nos	Percent
Client/Owner	58	27.2	< 5 years	30	14.1	< 5 Cr	25	11.7
Contractor	53	24.9	5 - 10 Years	46	21.6	5 - 10 Cr	12	5.6
Consultant	102	47.9	10 -15 Years	54	25.4	10 - 50 Cr	41	19.2
			> 15 Years	83	39.0	50 -100 Cr	51	23.9
						> 100 Cr	84	39.4
Total	**213**	**100**		**213**	**100**		**213**	**100**

Additionally, responses for all variables span from 3 to 4 on a five-point Likert scale, reflecting a broad range of scores. However, certain variables have mean values below three and median scores of less than two, indicating a perceived minimal impact on overall delays. Consequently, three variables (DA22, DA35, DA41) were excluded, leaving 42 attributes for further analysis.

The univariate normality test results for skewness and kurtosis (Curran et al., 1996) are within acceptable limits, indicating a reasonably normal univariate data distribution.

Table 3: Results of univariate normality test

Delay attributes	N=45
Max Value of Skewness	1.339
Max Value of Kurtosis	1.518

Nevertheless, Mardia's multivariate normality test uncovers significant deviations in both skewness and kurtosis, showing a lack of multivariate normality, affecting EFA's selection of extraction methods (Watkins, 2021).

Table 4: Results of multivariate normality test

Delay attributes	b	z	p-value
Skewness	599.19	21271.48	0.000
Kurtosis	2080.29	27.88	0.000

Regarding univariate outliers, extreme values were identified but are likely representative responses on a Likert scale. Multivariate outlier testing using Mahalanobis metrics indicates the presence of a few outlier cases.

Table 5: Results of Multivariate Outlier Test

Residuals statistics	DA (42 Var)			
	Min	Max	Chi 0.001	N
Mahal. Distance	12.468	91.29	76.084	213
Cook's Distance	0.000	0.136		213

However, upon closer examination, these outliers match the variables identified in univariate testing for outliers. The influence of these on "predictor variables" is minimal as Cook's distance metric is within acceptable limits. Thus, these outliers are unlikely to significantly affect variable scores. Additionally, the online survey's mandatory response format ensures the dataset is complete, with no missing entries.

Based on the above considerations, the data appears suitable for further exploratory factor analysis.

4.4 Exploratory factor analysis

Checking the appropriateness of data for EFA, selecting the factor analysis model and factor extraction method, and deciding on the number of factors to be retained and the method of rotation to be employed are the essential steps to be carried out and reported in an EFA process (Watkins, 2021).

4.4.1 Data appropriateness

Exploratory Factor Analysis (EFA) relies on a correlation matrix, requiring acceptable covariance within it. This can be visually assessed by looking for multiple correlation coefficients ≥ .30 (Hair et al., 2019; Tabachnick & Fidell, 2019). Bartlett's test of sphericity assesses matrix appropriateness, and the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy provides a comprehensive evaluation of correlation matrix appropriateness (Kaiser, 1974). While Kaiser initially set a threshold of .50, experts suggest ≥ .60, with ≥ .70 preferable (Hoelzle & Meyer, 2012; Watson, 2017).

A visual inspection of the correlation matrix reveals significant correlations above 0.3, with none exceeding 0.80. Bartlett's test of sphericity confirms that the correlation matrix is not an identity matrix. The KMO measure also indicates suitability, showing an overall score of 0.89, with individual variable values exceeding 0.70.

Table 6: KMO Test and Bartlett's test of Sphericity

Kaiser-Meyer-Olkin measure of sampling adequacy		0.896
Bartlett's test of sphericity	Approx. Chi-Square	5392.518
	df	861
	Sig.	0.000

These metrics together indicate that the correlation matrix is well-suited for performing exploratory factor analysis (EFA).

4.4.2 Factor analysis model

Researchers emphasise considering two models: "principal components analysis" (PCA) and "common factor analysis". Watkins, (2021), citing Widaman, (2018), argues that if the goal is to understand and present latent constructs or factors, only FA techniques should be used, not PCA, while further citing other authors/researchers like Bandalos, (2018), Finch, (2013); Haig et al., (2018), who have also expressed similar opinions while stressing the fact that the variables in real life do have some error variance.

This study hypothesises that a large set of project delay attributes can be simplified using underlying factors. Accordingly, a common factor model meets this study's requirements.

4.4.3 Extraction of factor

The primary distinction between methods of extracting factors lies in the choice between "Maximum Likelihood" (ML) and "Least Squares" approaches. ML relies on data randomness and multivariate normality assumptions, whereas least squares methods do not make distributional assumptions (Fabrigar & Wegener, 2012).

Since multivariate normality is not established, as discussed in the data screening section, the ML extraction method would not be suitable, and a least squares approach (PA) is employed. This aligns with the recommendations of other researchers like Watson (2017), who suggest that ML may be suitable for large sample data showing multivariate normality, while principal axis factoring may be more appropriate for smaller samples with non-normal data distributions.

4.4.4 Number of factors

A critical decision-making step in Exploratory Factor Analysis (EFA) is determining an appropriate number of factors (Tabachnick & Fidell, 2019). Scholars advise integrating empirical techniques and theoretical insights in this process (Hair et al., 2019) and suggest various empirical guidelines such as Parallel Analysis, Minimum Average Partial (MAP) method, and Cattell's value graphing method.

