Identifying Delay Attributes and Attributable Parties Influencing the Construction Schedule Performance of Hydroelectric Projects in the Indian Scenario

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Abstract : This study aims to identify the numerous attributes which delay the construction of hydroelectric projects in India. This study is of utmost importance because no prior study has particularly examined delays and associated issues in the Hydro-Electric Project industry. The results of a questionnaire survey of Contractors, Clients, Consultants, and Sub-Contractors are presented in this study. Delay in issuing Good for Construction Drawings is one of the top attributes acknowledged to have a considerable impact on project delivery delays. Delay due to interfacing of activities, Delay owing to late handover of E & M Contractor, Non-availability of an unencumbered right of way to the project site and Frequent revisions to Good for Construction Drawings are cited as the cause. The findings provide a better understanding of the attributes that contribute to the delayed commissioning of Hydro Electric Projects in India and will aid construction parties and project management professionals in implementing effective corrective measures to ensure the timely completion of Project works.

Keywords: *Construction Project Management; Construction Delay Attributes; Scheduled Performance; Severity Index; Hydroelectric Projects.*

INTRODUCTION

Nature is altered through construction. Ancient architectural wonders show that people have been building things for a long time. In the world we live in now, new technologies have completely changed the construction industry.

Electricity is the most important infrastructure needed for a country like India to grow. Hydroelectric power has been India's most reliable source of clean energy for a long time. According to the Central Electricity Authority's reassessment studies of India's hydroelectric power potential in various river basins, the country has a total hydroelectric power potential of 84044 MW (at 60% load factor), which, when fully developed, would result in an installed capacity of about 148701 MW based on the likely average load factor.

Delays in building the project became a normal part of the time it took to build it. Across the country, it seems that over 40% of construction projects are not doing as well as they should. (Iyer and Jha, 2006) In the Indian construction industry, especially for infrastructure projects, it is common for projects to start up much later than they should. Even with better monitoring tools and a better understanding of how to run a project, construction projects still take longer than expected. To avoid or lessen the effects of delays, it's important to know why they happen in the first place. It is also important to find out who is to blame for the delays. Hamzah et al., (2011) say that a delay is any action or event that makes the time needed to finish the tasks in a contract longer. It usually shows up as extra work or a delay at the beginning or end of an activity. The main goal of this research is to find out what causes hydroelectric projects in India to take longer to start up than planned.

LITERATURE REVIEW

Delays in the completion of Construction projects are a topic that has been examined extensively by scholars around the world. The significance of construction delays stems from the fact that they are a significant attribute in determining the success of construction

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projects. Variables affecting the time delay vary from project to project and company to company. (Ahsen et al., 2021)

According to the research, infrastructure project cost overruns are a worldwide occurrence. In a series of empirical investigations spanning twenty countries and five continents, it was demonstrated that infrastructure projects frequently have cost overruns. (Flyvbjerg et al., 2002, Flyvbjerg et al., 2003, Flyvbjerg, et al., 2004) Simple or sophisticated, most construction projects experience delays. A construction delay could be described as a time period that extends beyond either the contract date or the date that the parties agreed upon for the completion of a project (Assaf & Al-Hejji, 2006)

Iyer and Jha (2006) have identified fifty-five success and failure characteristics. The analyses uncovered the following critical success factors: the competence of the project manager, the support of upper management, the project manager's coordinating and leadership skills, participant monitoring and feedback, coordination among project participants, and the owner's competence and favourable climatic conditions. Iyer & Jha (2006) determined the factors influencing the performance of the projects. The study concluded that two success elements and one failure factor greatly contributed to the current performance level of the project: participant commitment, owner competency, and conflict among project participants. In the Malaysian construction industry, (Sambasivan & Soon, 2007) identified ten delay reasons and their impact on project completion. Sweis et al. (2007) analysed and categorised the reasons for residential building delays.

Using a selected set of 45 attributes (Doloi et al., 2012), identified the important factors affecting the delay in the Indian construction industry and established the relationship between the critical qualities for constructing prediction models to evaluate the influence of these factors on delay. The causes and effects of construction delays in the Nigerian construction industry were investigated by Olusegun and Akinsulire (2012). Mizanur et al. (2014) evaluated the leading causes of delay in Bangladeshi building projects.

Long et al. (2004) have researched the characteristics that contribute to the success of large construction projects in Vietnam. Wa'el et al. (2007) investigated the key causes generating delays in Malaysian building construction projects. Adnan et al., (2009) evaluated the causes of time and budget overruns in the Gaza Strip. Ren and Dainty (2008) identified the primary causes of construction project delays in Dubai. Kaliba et al., (2009) determined the reasons for delays in Zambian road construction projects. Assaf and Al Hejji (2006) used the frequency index and severity index to rank the various risk elements of Saudi Arabian building projects. According to (Odeyinka and Yusif 1997), seven out of ten projects surveyed in Nigeria had execution delays. Nonetheless, Frimpong et al. (2003) explored the causes of time and expense overruns in groundwater building projects in Ghana.

