Systematic Processing Framework for Identifying, Assessing and Overcoming Delays in Construction Projects in India

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Abstract For nations and organisations, infrastructure development is considered to be one of the most advantageous activities in renovation and rejuvenation of the society for bringing strategic objectives and goals from merely written plans to reality. Although delays in construction industry has been the focus of extensive investigation over a few decades now, few academics made an attempt to investigate how delays affect both public and private building projects in many countries around the world, particularly in developing and financially struggling nations. The purpose of this work is to close a critical knowledge gap in this area by identifying, assessing and overcoming the major causative factors of delays in construction projects in Nashik, India. The main objective of the study is to develop and construct a systematic processing framework in the form of flowchart for the study area. The procedure for gathering data for the study is carried out by questionnaire survey involving 250 construction industry professionals based on simple random sampling, with 48 critical delay factors that are divided into seven main categories. Relative importance index (RII) analysis was used to rank the respondents' feedback. Using IBM SPSS Statistics, the data's internal consistency and reliability, or Cronbach's alpha, were examined (Version 28) and it was found out to be 0.74. Results showed that disputes in labour and labour strikes (RII = 0.855), poor material management (RII = 0.851) and contractor's incompatibility with new technology (RII = 0.845) were listed as the top three reasons for construction project delays in Nashik, India. The top most factors influencing delay were shown in simplified manner with Ishikawa diagram. The systematic processing framework was developed to overcome the problem on hand. The municipal corporation of Nashik, in order to become successful and efficient, construction employees need to be trained in the necessary technical skills, which requires significant investment from higher education institutions as well as other stakeholders. This study paves the pathway for the future developments of

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construction management models to use in residential and infrastructure projects in Nashik as well as in Indian construction industry.

Keywords Construction delays · Construction industry · Causes of delay · Systematic processing framework · Relative importance index

1 Introduction

1.1 General

For nations and organisations, infrastructure development is considered to be one of the most advantageous activities in renovation and rejuvenation of the society for bringing strategic objectives and goals from merely written plans to reality. The effectiveness of a nation's initiatives and its capacity to meet its development goals are gauged by the performance of those projects. Delay can be considered as the amount of time that is spent beyond the agreed-upon delivery date or the contract's expiration date. Delays in building projects can occur for a variety of reasons (variations, low productivity, lack of resources, etc.), and these reasons can differ from one location to another. Additional changes brought about by delays include postponements, higher prices, and even contract termination. The fact that construction project delays are an unavoidable aspect of the project's construction life was also stressed.

Even while modern construction projects use better management practices and very advanced technologies, they still experience delays that push back the project's completion date. Construction project delays and cost escalations are a significant issue in India, as they are in many other developing nations. Despite the sector's expanding importance in India, numerous projects are still not finished on desired schedule or within the allotted budget. This suggests that a project's delays will always have unfavourable effects on the way the contract turns out. These construction project delays stifle economic activity across the globe, causes less work opportunities, also turn off overseas investments in Indian infrastructure development (Hemanta et al. 2012). Additionally, the nature and timeframe of projects (it can last anywhere between couple of months to couple of years.) affect the features of delay causes and the extent of their impact. Construction delays are typically attributed to improperly managed projects that might have been stopped if a productive method of analysing the associated repercussions had been implemented.

Many research works prior to this study have also stated that a rigorous application of project management techniques can significantly lessen the difficulties related to delays in many projects, notably in construction projects. Therefore, a key aspect in this difficulty is the lack of project management techniques for dealing with these delays. However, research has shown that despite implementing different project management techniques, construction projects still confront the issue of project delays in the majority of countries, particularly in low as well as middle-income countries. Additionally, the repercussions of delays in construction projects extend beyond the construction industry to the entire economies of the affected nations.

Therefore, it's indeed essential for all concerned parties of the organisation or endeavour concerned to put out effort to determine and assess the causes of such occurrences in order to prevent them in future practices. Numerous studies have been conducted recently to pinpoint the primary reasons why construction projects around the world delay. The main goals of these research were to classify the main reasons for delays and to evaluate the benefits of BIM over the conventional method. The main goal of this research activity is to examine the causes of the delays in building projects in India by designing a framework for systematic processing called as a systematic processing framework.

None of these research initiatives have been carried out in Nashik, Maharashtra, India. Furthermore, the plenty of these research activities focus on certain areas, and it is unclear whether they are relevant in the context of Indian construction. This inhibits the resources accessible to industry partners involved to address the many delay issues that are discussed in the research. And because the construction industry in India is currently expanding at an increasing rate, it is necessary to pinpoint those few significant causes that will enable all the interested parties in infrastructure sector to focus their expertise and capital on hand towards addressing the most prominent determinants of construction delays for accomplishing ideal and beneficial results.