Parallel Analysis was conducted using O'Connor's syntax command file, with 213 cases and 42 variables. Real eigenvalues were then calculated based on the discussed factor model and extraction method in SPSS. MAP results were also obtained using the corresponding syntax file.

Table 7: Result of "Parallel Analysis"

Factor	Eigenvalues	
	Real	Random
1	12.996	1.178
2	3.935	1.061
3	2.252	0.973
4	1.339	0.895
5	1.122	0.831
6	0.912	0.772
7	0.815	0.715
8	0.752	0.661
9	0.595	0.612

Table 8: Minimum average partial results

The smallest average squared partial correlation is	0.0133
The smallest average 4th power partial correlation is	0.0006
The Number of Components as per original MAP Test (1976) is	4
The Number of Components as per revised MAP Test (2000) is	7

The findings suggest that retaining around seven to eight factors provides an optimal balance between inclusiveness and simplicity, consistent with both empirical data and theoretical foundations.

4.4.5 Factor rotation

Rotation techniques encompass both orthogonal rotations (resulting in uncorrelated factors) and oblique rotations (allowing for factor correlations). While orthogonal rotations are favoured for their simplicity and straightforward interpretation, oblique rotations are advocated for their precision and to acknowledge the fact that most variables are correlated to some degree (Bandalos & Finney, 2018). (Watkins, 2021), citing Schmitt, (2011), affirms that oblique rotations are generally preferable as they tend to yield more realistic and statistically robust factor structures. Hence, an oblique rotation is considered suitable for this study.

4.5 Result of exploratory factor analysis

Using the previously outlined methodology and parameters, forty-two variables underwent factor analysis. An initial solution was obtained in SPSS without placing any restriction on the number of factors in the parameter selection. Following the standard guideline advocated by many researchers (Fabrigar et al., 1999; Gorsuch, 1983), factor loadings below 0.30 were omitted from the analysis to facilitate substantive interpretation. The approximation threshold for significant factor loadings, as proposed by (Norman & Streiner, 2014) given by (5.152) / √(N-2), yielded 0.35 for the data set. This value exceeded the chosen cutoff of 0.30 for the analysis.

The initial solution pointed to eight factors, supported by “eigenvalues” surpassing 1.0, collectively explaining 58% of the total variance. However, some variables exhibited low intercorrelations and loaded onto more than one factor with low loading values, rendering interpretation impractical. Consequently, twelve such variables were removed, and EFA was rerun on the remaining thirty attributes using the same parameters as before. Removing variables did not significantly change the KMO value, which remained relatively high, dropping slightly from 0.896 to 0.881. Additionally, “Bartlett’s test” continued to yield a significant result. The revised solution consisted of seven factors explaining 56% variance. The factor solution is thus obtained is provided in Table 9 below.

Table 9: Final EFA results

Delay attributes	**Factor**						
	1	**2**	**3**	**4**	**5**	**6**	**7**
DA30_Inadequate and irregular quality check system	0.764						
DA29_Poor site management and Supervision	0.733						
DA31_Poor Communication channels between team members	0.609						
DA33_Poor coordination among parties	0.466						
DA34_Bureaucracy in client's organisation	0.371						
DA1_Inadequate initial planning of project		0.716					
DA4_Changes in Design by owner during construction		0.618					

DA5_Inaccurate design criteria by owner/consultant		0.450					
DA10_Variation orders/changes of scope by owner during construction		0.413					
DA8_Non availability of drawing/design on time			0.615				
DA6_Inadequate details in the drawings			0.573				
DA44_Ambiguity in specifications and conflicting interpretation by parties			0.496				
DA7_Poor constructability of the design.			0.385				
DA37_Hostile Public interruptions				0.699			
DA36_Adverse weather conditions				0.697			
DA42_Restricted access at site				0.663			
DA39_Issues regarding permissions/ approvals from other stakeholders				0.662			
DA40_Force majeure: war, revolution, riot, strike, earthquake, etc.				0.623			
DA38_Differing or unforeseen site/subsurface conditions				0.581			
DA43_Site accidents due to negligence/lack of safety measures				0.484			
DA26_Slow decision making by Client					-0.777		
DA27_Delay in approval of completed stages by client					-0.668		
DA28_Inadequate project monitoring and feedback by Client					-0.662		
DA32_Conflict between owners and other parties					-0.378		
DA19_Shortages of materials / Delay in procurement of material by Contractor						0.756	
DA18_Contractor’s financial difficulties						0.719	
DA20_Shortage of equipment						0.651	
DA2_Inadequate initial technical/Cost assessment by Contractor							-0.596
DA3_Inaccurate estimation of material quantities							-0.473
DA15_Gap between construction costs and stage payments							-0.433

This aligned with the number of factors recommended by both Parallel Analysis (PA) and Minimum Average Partial (MAP) analysis, making it an acceptable factor solution. Reliability analysis using Cronbach’s Alpha yielded results presented in Table 10.

Table 10: Internal reliability assessment of factors

Factor	**No. of Attributes**	**“Cronbach's Alpha” (C_α)**
Factor 1	5	0.820
Factor 2	4	0.686
Factor 3	4	0.765
Factor 4	7	0.866
Factor 5	4	0.759
Factor 6	3	0.822
Factor 7	3	0.733

While a Cronbach's alpha of 0.70 or higher is commonly deemed acceptable, lower values (e.g., 0.60) may suffice for initial reliability assessment (DeVellis & Thorpe, 2021). All extracted factors exhibit robust internal reliability, affirming that the attributes within each factor collectively contribute to a shared underlying construct.