Zaman et al., (2022) empirically investigated the effects of major delay variables on the success of international mega construction projects, with leadership self-efficacy serving as a moderator. The research showed a negative correlation between crucial delay variables and the success of international mega construction projects.

There is no unanimity in the literature about the identification of elements that influence building construction timelines. One explanation for this is that researchers have approached the topic from a variety of angles. Even the most recent study on construction delays reveals divergent perspectives on what constitutes a major cause of building project delays. (Hegab et al., 2007, Abdul Rahman et al., 2006, Youngjae et al., 2005, Yates & Epstein. 2006, Zaneldin, 2006, Zwikael, Cohen, Sadeh, 2006, Arditi & Pattanakitchamroon, 2006)

Muizz et al. (2022) conducted a meta-data analysis utilising Relative Importance Index (RII) values from 15 prominent studies on the reasons of construction delays. The effect summaries derived from the meta-analysis revealed that the top five causes of delays are as follows: "contractor's financial difficulties," "delay in approval of completed work," "slow delivery of materials," "poor site organisation and coordination between various parties," and "poor planning of resources and duration estimation/scheduling."

In their study, (Gholamreza and Meghdad 2021) found that major urban building projects are more

susceptible to cost overruns and delays. Moreover, the time and cost-performance of new build projects is generally superior to that of renovation projects. According to Tshidavhu & Khatleli (2020), contractual disputes are a major contributor to schedule and budget overruns in South African projects.

(Susanti et al., 2021) analysed 15 delay attributes in a construction project, including land acquisition, delay, location, social, contract change orders, rework, quality of subcontractor, delay in permits, poor planning, unstable material price, law and regulation, the owner required, inflation, payment delay, cash flow and bad weather and concluded that land acquisition delay is the leading attribute in Indonesia.

Abdulrahman et al., (2022) suggest the experience and professional competence of the Contractor as a deciding role as experienced contractors are more familiar with different project steps, and are more likely to know what obstacles they may expect. This indicates the importance of attributable parties causing delays. Savitha and Pradeep (2014) have identified 53 causes of delays and categorized them into 11 attributable parties / groups.

It is evident from the aforementioned literature study that project management ideas cannot be generalised across industries or sectors. There are differences in the understanding and practices of project management between industries, countries, and applications. According to the literature, development projects are notorious for cost and time overruns. A crucial aspect of the majority of Infrastructure Development projects is the intricate network of parties involved. Thus, the causes of delays in the completion of construction projects vary from industry to industry and country to country. Therefore, it is essential to determine the causes of Hydro Electric project delays.

RESEARCH METHODOLOGY

Even though a substantial amount of research has been undertaken on construction delays in other countries, no unique study has been conducted on delays and related problems in India's hydroelectric projects. The objective of this study is to determine the key attributes or incidents impeding the development of hydroelectric projects in India.

Survey Questionnaire

A comprehensive literature analysis revealed a variety of variables that are delaying the construction phase. This study's questionnaire was created by analysing key delay characteristics published in the literature and the researcher's prior experience. In addition, interviews were conducted with Indian construction professionals to reflect a cross-section of the known causes of delays in the Indian scenario. The purpose of the interviews with construction professionals was to acquire insight into the applicability of elements discovered in the literature to Indian hydropower projects and to uncover industry-specific characteristics. These inputs were incorporated into the questionnaire's final form. Thus, fifty-five delay characteristics were identified and grouped into five main categories: C1: Traceable to Client, C2: Attributable to Civil Contractor, C3: Attributable to Other Contractor, C4: Attributable to other administrative agencies, and C5: Not attributable to any party. *Table 1* below shows the reasons attributable to various parties.

It has been noted that inefficiencies in project management, site conditions, administrative obstacles, and acts of God have all impacted the scheduled performance. The questionnaire encompasses all such delays that pose a significant hindrance to hydroelectric projects.

Three sections made up the questionnaire: the first

Table 1: Attributable Parties for Delay Reasons

Attributable Party	A Number of Reasons Identified
C1: Attributable to Client	28
C2: Attributable to Civil Contractor	11
C3: Attributable to Other Contractor	5
C4: Attributable to other administrative authorities	2
C5: Not attributable to any parties	9
Total	55

asked respondents for demographic details; the second asked them to rate the impact of the 55 attributes, and the third asked them to rate the frequency with which these 55 attributes occurred. The influence of the variables on construction delay was rated on a 5-point scale. The numbers 1 through 5 represent "no effect," "slight effect," "substantial effect," "extremely significant effect," and "very significant effect," respectively. On a three-point scale, with 1 denoting "low," 2 denoting "medium," and 3 denoting "high," respondents were asked to rate the frequency of occurrence of each attribute with respect to their current project in section two.