Typically, shortcomings in the implementation processes are to blame for most construction projects' inability to reach their goals, which eventually causes the contractor and customer to become unhappy. Numerous significant projects have so far fallen short of their deadlines due to the industry's inability to manage delays in construction projects. The above insinuates towards that the failure to complete the infrastructure project will always have unfavourable effects upon the outcome of the contract. Construction delays are commonly used in reference to poor onsite project management that might have been addressed if a productive method of analysing the associated repercussions had been implemented. Therefore, a key aspect in this difficulty is the lack of project management techniques for dealing with these delays. However, research has shown that despite implementing different project management techniques, construction projects still confront the issue of project delays in the majority of countries, especially in developing and financially struggling countries. Despite the fact that delays in infrastructure ventures and schemes have been a theme for investigation for decades and although several studies have been directed at their effects towards public and private infrastructure programmes in other nations, particularly in developing and financially struggling nations across the world, none of such studies have been carried out in Nashik, Maharashtra, India. Furthermore, most of these investigations concentrate on designated locations, and it is unclear whether or not they are relevant to the global construction industry environment. This restricts the resources industry participants have accessible to address the many delay issues that are discussed in the research. And because the construction industry in India is currently expanding at an increasing rate, it is right time to investigate a few delay factors that will enforce organisations and project participants to channel their efforts and available resources as well as wealth on addressing the most important causes of construction delays in order to achieve ideal and beneficial results.

The purpose of this research initiative, which only features residential building construction projects in Nashik, India, is to close a critical information gap by examining, classifying, and assessing the factors that affect delays in infrastructure projects. The background information on building project delays is given in the first section of the study, which is followed by a review of previous studies that have been done in various nations that are pertinent. Before examining the study's conclusions, the methodology employed in this research project and the insights gained by using analytical techniques too are highlighted. The study repercussions, final thoughts, and noteworthy suggestions are expressed during this report's closing part. These are focused on using the right management approaches that also serve as a guide for implementing the concrete strategies necessary to handle and reduce the significant delay issues identified, while conducting forthcoming infrastructure projects in India and worldwide.

1.2 Problem Statement

In "Annual report 2020–21 (Annual Reports—Ministry of Housing and Urban Affairs 2020–21), the Ministry of Housing and Urban Affairs (MHUA) in 4.1/No. 3 of (2020)" addressed the issue of how 75% of public construction projects took longer than expected and were delayed. Due to the contractor's inability to participate in more projects, delays result in a loss of output and income. Therefore, the opportunity cost the predicament that the contractor strives is equivalent to the profit the contractor loses. Due to the aggressive tendering procedure, the contractor with the lowest bid/winning price wins the contract or tender. This is the major reason public construction projects known as PPP project or initiatives frequently perform poorly and are delayed.

1.3 Objectives of Study

- To identify and assess the major causative factors of delay in building construction project in the study area using RII and SPSS software.
- To find the most impactful delay factors in construction projects in the study area of Nashik, India.
- To develop systematic processing framework to overcome delays in construction projects in Nashik, India.

2 Literature Review

It is evident from the literature review's findings that numerous studies have identified and looked into the elements that cause infrastructure project delays in different countries. However, because the jurisdictive and socio-cultural context as well as the motives for delays alter by location and project characteristics, so generalisations made from studies on similar kinds of projects and those undertaken in other countries may not be totally appropriate for the extent and character of the current study. Consequently, by identifying and examining the major causes of delays in Indian road and construction projects, the current investigation aspires to close a huge knowledge gap. This will make it possible for project managers and decision-makers to be aware of the fact that project delays are relatively common, making it crucial to identify them early on.

Construction delay classification:

- Excusable but non-compensable delay—Such delays persist on by events that are not the fault of any of the parties.
- Compensable delay—Such delays persist due to the result of the owner's actions or those of a third party for whose actions the owner is responsible.
- Inexcusable delay—Such delays persist due to the fault of the contractor, his subcontractors, or the material suppliers.