5. DISCUSSION OF CRITICAL DELAY FACTORS

To facilitate the communication of EFA results, naming factors rooted in the conceptual foundation of factors is typically done (Thomas G. Reio & Shuck, 2015). The following sections provide an interpretation of the factors and outline the rationale behind their naming.

***Delay Factor 1* : Poor quality assurance and site management**

This factor comprises five measured variables contributing to project delays. These attributes indicate insufficient quality control measures and inefficient on-site management practices. The attribute *'Inadequate and Irregular Quality Check System*' results directly from poor-quality assurance and site management. It highlights a broader issue with the overall quality control framework when oversight of quality checks is lacking. *'Poor Site Management and Supervision'* is a key component, impacting various project aspects like quality, efficiency, and adherence to timelines. Additionally, subpar site management often leads to '*poor communication channels'*, causing misunderstandings, conflicting instructions, and project delays.

'Poor Coordination Among Parties' directly stems from deficient site management, hindering seamless coordination among project stakeholders. This can result in overlapping tasks, resource misallocation, and conflicts, contributing to delays. Similarly, inadequate site management practices can potentially worsen *bureaucratic challenges* within the client's organisation, amplifying delays in decision-making and approval processes. Therefore, "Poor Quality Assurance and Site Management" is an umbrella term encompassing interconnected attributes and shares a common root cause: the inadequacy of quality control measures and the inefficiency of on-site management practices.

***Delay Factor 2*: Inadequate pre-project diligence by owner**

On this factor, four measured variables loaded prominently encompassing critical aspects related to initial project planning and design criteria, all indicative of inadequate due diligence. For example, '*Inadequate Initial Planning of Project'* attribute underscores the significance of robust initial planning. An owner failing to conduct adequate due diligence may result in a superficial or incomplete project plan. Inadequate pre-project diligence might result in evolving needs or a lack of a well-defined design plan, leading to later adjustments during construction, manifesting as '*Changes in Design by Owner During Construction'*. *Inaccurate Design Criteria by the Owner* also signifies a lack of thorough pre-project investigation. Similarly, the presence of '*variation orders and changes in project scope'* initiated by the owner during construction points to a potential deficiency in the initial project definition. In summary, when an owner does not conduct adequate pre-project planning and investigation, it can lead to a range of challenges, including incomplete initial planning, evolving design needs, unclear design criteria, and the need for variations in project scope and, therefore, the factor is aptly named "Inadequate Pre-project Diligence by Owner".

***Delay Factor 3*: Deficiency in design information integrity and accessibility**

Four measured variables loaded prominently onto Factor 3. These variables collectively point towards the significance of the deficiencies in design-related information's availability, accuracy, and usability. '*Non-availability of Drawing/Design on Time*' as an attribute is a direct consequence of the underlying factor. When design information is not accessible on time, it indicates a breakdown in the flow of crucial information. This lack of accessibility stems from inefficient processes and systems for organising and disseminating design data.

Design Information Integrity and Accessibility is fundamental in ensuring that design details are complete and comprehensible; hence, when design information lacks the necessary level of detail (‘*Inadequate Details in the Drawings’)*, it reflects a deficiency in the integrity of the information provided. This deficiency can be attributed to inadequacies in the processes governing the creation and verification of design documentation.

When *specifications are ambiguous or subject to conflicting interpretations*, it indicates a lack of integrity in the design information provided. This ambiguity arises from shortcomings in the processes for defining and articulating project requirements. The attribute ‘*Poor Constructability of the Design’* is again a manifestation of the underlying factor of "Design Information Integrity and Accessibility", as the factor is integral in ensuring that designs are not only conceptually sound but also practically constructible. Addressing constructability concerns requires additional time and resources, leading to delays in project execution.

Therefore, as described above, the factor is aptly named "Deficiency in Design Information Integrity and Accessibility", as deficiencies in this factor lead to a cascade of challenges, including delayed access to crucial information, inadequate detailing, specification ambiguities, and constructability issues.

***Delay Factor 4:* External constraints and site dynamics**

This factor had seven measured variables loading prominently onto it. Within this factor, these variables collectively indicate a range of external factors and site-specific conditions that can substantially influence the progress of construction projects. ‘*Hostile Public Interruptions’* represent an external constraint that can disrupt construction activities. These interruptions can arise from various events such as protests, demonstrations, or public gatherings. ‘*Adverse Weather Conditions’* are integral to the external constraints that affect construction projects. Adverse weather, including heavy rain, storms, extreme temperatures, or other environmental factors, can impede construction activities, leading to delays in the project schedule.

Similarly, ‘*site access restrictions’* are a direct consequence of external constraints. These restrictions can arise due to factors such as limited entry points, nearby construction activities, or zoning regulations. When site access is restricted, it can lead to logistical challenges in transporting materials and equipment, as well as congestion issues. ‘*Issues Regarding Permissions/Approvals from Other Stakeholders’* highlights the influence of external constraints, as the project's progress is contingent on interactions with various external entities, such as regulatory authorities or neighbouring property owners. Delays or complications in obtaining these permissions can significantly impact project timelines. ‘*Force majeure’* events represent extreme and uncontrollable external circumstances. These events, including war, revolution, riots, strikes, earthquakes, and similar occurrences, can profoundly impact construction projects. *‘Unpredictable site or subsurface conditions’* represent a significant external dynamic. These conditions may only become apparent after the commencement of construction activities. They can include unexpected soil characteristics, hidden obstructions, or geological features. Dealing with these unforeseen conditions necessitates adaptability and can lead to necessary adjustments in project execution.