To ensure that the questions were clear and easy to understand, the preliminary questionnaire was pilot-tested on a sample of responders. Nine construction experts with vast experience in the field took part in the project. The participants were two contract managers, four project managers, and three planning managers. The respondents suggested minimal modifications to the questionnaire, mostly to enhance its readability and effectiveness. A few questions required rewording to eliminate ambiguity. The questionnaire was amended to incorporate the responses of the respondents.

Sample Population

The sample population comprised of Client organisation representatives, Consultants, Contractors, and Sub Contractors working on Hydro Electric Projects in India. The sample population consisted of construction professionals functioning in various domains of Construction Project Execution/Management, ranging from site engineers to directors.

Questionnaires and interviews with individuals engaging in work front activities are an intermittent way for collecting data on these activities. The use of questionnaires and interviews is prevalent due to the fact that construction experts have superior knowledge of the situations on the ground. Chang & Borcherding (1986) developed working professional questionnaire sampling for performance measurement as an upgrade to the working professional questionnaire survey. The working professional questionnaire sampling replicates the work sampling technique by randomly selecting working professionals in the field and asking them to complete questionnaires.

In the government sector, significant hydroelectric projects were being built. The respondents were contacted through email, and Google Form surveys were distributed to collect responses. The poll received a total of 215 responses, including 71 Clients, 39 Consultants, 74 Contractors, and 31 Subcontractors responses. The respondent's characteristics are outlined in *Tables 2(a), (b), and (c).*

Table 2: (a) Respondents' Profile: Category of Organisation

	Frequency	Percent
Client	71	33.0
Consultant	39	18.1
Contractor	74	34.4
Sub-Contractor	31	14.4
Total	215	100.0

Table 2: (b) Respondents' Profile: Organisation's Turnover

	Frequency	Percent
100-250 crores	18	8.4
250-500 crores	16	7.4
500-1000 crores	69	32.1
less than 100 crores	20	9.3
more than 1000 crores	92	42.8
Total	215	100.0

Table 2: (c) Respondents' Profile: Experience in Construction Industry

	Frequency	Percent
Diploma	31	14.4
Graduate	105	48.8
Others	6	2.8
Post Graduate	73	34.0
Total	215	100.0

Table 2: (d) Respondents' Profile: Highest Educational Qualification

	Frequency	Percent
Diploma	31	14.4
Graduate	105	48.8
Others	6	2.8
Post Graduate	73	34.0
Total	215	100.0

Table 3 below lists the 55 identified delay attributes and their respective attributable party which influences the delayed project commissioning.

Table 3: Details of Delay Attributes

Delay ID	Delay Attributes	Attributable Party
DA1	Delay in issuing Good for Construction Drawing by Client	C1: Attributable to Client
DA2	Frequent issuance of revised drawings	C1: Attributable to Client
DA3	Delay in providing instruction by Client, when there requires any deviation from an already approved methodology	C1: Attributable to Client
DA4	Delay in approval by Client leading to delay in design and timely procurement and delivery to site	C1: Attributable to Client
DA5	Delay in providing inputs/confirmation pertaining to site conditions/ date	C1: Attributable to Client
DA6	Delay due to Interfacing of activities - Delay due to late handing over of Civil Contractor	C2: Attributable to Civil Contractor
DA7	Delay due to Interfacing of activities - Delay due to late taking over of E & M Contractor	C3: Attributable to Other Contractor
DA8	Delay due to Interfacing of activities - Delay due to late handing over of E & M Contractor	C3: Attributable to Other Contractor
DA9	Delay due to Interfacing of activities - Delay due to late taking over of Civil Contractor	C2: Attributable to Civil Contractor
DA10	Delay due to Interfacing of activities - Delay due to late handing over of Client	C1: Attributable to Client
DA11	Delay due to Interfacing of activities - Delay due to late taking over of Client	C1: Attributable to Client
DA12	Delay due to Disruption of works due to strike by E & M Contractor's personnel	C3: Attributable to Other Contractor
DA13	Delayed start of work by E&M Contractor	C3: Attributable to Other Contractor
DA14	Delay due to increased duration of activities of E & M Works	C3: Attributable to Other Contractor
DA15	Delay due to Adverse geological conditions (Shear failure, Cavity formation etc.) resulting in reduced progress of work due to unfavourable working conditions	C2: Attributable to Civil Contractor
DA16	Delay due to Additional Time required in the treatment of Geological over breaks.	C2: Attributable to Civil Contractor
DA17	Delay in treatment of Geological over breaks by the Contractor	C2: Attributable to Civil Contractor
DA18	Delay in instruction from the Client regarding the treatment of geological surprise	C1: Attributable to Client
DA19	Delay due to additional duration required for the execution of newly introduced additional works	C1: Attributable to Client

Table 3: Details of Delay Attributes *(Contd...)*

Delay ID	Delay Attributes	Attributable Party
DA20	Delay due to additional duration required for the execution of increased quantity	C1: Attributable to Client
DA21	Delay due to additional duration required due to variation in the anticipated length of tunnels resulting in change in time cycles	C1: Attributable to Client
DA22	Delay due to change in specified Sequence of Work by introducing additional work	C1: Attributable to Client
DA23	Delay in finalisation of Rate of extra item by Contractor	C2: Attributable to Civil Contractor
DA24	Delay in finalisation of Rate of extra item by Client	C1: Attributable to Client
DA25	Delay in finalisation of specification of extra item / Delay in issuance of drawings of extra item by Client	C1: Attributable to Client
DA26	Delay in finalisation of specification of extra item / Delay in issuance of drawings of extra item by Contractor	C2: Attributable to Civil Contractor
DA27	Access Road to work site was not handed over by Client	C1: Attributable to Client
DA28	Access Road to work site handed over to by Client is not fit for plying Contractor's heavy machinery	C1: Attributable to Client
DA29	Delay due to Repair works being carried out by Client on the approach roads	C1: Attributable to Client
DA30	Stoppage of works by locals for demands to be addressed by the Client	C1: Attributable to Client
DA31	Stoppage of works by locals for demands to be addressed by local Administration	C4: Attributable to other administrative authorities
DA32	Road blockage created by locals demanding fulfilment of R & R implementation	C1: Attributable to Client
DA33	Commotion and disorder and the resulting suspension of works	C1: Attributable to Client
DA34	Stoppage of works by locals demanding employment	C1: Attributable to Client
DA35	Delay due to Heavy rainfall	C5: Not attributable to any parties
DA36	Delay due to Glacier Avalanches	C5: Not attributable to any parties
DA37	Delay due to Chilling low temperature and heavy snowfall	C5: Not attributable to any parties
DA38	Delay due to damage of temporary structures (e.g. Coffer dam, worker camp etc.) caused by heavy rains/ snow	C5: Not attributable to any parties
DA39	Delay due to damage of permanent structures caused by heavy rains/ snow/ avalanche	C5: Not attributable to any parties

Table 3: Details of Delay Attributes *(Contd...)*

Delay ID	Delay Attributes	Attributable Party
DA40	Suspension of ongoing works due to wanting of MoEF Clearance to be obtained by Client	C1: Attributable to Client
DA41	Delayed start of work due to wanting of MoEF Clearance to be obtained by Client	C1: Attributable to Client
DA42	Suspension of ongoing works due to wanting of Pollution Control Board Clearance to be obtained by Client	C1: Attributable to Client
DA43	Delayed start of work due to want of Clearance from Mining & Geology Dept. to be obtained by Client	C1: Attributable to Client
DA44	Delayed start of works due to delay by Client in obtaining statutory clearances from statutory bodies (other than MoEF & Geology Dept.)	C1: Attributable to Client
DA45	Suspension of ongoing works due to want of Clearance from statutory officials (other than MoEF & Geology Dept.) to be obtained by Client	C1: Attributable to Client
DA46	Land slide and Shooting stones along the access road to work site and at work site	C5: Not attributable to any parties
DA47	Delay due to unplanned haphazard road widening/ road restoration works being carried out by various organizations like PWD, BRO etc.	C4: Attributable to other administrative authorities
DA48	Flash flood and the resulting washing away/ damage of access road to site	C5: Not attributable to any parties
DA49	Delay on account of production loss due to fatal accidents	C2: Attributable to Civil Contractor
DA50	Delay on account of production loss due to Loss time injury accidents	C2: Attributable to Civil Contractor
DA51	Delay due to difficulty to retain skilled manpower in site due to fear psychosis	C2: Attributable to Civil Contractor
DA52	The discrepancy in data provided by client viz. between two bench marks, discharge at river site etc.	C1: Attributable to Client
DA53	Reduction of Productivity consequent to delays due to reasons beyond control of Contractor	C5: Not attributable to any parties
DA54	Disruption and delay in underground tunneling works due to leakage of gas	C5: Not attributable to any parties
DA55	Delay due to Heavy ingress of water in tunnels through Adit.	C2: Attributable to Civil Contractor

The Client is required to carry out certain responsibilities as mentioned in the Contract. Client shall grant Contractor access to and possession of all portions of the Site within the time specified in the Contract Data; Client shall assist Contractor in obtaining necessary permits, licences, approvals etc.; Client shall make financial arrangements for ensuring timely payments to Contractor/ Subcontractor against the works executed are some of them. Any failure to perform the responsibilities will impede the progress of the work on site. Such delays are attributable to the Client.