Therefore, it can be concluded that the factor "External Constraints and Site Dynamics" serves as the underlying cause for the identified attributes. It encompasses a range of uncontrollable external factors and site-specific conditions that significantly influence the progress of construction projects.

***Delay Factor 5:* Poor client engagement**

Four measured variables loaded prominently onto this factor. Within this factor, the attributes seem to represent a deficiency in the client's active involvement, responsiveness, and effectiveness in guiding the construction project. Therefore, the factor is called “Poor Client Engagement”.

The measured variable ‘*Slow Decision Making by Client’* is a direct consequence of poor client engagement. When the client is not sufficiently engaged or responsive, it leads to delays in the decision-making process. This delay can be attributed to factors such as a lack of timely attention or a complex decision-making structure within the client's organisation. Poor Client Engagement directly influences the client's efficiency in '*approving completed stages of the project'*. Inadequate client engagement can result in delays in reviewing and providing feedback on completed work. This may be due to a diminished sense of urgency or a lack of prioritisation in the client's engagement with the project. Similarly, the variable '*Inadequate Project Monitoring and Feedback by Client'* reflects the consequence of insufficient client engagement in project oversight. When the client is not actively engaged in monitoring progress or providing timely feedback, it can lead to uncertainties and inefficiencies. This may result from a lack of consistent communication channels or a reduced emphasis on project oversight.

While the attribute '*Conflict Between Owners and Other Parties'* is somewhat less strongly correlated with the others, the genesis of this attribute still lies in poor client engagement because poor client engagement may exacerbate conflicts, as the client may not be effectively mediating or resolving disputes or providing a conducive atmosphere for all stakeholders to work effectively without conflicts arising in the first place. This can lead to delays as conflicts remain unresolved or require third-party intervention. In summary, "Poor Client Engagement" is at the core of the identified attributes. It signifies a deficiency in the client's active involvement and responsiveness in critical aspects of the construction project.

***Delay Factor 6*: Constraints in resource availability**

Factor 6 exhibited significant loading with three measured variables. The underlying construct for these attributes could be termed "Constraints in Resource Availability." This construct encompasses the various challenges and limitations the contractor faces in terms of materials, financial resources, and equipment, all of which can significantly impact construction projects. The variable '*Shortages of Materials / Delay in Procurement of Material by Contractor'* indicates that the contractor may face challenges in procuring necessary materials for the construction project. Shortages or delays in material procurement can occur due to various factors, such as supply chain disruptions, logistical issues, or unforeseen demand spikes. These constraints directly impact the contractor's ability to execute work on schedule.

Similarly, the '*Contractor's Financial Difficulties'* are only a manifestation of his resource constraints. When a contractor faces financial difficulties, it can lead to constraints in funding necessary resources for the project, including materials, labour, and equipment. This can result from various factors, such as cash flow challenges, unexpected costs, or economic downturns. When the contractor's resources are constrained, it results in the '*shortage of equipment'* at the site, though sometimes the equipment shortages may arise from factors like maintenance issues. In conclusion, "Constraints in Resource Availability " examines how the contractor's resources affect project execution. It looks at challenges like material availability, financial stability, and equipment adequacy.

***Delay Factor 7*: Poor appraisal competence of contractor**

Three measured variables loaded prominently onto Factor 7. Within this factor, the variables seem to indicate a deficiency in the contractor's proficiency in technical assessment, cost estimation, and material quantity evaluation. In other words, they are indicative of the 'Poor Appraisal Competence of Contractor'. The attribute of '*inadequate initial technical and cost assessment'* is a direct consequence of poor appraisal competence on the contractor's part. When the contractor lacks the necessary expertise or resources to conduct thorough assessments at the project's outset, it leads to inaccuracies in project planning, budgeting, and scheduling. Poor appraisal competence of the Contractor directly influences the '*accuracy of material quantity estimations'* made by the contractor. When material quantities are inaccurately estimated, it can lead to shortages, delays, or excess costs during construction. This inaccuracy directly results from the contractor's insufficient appraisal competence, which may stem from inadequate site surveys or limited knowledge of specific project requirements.

'Gap Between Construction Costs and Stage Payments' reflects discrepancies between the actual construction costs incurred by the contractor and the payments received at various stages of the project. If a contractor is not proficient in appraising the project documents properly and thereby accounts for these gaps by ensuring sufficient provision for contingencies in line with these stages, the misalignment between costs and payments could strain the contractor's cash flow and financial stability, thereby derailing the entire project. Therefore, Factor 7 is aptly named "Poor Appraisal Competence of Contractor" as it signifies a deficiency in the contractor's proficiency in accurately assessing technical aspects, estimating costs, and evaluating material quantities.

6. RANKING OF FACTORS

Once the factors are extracted, it is important to assess not only the magnitude of each factor's contribution but also its relative significance within the broader system. For this purpose, the calculation of summated scores constitutes a crucial step in the data analysis process, enabling one to conduct a wide array of statistical analyses such as Relative Importance Index (RII) and Analysis of Variance (ANOVA) effectively (Stevens, 2002). Accordingly, summated factor scores were calculated for the extracted delay factors by adding the individual's responses to the items or variables that fall within a factor (Tabachnick & Fidell, 2013).