The Contractor's principal responsibility is to design (if specified in the Contract), execute, complete, and maintain the Works in accordance with the Contract, and to correct any flaws in the Works. The Contractor is responsible for ensuring the adequacy, stability, and safety of all Site activities and construction processes. Failure to comply with the responsibilities may impede the smooth operation of project activities and result in project delays. Such delays are attributable to the Contractor.

Sometime, Contractor entrusts some part of works to a specialized/ more experienced firm as a Subcontractor for execution of some specialized job. Sub-Contractor shall be responsible for the execution of works in accordance with the Contract, in compliance with the time schedules and quality parameters agreed with the main contractor. Any failure to do so may hamper the smooth progress of works and attracts penalty and such delays are attributable to Sub Contractors.

Hydro Electric projects are spread across vast area in public land. This attracts many interactions with public and public administrative activities happening there. Sometime, project execution activities get impacted due to such administrative activities and delays arising out of this are attributable to other administrative authorities, who are not direct stakeholders in the Hydroelectric project execution.

There is a possibility that the Contractor would face impediments on the construction site while doing the work. Such occurrences are beyond the control of a Party, for which it could not have fairly prepared before to entering into the Contract, and which, having occurred, it could not have reasonably prevented. Such delay events are not attributable to any parties.

Data Analysis

Numerous researchers (Kadir et al., 2005, Iyer & Jha, 2006) believe that the mean and standard deviation of each attribute is unsuitable for assessing overall rankings because they do not reflect any relationship between the attributes; consequently, relative importance index is used (R.I.I). Using the following formula, a relative significance index was computed for each element.

$$\text{Importance Index} = \frac{5n_1 + 4n_2 + 3n_3 + 2n_4 + n_5}{5(n_1+n_2+n_3+n_4+n_5)}$$

The number of respondents who chose "very significant effect" is n_1, while those who chose "very significant effect" are n_2. n_3 represents the proportion of respondents who selected "major effect," n_4 the proportion who selected "slight effect," and n_5 the proportion who selected "no effect."

The following equation was used to evaluate the frequency index.

$$\text{Frequency Index} = \frac{3n_1 + 2n_2 + n_3}{3(n_1+n_2+n_3)}$$

n^1 is the number of respondents who said "high rate of occurrences," n_2 is the number of respondents who said "medium rate of occurrences," and n_3 is the number of respondents who said "low rate of occurrences."

Multiplication of the importance and frequency indices resulted in a severity index (SI) for each attribute (Sivarajah, 2021), which was employed for analysis to rank the overall impact of the attribute on delayed delivery of Hydro Electric Projects in India:

Severity index = Importance index x Frequency index

Table 4 represents the ranking of the attributes based on the severity index, relative importance index and frequency index, and for the sake of brevity, only the top ten attributes are shown in *Table 4* below.

The consistency of respondents' rating of criteria was evaluated using a Spearman rank correlation. (*Table 5*). A high correlation coefficient suggests that respondents' rankings of elements are very congruent. According to Table 5, there was a strong correlation between Client and Sub-Contractors and Client and Consultant in the ranking of attributes, whereas there was a moderate correlation between the remaining respondents, namely Client and Contractor, Consultant and Sub-Contractor, Client and

Contractor, and Contractor and Sub-Contractor.

Table 6 below indicates the difference in perception among project participants on the delay attributes. It is evident that different stakeholders are having different points of interest in the Contract, and thus there is a variation in the perception of stakeholders. This

Table 4: Ranking of Delay Attributes Based on S.I, R.I.I and F.I

Delay ID	Severity Index	Rank		Delay ID	Relative Importance Index	Rank		Delay ID	Frequency Index	Rank
DA1	0.79987	1		DA1	0.90512	1		DA1	0.88372	1
DA6	0.69752	2		DA6	0.84093	2		DA15	0.85271	2
DA15	0.69645	3		DA33	0.82977	3		DA2	0.83411	3
DA8	0.67061	4		DA8	0.82233	4		DA6	0.82946	4
DA27	0.66986	5		DA15	0.81674	5		DA27	0.82016	5
DA2	0.65798	6		DA27	0.81674	5		DA8	0.8155	6
DA32	0.62395	7		DA32	0.80651	7		DA16	0.81085	7
DA33	0.62007	8		DA2	0.78884	8		DA14	0.79225	8
DA16	0.61323	9		DA17	0.77209	9		DA18	0.7876	9
DA17	0.60092	10		DA30	0.76093	10		DA17	0.77829	10