RII provides valuable insights into the relative ranks and prioritisation of factors and is chosen over other straightforward methods like mean and standard deviation as they are not capable of taking into account the nuanced understanding of the relative importance of each factor in the context of the entire system and may treat all factors equally (Iyer & Jha, 2006; Kumaraswamy & Chan, 1998).

The Relative Importance Index (RII) in the given case can be determined using the below given formula:

$$RII_i = \frac{\Sigma(W_i \times X_i)}{N \times H_i}$$

Where:

- RII_i is the Relative Importance Index for the i^{th} factor
- W_i is the weighted total calculated score of the i^{th} factor.
- X_i is the mean score of the i^{th} factor.
- N is the total number of factors.
- H_i is the highest score that can be accorded to the factor i.

The product $W_i \times X_i$ is calculated by determining the different categories of summated factor scores within a specific factor and multiplying each category by its corresponding frequency. The highest possible factor score is derived by multiplying the highest rating that can be accorded to a variable (5) by the number of variables that load onto a particular factor.

Using the above methodology, RII is calculated for all factors.

Table 11: Relative importance index ranking of factors

Critical delay factor	No. of respondents 'N'	Highest score for factor 'H'	Weighted total score 'W'	RII 'W/(N x H)'	Mean score 'W/N'	Rank
CDF 1: Poor Quality Assurance and Site Management	213	25	4064	0.763	19.080	4
CDF 2: Inadequate Pre-project Diligence by Owner	213	20	3770	0.885	17.700	1
CDF 3: Deficiency in Design Information Integrity	213	20	3244	0.762	15.230	5
CDF 4: External Constraints and Site Dynamics	213	35	5273	0.707	24.756	7
CDF 5: Poor Client Engagement	213	20	3581	0.841	16.812	2

CDF 6: Constraints in Resource Availability	213	15	2664	0.834	12.507	3
CDF 7: Poor Appraisal Competence of Contractor	213	15	2279	0.713	10.700	6

The most influential factor contributing to delays, according to the RII, is identified as "*Inadequate Pre-project Diligence by Owner*". This underscores the critical importance of thorough pre-project assessments and planning by the owner. This factor, though having received the third highest average score, is ranked first in terms of its impact on the project delay. This indicates that this factor, though deemed critical, is relatively often overlooked in terms of its impact on causing delays and may have a substantial effect on delay despite not being commonly acknowledged.

Following closely in importance is the factor of "*Poor Client Engagement*" (CDF 5). This indicates that active and engaged involvement from the client is crucial in minimising delays. The third most critical delay factor is "*Constraints in Resource Availability*" (CDF 6), while "*Poor Quality Assurance and Site Management"* (CDF 1) is identified as the fourth most critical delay factor. "*Deficiency in Design Information Integrity*" (CDF 3) is ranked fifth in importance, indicating that accuracy and integrity in design information are crucial for timely project execution. "*Poor Appraisal Competence of Contractor*" (CDF 7) is perceived as the sixth most critical delay factor. "*External Constraints and Site Dynamics*" (CDF 4), while still significant, is regarded as the least critical among the identified delay factors. Interestingly, despite receiving the highest average score, it is ranked last in terms of its relative importance in contributing to project delays. This indicates a disparity between its perceived severity and its actual impact on project timelines and indicates that while external factors and site-specific dynamics can contribute to delays, they are not considered the primary drivers. Factors such as pre-project diligence, client engagement, and resource availability hold greater weight in preventing delays.

7. EVALUATIONS ACROSS CATEGORICAL GROUPS

This section focuses on analyzing the assessments made by different categorical groups within the dataset, allowing for an in-depth understanding of how various groups perceive and evaluate the identified delay factors. By scrutinizing these evaluations, we can identify potential variations in perspectives based on roles, geographical location or other distinguishing characteristics, which may provide valuable insights into the factors influencing project delays from diverse viewpoints.

Employing the Analysis of Variance (ANOVA) methodology emerges as the most robust approach that has been widely utilised in similar studies to detect significant variations across categorical groups (Barbur et al., 1994; De Smith, 2015). Since the interest in finding the discrepancies between categorical groups is primarily focused on respondents' scoring, the summated factor score is used for analysis within the categories under investigation.

Using "Role" as a grouping variable and the summated scores of CDF1 to CDF7 as variables, the Levene's statistic was found to be non-significant for all seven variables at an alpha level of 0.05. This indicates that the assumption of homogeneity of variances holds for these variables, suggesting that the variances of the groups do not differ significantly. Subsequently, one-way ANOVA was conducted in SPSS to assess whether the mean scores for CDF1 to CDF7 differ across the various roles in the construction industry. The results of this analysis are presented in Table 12, which outlines the F-values, p-values providing insights into how the perceived importance of delay factors varies based on the role of the respondent.