Table 5: Spearman Rank Correlation

Respondents	Spearman rank correlation
Client - Consultant	0.753
Client - Contractor	0.694
Client - Subcontractor	0.891
Consultant - Contractor	0.684
Consultant - Sub Contractor	0.701
Contractor - Sub Contractor	0.667

Table 6: Different Stakeholders' Response

Category	ID	Delay Attributes (DA)	All Response		Client's Response		Consultant's Response		Contractor's Response		Sub Contractor's Response	
			S.I	Rank	S.I	Rank	S.I	Rank	S.I	Rank	S.I	Rank
C1: Attributable to Client	DA 1	Delay in issuing Good for Construction Drawing by Client	0.800	1	0.778	1	0.850	1	0.811	1	0.760	1
C2: Attributable to Civil Contractor	DA 6	Delay due to Interfacing of activities - Delay due to late handing over of Civil Contractor	0.698	2	0.651	5	0.730	2	0.738	2	0.670	3
C2: Attributable to Civil Contractor	DA 15	Delay due to Adverse geological conditions (Shear failure, Cavity formation etc.) resulting in reduced progress of work due to unfavourable working conditions	0.696	3	0.756	2	0.720	5	0.699	5	0.533	13
C3: Attributable to Other Contractor	DA 8	Delay due to Interfacing of activities - Delay due to late handing over of E & M Contractor	0.671	4	0.672	3	0.649	7	0.661	9	0.712	2
C1: Attributable to Client	DA 27	Access Road to work site was not handed over by Client	0.670	5	0.629	8	0.727	3	0.721	3	0.572	8
C1: Attributable to Client	DA 2	Frequent issuance of revised drawings	0.658	6	0.655	4	0.717	6	0.638	12	0.633	5

Table 6: Different Stakeholders' Response *(Contd...)*

Category	ID	Delay Attributes (DA)	All Response		Client's Response		Consultant's Response		Contractor's Response		Sub Contractor's Response	
C1: Attributable to Client	DA 32	Road blockage created by locals demanding fulfillment of R & R implementation	0.624	7	0.592	10	0.644	9	0.675	8	0.554	9
C1: Attributable to Client	DA 33	Commotion and disorder and resulting suspension of works	0.620	8	0.621	9	0.723	4	0.612	17	0.516	17
C2: Attributable to Civil Contractor	DA 16	Delay due to Additional Time required in treatment of Geological over breaks.	0.613	9	0.649	6	0.605	13	0.635	13	0.488	19
C2: Attributable to Civil Contractor	DA 17	Delay in treatment of Geological over breaks by the Contractor	0.601	10	0.640	7	0.610	12	0.560	23	0.597	6

indicates the absence of convergent thinking and is in deviation from the primary objective of the ultimate goal, the time-bound completion of project work.

RESULTS AND DISCUSSION

The research found that the Delay in Providing Good for Construction Drawings by the Client is a continuous issue that has a significant negative impact on Hydroelectric Projects. A second problem that emerged from discussions with practitioners was the inadequate management of interfacing operations between the Civil/Electro-Mechanical Contractor and the Client, as well as the delays caused by the occurrence of numerous geological surprises in underground structures. It has been observed that awarding a contract without completing the Resettlement and Rehabilitation formalities causes unrest among the local residents, and the respondents have noted that these local residents frequently create a chaotic environment in the projects, making this a significant attribute affecting the scheduled performance.

Considering all comments and the various types of responders, the highest-ranked criteria are discussed below. In addition, the disparities in the weighting of the elements by the various respondents are discussed.

With a severity index of 0.800, Delay in issuing the Good for Construction Drawing by the Client was regarded as the most significant issue creating delays in the on-time completion of Hydro Electric Projects. Clients, Consultants, Contractors, and Subcontractors have all identified Delay in issuing the Good for Construction Drawing by the Client as the most crucial attribute. Generally, the drawing requirement schedule is communicated to the client well in advance, in accordance with the Construction Schedule, which depicts the dates by which the Good for Construction Drawings must be issued by the client to the contractor for the best work progress and timely

completion of the project. It has been found that, in the majority of instances, these promised dates are missed and site activity ceases due to a lack of client drawings or instructions. 72% of respondents reported that the absence of construction drawings was a frequent issue on their construction sites. Numerous researchers (Doloi et al., 2012, Kadir et al., 2005, Abdulhamid et al., 2012) have recognized the lack of timely availability of drawings/designs as the most significant attribute affecting scheduled performance, therefore validating the results of this study.

Delay due to Interfacing of activities - Delay due to late handing over of Civil Contractor, scored second with a SI of 0.698, and 56% of respondents have experienced material delivery delays frequently at their construction sites. Hydroelectric projects have the most intricate type of interface operations. During the construction of the Turbine Hall and Transformer Hall, a variety of embedded components must be installed within civil structures. The installation of embedded components and subsequent execution of civil works are to be performed in close coordination between the Civil and Electro-Mechanical (Sub) Contractors, with the Client and Consultant's approval. In reality, all parties are involved in the execution of interface activities. The commissioning of the project has been repeatedly delayed due to poor management of interfacing operations between the stakeholders. The handover/takeover of structures between the Civil and E&M Contractors and the resulting lack of site access for the other Contractor are delaying the execution of interface activities. This is a result of the continual failure of interacting Contractors to meet their commitments in keeping to the construction timetable, resulting in schedule slippage. The client's lack of stringent monitoring is accelerating interface delays. Delay as a result of Interfacing of operations - Delay as a result of the late handover of the Civil Contractor can result in the cessation of activity on site. The second most important factor delaying construction projects in Malaysia (Wa'el A., 2007) is lack of coordination, and this is in corroboration with interfacing delay events observed in Hydroelectric projects.

Client ranked Delay due to interfacing of activities - Delay due to late handover of Civil Contractor significantly lower than all other respondent groups, with frequent release of amended drawings assessed as having a greater impact on on-time performance. The client recognises the significance of timely supply of accurate drawings as opposed to frequent revisions of previously issued drawings and therefore ranks these criteria higher than Delay due to late handover of Civil Contractor.

Delay due to Interfacing of operations - Delay due to late handover of E & M Contractor scored fourth with a SI of 0.671. However, the Consultant and Contractor had different rankings, placing them seventh and ninth, respectively. Typically, in interfacing activity management, the E&M Contractor passes over the work front to the Client after repairing any necessary embedded components, and the Client then hands it over to the Consultant or Contractor, as required, after doing any required quality assurance checks. As they are not directly involved in this process, Consultants and Contractors rated the severity of the attribute lower than all other respondent groups. Because of the E & M Contractor's interference, the Civil Contractor was held up for considerably longer than expected, and the E & M Contractor was unable to hand over the structures on time. The micro-level planning and scheduling of activities by the Civil Contractor has been severely disturbed as a result of this delay.

Delay due to Adverse geological conditions (Shear failure, Cavity formation, etc.) resulting in lower work progress due to unfavourable working conditions was identified as the third most influential attribute affecting the construction schedule of Hydro Electric Projects, with a SI of 0.696. The client ranked unfavourable geological conditions as the second most damaging attribute on schedule performance. Despite this, approximately 37% of respondents ranked the problem as occurring with moderate to high frequency. Adverse geological conditions denote a geological surprise encountered during the course of the work that was neither anticipated nor anticipated by an experienced Contractor/Client/Consultant. Typically, these geological surprises take the form of Shear Failures and Massive Cavity forms along the underground structures.

There were instances of cavity formation and constant loose rock falling from the crown portion of the tunnel,

making it almost impossible to carry out any work inside the tunnel. In a few instances, shear failures necessitated lengthy repair processes, which interrupted construction. To ensure the timely completion of the project, a detailed construction schedule and methodology were developed based on the information provided in the Contract documents regarding the projected distribution of Rock Classes throughout the tunnel sections. Nonetheless, during the actual execution of the works, rock classes encountered differed from those anticipated in the contract, causing delays in the construction of numerous underground structures. Excavation through such uncharted geology presented unforeseen challenges, resulting in significantly less progress than anticipated.

The fact that the client did not give over the access road to the work site was deemed by respondents to be a significant attribute influencing the performance timetable. Discussions with construction staff indicated that faulty administration by Client organizations is delaying the transfer of a right of way, free of encumbrances, to the Contractor for the project. The fact that the client did not hand over the access road to the work site has been identified as one of the top six problems affecting the timely completion of construction contracts. However, the Client and Subcontractor's perceptions of the issue were less severe than those of other respondent groups. Generally, the client formally hands over the access road to the contractor. However, in the majority of situations, the access road may not be suitable for the use of heavy construction equipment, and its upgrading will be undertaken simultaneously with the handover. This causes a conflict between the Client and the Contractor, with the Client claiming that the road has been handed over with just minor work remaining. Since the right-of-way is transferred to the general contractor, subcontractors are not directly involved in the handing over of the road and are rarely involved in these difficulties. Consequently, the Client and Subcontractors placed the delay in handing over the Access Road to the job site far lower than the Contractors and Consultants. However, even after the delayed handing over, the road provided by the Client was in a very poor condition and could not be termed as motorable for a Project of this magnitude and the equipment usage thereto. The contractor, upon having been in possession of the said road, had attempted to repair the road however due to the very poor condition of the road, the efforts were rendered futile in many cases. Naveenkumar G.V and Prabhu V (2016) has identified that the delay in preliminary handing over the site was one of the most important factors that may lead to cost overrun.