Table 12: Results of One-way ANOVA across categorical variable "Role"

Variables	SS	df	MS	F	Sig.
CDF 1: Poor Quality Assurance and Site Management	94.566	2	47.283	5.949	0.003
CDF 2: Inadequate Pre-project Diligence by Owner	23.655	2	11.827	3.116	0.046
CDF 3: Deficiency in Design Information Integrity	1.160	2	0.580	0.086	0.918
CDF 4: External Constraints and Site Dynamics	84.708	2	42.354	2.378	0.095
CDF 5: Poor Client Engagement	12.614	2	6.307	1.254	0.287
CDF 6: Constraints in Resource Availability	6.596	2	3.298	1.142	0.321
CDF 7: Poor Appraisal Competence of Contractor	0.120	2	0.060	0.017	0.983

It can be observed that the 'p-value' for all variables with an exception of CDF1 and CDF2 is more than the significance value of 0.05, meaning there is no statistically significant variance in scores across assessments made by Clients, Consultants and Contractors. The results indicate that for the critical delay factors "Poor Quality Assurance and Site Management (CDF1)" and "Inadequate Pre-project Diligence by Owner (CDF2)", there are statistically significant differences in how these three groups perceive their impact on project delay.

A post-hoc analysis of the variable using Gabriel's test was conducted to show the pairwise differences between the groups. Gabriel's test is considered more robust in situations with unequal sample sizes compared to Tukey's HSD because Gabriel's test does not assume equal sample sizes or homogeneity of variances to the same extent as Tukey's HSD (Bretz et al., 2010). A p-value = 0.003 & 0.019 for CDF1 signifies a statistically significant between the scores given by contractors and those provided by consultants and clients. Similarly, for CDF2, p=0.042 <.050 indicates a difference in scores between Contractors and Consultants.

Table 13: Post-hoc analysis of factors CDF1 and CDF2

Dependent variable			Mean difference (I-J)	Std. error	Sig.	95% Confidence interval	
						Lower bound	Upper bound
CDF 1: Poor Quality Assurance and Site Management	Client/Owner	Contractor	1.47202*	0.53572	0.019	0.1833	2.7608
	Client/Owner	Consultant	-0.10345	0.46363	0.994	-1.2083	1.0014
	Contractor	Consultant	-1.57547*	0.47737	0.003	-2.7093	-0.4416
CDF 2: Inadequate Pre-project Diligence by Owner	Client/Owner	Contractor	-0.37833	0.37022	0.667	-1.2690	0.5123
	Client/Owner	Consultant	0.42799	0.32040	0.445	-0.3355	1.1915
	Contractor	Consultant	.80633*	0.32990	0.042	0.0227	1.5899

Further analysis into homogeneous subsets for both factors indicates that for CDF 1, the mean score given by Contractors (M = 17.924) is indeed significantly different from both Clients/Owners (M = 19.396) and Consultants (M = 19.500). However, for CDF 2, though the mean score provided by Consultants (M = 17.382) is lower than both Clients/Owners (M = 17.810) and Contractors (M = 18.188), all three means are still in the same subset, indicating that the difference is not highly significant.

Table 14: Post-hoc subsets for factors CDF1 and CDF2

CDF 2: Inadequate pre-project diligence by owner Gabriel[a,b]			**CDF 1: Poor quality assurance and site management** Gabriel[a,b]			
Role	N	'Subset for alpha = 0.05'	Role	N	'Subset for alpha = 0.05'	
		1			1	2
Consultant	102	17.3824	Contractor	53	17.9245	
Client/Owner	58	17.8103	Client/Owner	58		19.3966
Contractor	53	18.1887	Consultant	102		19.5000
Sig.		0.056	Sig.		1.000	0.995

The findings reveal that while the three main project proponents - *viz* owners, consultants, and project managers - unanimously agree on the critical delay factors in the context of Indian construction projects, there is a slight divergence in the perceptions of contractors. Specifically, contractors tend to rate the impact of Poor Quality Assurance and Site Management as less critical compared to the other two groups.

A similar comprehensive analysis of Critical Delay Factors (CDFs) employing "*Geography*" as a categorical variable was conducted to evaluate if there were any regional disparities in project evaluations. From the results, it was evident that the examination of responses regarding Critical Delay Factors reveals no discernible differences in assessments in project evaluations across different geographical locations in India.

Therefore, it can be summarized that the results exhibit a consistent pattern in scores on critical delay factors across roles and geographic locations within the contemporary Indian construction sector.

8. CONCLUSION

Based on the responses to the questionnaire survey by various project professionals across India, this study identified seven critical delay factors that drive the prevalent delay attributes in the construction sector. These factors are Poor Quality Assurance and Site Management, Inadequate Pre-project Diligence by Owner, Deficiency in Design Information Integrity, External Constraints and Site Dynamics, Poor Client Engagement, Constraints in Resource Availability, and Poor Appraisal Competence of Contractor.

The study ranked these critical delay factors in order of importance, revealing that Inadequate Pre-project Diligence by Owner and Poor Client Engagement were recognized as the most impactful factors. This underscores the significant role that clients play in the success of construction projects. Constraints in Resource Availability and Poor Quality Assurance and Site Management also ranked highly, highlighting the importance of consistent resource availability and robust quality assurance plans.

One key finding is that while external factors and site-specific dynamics contribute to delays, they are not viewed as primary drivers. Instead, pre-project diligence, client engagement, and resource availability hold greater weight in preventing delays. Additionally, the study found a consistent pattern in the assessments by experts across different roles and geographic regions, indicating a unified perspective within the industry professionals.

The scientific contribution of this research lies in its comprehensive identification and ranking of critical delay factors specific to the contemporary Indian construction industry. By bridging the gap in existing literature, this study provides a deeper understanding of the underlying constructs that influence project delays. The methodology and findings can be adapted to different project environments worldwide, offering valuable insights for global construction practices.

Furthermore, this research forms part of ongoing efforts to examine the interplay between critical success factors and critical delay factors in Indian construction projects. By evaluating how critical success factors can mitigate delays, the study aims to enable informed interventions for improved project performance. The findings from this research enhance the overall knowledge base on construction project performance and provide valuable practical insights for project professionals in the construction industry.

REFERENCES

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. https://doi.org/10.1016/J.PROENG.2016.04.121

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, *24*(4), 349–357. https://doi.org/10.1016/J.IJPROMAN.2005.11.010

Assaf, S. A., Al-Khalil, M., & Al-Hazmi, M. (1995). Causes of Delay in Large Building Construction Projects. *Journal of Management in Engineering*, *11*(2), 45–50. https://doi.org/10.1061/(asce)0742-597x(1995)11:2(45)

Baldwin, J., Manthei, J., Rothbart, H., & Harris, R. (1971). Causes of Delay in the Construction Industry. *Journal of the Construction Division*, *97*(2), 177–187. https://doi.org/10.1061/JCCEAZ.0000305

Baldwin, J. R., Manthei, J. M., Rothbart, H., & Harris, R. B. (1973). Closure to "Causes of Delay in the Construction Industry." *Journal of the Construction Division*, *99*(1), 206–206. https://doi.org/10.1061/JCCEAZ.0000375

Bandalos, D. L. (2018). *Measurement theory and applications for the social sciences*. Guilford Publications

Bandalos, D. L., & Finney, S. J. (2018). Factor analysis: Exploratory and confirmatory. In *The reviewer's guide to quantitative methods in the social sciences* (pp. 98–122). Routledge.

Barbur, V. A., Montgomery, D. C., & Peck, E. A. (1994). Introduction to Linear Regression Analysis. *The Statistician*, *43*(2), 339. https://doi.org/10.2307/2348362

Battaineh, H. T. (1999). *Information System of Progress Evaluation of Public Projects in Jordan* [M.Sc Thesis]. University of Science and Technology

Chan, D. W. M., & Kumaraswamy, M. M. (1997). A comparative study of causes of time overruns in Hong Kong construction projects. *International Journal of Project Management*, *15*(1), 55–63. https://doi.org/10.1016/S0263-7863(96)00039-7

Curran, P. J., West, S. G., & Finch, J. F. (1996). The Robustness of Test Statistics to Nonnormality and Specification Error in Confirmatory Factor Analysis. *Psychological Methods*, *1*(1), 16–29. https://doi.org/10.1037/1082-989X.1.1.16

De Smith, M. (2015). *STATSREF: Statistical Analysis Handbook-a web-based statistics*. The Winchelsea Press, Winchelsea, UK

DeVellis, Robert. F., & Thorpe, Carolyn. T. (2021). *Scale development: Theory and applications*. Sage Publications

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. https://doi.org/10.1016/j.ijproman.2011.10.004

Fabrigar, L. R., MacCallum, R. C., Wegener, D. T., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods*, *4*(3), 272–299. https://doi.org/10.1037/1082-989X.4.3.272

Fabrigar, L. R., & Wegener, D. T. (2012). Structural equation modeling. In *Applied multivariate statistics for the social sciences* (pp. 549–594). Routledge

Finch, W. H. (2013). Exploratory factor analysis. In *Handbook of quantitative methods for educational research* (pp. 167–186). Brill

George, D., & Mallery, M. (2003). *Using SPSS for Windows step by step: a simple guide and reference*. Boston, MA: Allyn & Bacon

Gorsuch, R. L. (1983). Three methods for analyzing limited time-series (N of 1) data. *Behavioral Assessment*

Gorusch, R. L. (1983). Factor Analysis (2nd ed.). Erlbaum

Gunduz, M., Gabriel, H. F., Ullah, F., Nielsen, Y., & Ozdemir, M. (2014). Fuzzy assessment model to estimate the probability of delay in Turkish construction projects. *Academia.Edu*. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000261

Gündüz, M., Nielsen, Y., & Özdemir, M. (2013). Quantification of Delay Factors Using the Relative Importance Index Method for Construction Projects in Turkey. *Journal of Management in Engineering*, *29*(2), 133–139. https://doi.org/10.1061/(ASCE)ME.1943-5479.0000129--

Gwaya, A. O., Masu, S. M., & Oyawa, W. O. (2014). Development of a Benchmarking Model for Construction Projects in Kenya. *International Journal of Soft Computing and Engineering (IJSCE)*, *4*(5), 31–37.

Haig, B. D., Haig, B. D., & Cecco, D. (2018). *Method matters in psychology*. Springer.