Frequent issuance of revised drawings has also been identified as one of the leading variables affecting the on-time completion of construction contracts. This necessitates additional labour and occasionally rework as well. However, Contractor saw this issue as less significant than other responder groups. Researchers determined that lack of development negatively impacts the morale and attitude of project staff. (Borcherding, 1976) Frequent issue of amended drawings reveals the disposition of project staff and validates the conclusions of the research.

Clients view the Delay attributable to Additional Time Required for Treating Geological Over breaks as more significant than the other respondents. Consultant views uproar and disruption, as well as the resulting stoppage of work, as a key cause for concern. These attributes are rated as more severe by consultants than by other groups of respondents.

Delays due to reasons attributed to the client, such as the Stoppage of works by locals demanding employment, and Delay in approval by the client resulting in delays in design and timely procurement and delivery have been viewed by the contractor as extremely significant attributes. These attributes are rated as more severe by contractors than by other groups of respondents. As the project's leader, the contractor is aware of how such occurrences can affect the overall project completion. 97% of the Contractors indicated that Stoppage of works by locals demanding employment occurred in their projects with a medium to high frequency, whereas 93% of the Contractors indicated that Delay in approval by Clients resulted in the delay in design and timely procurement and delivery to the site occurred with medium to high frequency.

Delays due to increased duration of activities of E & M Works and Delay in treatment of Geological over

breaks by the Contractor were also rated differently by Client/ Consultant/ Contractor and the other categories of respondents, with Sub Contractors placing a greater emphasis on these attributes than the other categories.

Thus, the parties involved in a Hydro Electric Project often have divergent views on what causes construction delays. Without considering the challenges indicated by the other project participants, the Contractors' planning for scheduled performance would be useless and could even face opposition. Incorporating the diverse perspectives of all players in the construction process and collaborating with them, the findings of this study could assist contractors in formulating effective plans for enhancing scheduled performance.

CONCLUSIONS

Clients rated attributes linked to inefficient project management, as having a substantial effect on scheduled performance. Consultant scored reasons that are not attributed to any party higher than the other responder groups. Consultants were more concerned than other respondents about the disturbance and ensuing stoppage of construction. Contractors highlighted occurrences of events directly attributable to the Client for delaying the project's completion as per schedule. Sub-Contractors ranked delay owing to E & M Works and delays by the Contractor as more worrisome than other respondents, and these concerns can be attributed to Contractors. Findings from this research demonstrate the importance that different stakeholders place on different aspects of a project's expected progress, all of which should be incorporated into successful planning to guarantee on-time performance.

This research shows the importance of the timely release of Good for Construction Drawings according to mutually agreed-upon timetables to allow contractors to plan and procure resources on construction sites. Client and Contractor must collaborate effectively. The client should set micro schedules with its design team or consultants. Implementing efficient technology, adopting proper information management systems, and coordinating with other designers are vital for preventing drawing issues on construction sites.

All stakeholders agreed that delays in the interface of operations at different levels affected the project's ability to finish on schedule. This hydroelectric-specific issue underlines the need for project participants to take proactive actions to improve interface activities. Coordination between designers and project management ensures that drawings are delivered on schedule, and communication between clients, Consultants, designers, and management from the beginning of the design phase minimizes costly drawing/design errors and modifications. Designers are not realizing how vital correct drawings available at correct time are to a construction project's success. This investigation identifies the causes behind hydroelectric project delays. Except for delays due to unfavorable geological circumstances and the accompanying reduction in work progress due to unfavourable working conditions, all other variables are under the control of project partners and can be addressed by appropriate management activities.

Improved construction management and stakeholder knowledge are necessary for timely project completion. Improving project completion requires a professional approach to construction management, use of effective and appropriate construction techniques, upgrading of the skills and training of the participants in the construction process. This study has identified, as per the opinions of the several individuals involved in Indian hydroelectric projects, the elements that contribute to the foreseeable delays in their execution. Those in charge of construction projects will benefit from the results of this research since they will be better able to plan measures to increase efficiency.

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