Hair, J. F., Risher, J. J., Sarstedt, M., & Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, *31*(1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203/FULL/HTML

Hoelzle, J. B., & J. Meyer, G. (2012). Exploratory Factor Analysis: Basics and Beyond. In *Handbook of Psychology, Second Edition*. https://doi.org/10.1002/9781118133880.hop202006

Hogarty, K. Y., Hines, C. V, Kromrey, J. D., Ferron, J. M., & Mumford, K. R. (2005). The Quality of Factor Solutions in Exploratory Factor Analysis: The Influence of Sample Size, Communality, and Overdetermination. *Educational and Psychological Measurement*, *65*(2), 202–226. https://doi.org/10.1177/0013164404267287

Iyer, K. C., & Jha, K. N. (2006). Critical Factors Affecting Schedule Performance: Evidence from Indian Construction Projects. *Journal of Construction Engineering and Management*, *132*(8), 871–881. https://doi.org/10.1061/(ASCE)0733-9364(2006)132:8(871)

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika*, *39*(1). https://doi.org/10.1007/BF02291575

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. https://doi.org/10.3846/13923730.2012.698913

Kumaraswamy, M. M., & Chan, D. W. M. (1998). Contributors to construction delays. *Construction Management & Economics*, *16*(1), 17–29. https://doi.org/10.1080/014461998372556

Leighton, K., Kardong-Edgren, S., Schneidereith, T., & Foisy-Doll, C. (2021). Using social media and snowball sampling as an alternative recruitment strategy for research. *Clinical Simulation in Nursing*, *55*, 37–42.

Lorenzo-Seva, U., & Ferrando, P. J. (2020). Unrestricted factor analysis of multidimensional test items based on an objectively refined target matrix. *Behavior Research Methods*, *52*(1), 116–130. https://doi.org/10.3758/S13428-019-01209-1

Lovering, H. D. (1972). Discussion of "Causes of Delay in the Construction Industry"; *Journal of the Construction Division*, *98*(2), 359–360. https://doi.org/10.1061/jcceaz.0000361

McCombes, S. (2022, November 30). *Research | Definition, Examples & Methods*. Www.Scribbr.Com/Methodology/Survey-Research/.

MOSPI. (2014). *Infrastructure Statistics -2014 (Third issue, VOL. I). I.*

Norman, G. R., & Streiner, D. L. (2014). *Biostatistics-The Bare Essentials* (4th ed.). PMPH.

Nunnally, J. C., & Bernstein, I. H. (1994). Psychometric Theory New York. In *Philosophical Magazine*. McGraw-Hill.

Odeh, A. M., & Battaineh, H. T. (2002). Causes of construction delay: traditional contracts. *International Journal of Project Management*, *20*(1), 67–73. https://doi.org/10.1016/S0263-7863(00)00037-5

Pourrostam, T., & Ismail, A. (2012). Causes and Effects of Delay in Iranian Construction Projects. *International Journal of Engineering and Technology*, *4*(5), 598–601. https://doi.org/10.7763/ijet.2012.v4.441

Samarghandi, H., Mohammad, S., Tabatabaei, M., Taabayan, P., Hashemi, A. M., & Willoughby, K. (2016). Studying the Reasons for Delay and Cost Overrun in Construction Projects: The Case of Iran. *Journal of Construction in Developing Countries*, *21*(1), 51–84. https://doi.org/10.21315/jcdc2016.21.1.4

Schmitt, T. A. (2011). Current methodological considerations in exploratory and confirmatory factor analysis. *Journal of Psychoeducational Assessment*, *29*(4), 304–321. https://doi.org/10.1177/0734282911406653

Shebob, A., Dawood, N., & Shah, R. K. (2012). Development of a methodology for analysing and quantifying the impact of delay factors affecting construction projects. *KICEM Journal of Construction Engineering and Project Management* , *2*(3), 17–29. https://doi.org/10.6106/JCEPM.2012.2.3.017

Statista. (2022). *Economy and Politics: 2021 In Numbers*.

Stevens, J. (2002). Chapter 3: Multiple Regression. In *Applied Multivariate Statistics for the Social Sciences.* (4th ed., pp. 80–161). Lawrence Erlbaum Associates.

Tabachnick, B., & Fidell, L. (2013). *Using Multivariate Statistics*. Pearson Education Inc.

Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics (7th Ed.)*. Boston: Allyn & Bacon/Pearson Education.

Thomas G. Reio, Jr., & Shuck, B. (2015). Exploratory Factor Analysis: Implications for Theory, Research, and Practice. *Advances in Developing Human Resources*, *17*(1), 12–25. https://doi.org/10.1177/1523422314559804

Trauner, T. J., Manginelli, W. A., Lowe, J. S., Nagata, M. F., & Furniss, B. J. (2009). Construction Delay: Understanding Them Clearly. *Analysing Them Correctly. 2nd Edition Ed*.

Velicer, W. F., & Fava, J. L. (1998). Effects of Variable and Subject Sampling on Factor Pattern Recovery. *Psychological Methods*, *3*(2), 231–251. https://doi.org/10.1037/1082-989X.3.2.231

Watkins, Marley. W. (2021). *A Step-by-Step Guide to Exploratory Factor Analysis with SPSS* (1st ed.). Routledge.

Watson, J. C. (2017). Establishing evidence for internal structure using exploratory factor analysis. *Measurement and Evaluation in Counseling and Development*, *50*(4), 232–238. https://doi.org/10.1080/07481756.2017.1336931

Widaman, K. F. (2018). On Common Factor and Principal Component Representations of Data: Implications for Theory and for Confirmatory Replications. *Structural Equation Modeling: A Multidisciplinary Journal*, *25*(6), 829–847. https://doi.org/10.1080/10705511.2018.1478730

Zidane, Y. J. T., & Andersen, B. (2018). The top 10 universal delay factors in construction projects. *International Journal of Managing Projects in Business*, *11*(3), 650–672. https://doi.org/10.1108/IJMPB-05-2017-0052/FULL/XML