One of the most endemic issues in the global construction sector is noted to be delays (Razek et al. 2008; Alinaitwe et al. 2013; Elhusseiny et al. 2021; Kikwasi 2013). The results of the analysis of the top five most significant delay reasons are given in Table 1 along with a comparison of delay factors across nine randomly chosen Asian nations. It is to be concluded that financial problems faced by owners and contractors in Asian countries (Pakistan Malaysia, Turkey, Vietnam, Jordan, Kuwait, Cambodia, UAE, and Iran; see Table 1) are among other similar findings (Enshassi et al. 2009; Ren et al. 2008; Shirowzhan et al. 2020).

When the data analysis was compared with that of Asian nations, it was discovered that, with the exception of Cambodia, "financial issues" is the most prominent frequently occurring factor that led to building delays in all eight Asian nations. This study's top ranking, "Difficulties in funding projects" by the contractor, illustrates the poor financial standing of contractors (Al-Momani 2000). A contract may have project delays if a project is given to a contractor who is experiencing financial difficulties (Assaf et al. 1995). This is typical in a number of nations, such as Vietnam, Jordan, Turkey, and Iran. Another element, "Dispute on Land Usage", was ranked third in the study. This is a result of the conflict over land compensation between the project owner and the landowner. For instance, project owners only offer government rates while landowners seek market rates. The third-place rating for Cambodian experiences follows the same ranking pattern. In this study, "improper project feasibility study" came in fourth place. Due to unrealistic project timetables, inaccurate estimates, a lack of planning for the project, as well as frequent changes made during the building phase, project owners bear responsibility for poor

Table 1 Comparison with nine selected Asian Countries

Countries	Top most five ranking causes of delay in construction projects				
	1	2	3	4	5
Kuwait	Change in commands	Financial constraints faced by owners/client	Lack of experience of the owner/ client	Unavailability of materials	Weather effects/change
Iran	Progress payment delay	Client requests for modifications during construction	Poorly managed site	Client's decision-making is moving too slowly	Contractors' financial difficulties
Malaysia (Endut et al. 2005)	Incorrect planning by the contractor	Contractor's improper site administration	Finance and payments for completed work	Subcontractor experience is insufficient	Issues/ conflicts involving subcontractors
Turkey	Changes in design and materials	Payment delays	Issues with cash flow	Financial issues with the contractor	Inadequate labour productivity
Jordan	Contractor's financial difficulties	Owner issues too many change orders	Contractor's poor scheduling and planning	Availability of low-skilled labour	Shortage of technical experts
Vietnam (Hoai et al. 2008)	Inadequate site monitoring and management	Inadequate project management support	Owner's financial difficulties	Contractor's financial issues/ difficulty	Design changes during or after the completion of project
UAE (Faradi and EI-Sayegh 2006)	Orders for changes or variations	Owner-caused delay	Owner-issued oral change orders	Owner's late payments	Due to intense competition, the contract price was low
Pakistan (Haseeb et al. 2011; Hussain et al. 2018)	Contractor having trouble financing the project	Progress payments that are late	Land use disagreement	Land use controversy/ dispute	Project is awarded at the lowest price
Cambodia	Working through the wet season/ monsoon	Flooding of the construction site/work area	Effects of road construction on nearby private property	The lowest-qualified bidder should get the job	Recurring failures of the equipment

project feasibility. The fifth-ranked element in this study—and the same ranking as in the UAE—is “award project to the lowest offer price”. Low bidders win is the conventional contractor selection criterion used in the majority of Asian countries, as evidenced in this situation (Odeh and Battaineh 2002).

3 Research Methodology

Current investigation uses a questionnaire survey approach to look into the key elements that significantly affect delay in construction projects in Nashik, India. This research follows quantitative approach for collecting information and data from the study population through field sources. The target population consists of 250 respondents residing in the Nashik city of Maharashtra state which includes contractors, consultants, project owners/clients and subcontractors, site engineers and other key players in the construction industry. Samples for the investigation were chosen using the straightforward simple random sampling procedure to reduce and remove any bias during sample selection. Structured questionnaires are utilised to collect the preliminary source of information in this research study by our own individual administration, allowing the researchers to directly get first-hand information from the respondents. Based on their work experiences and judgement, the respondents were given questionnaires to learn their thoughts and level of knowledge on delays in building projects. In the light of their expertise and professional experiences, the respondents were individually given the questionnaires to get their thoughts and learn what they knew about delays in building projects. The study’s goal and the frequent delay causes that were discovered throughout the literature analysis were taken into consideration when creating the questionnaire survey. This study examined 48 total elements that have been identified as influencing delays in building projects and were grouped into seven key categories. These categories include delays linked to contractors, consultants, owners/clients, labour, and equipment, materials, projects, and delays connected to outside factors. In addition, “the contribution level of each of these elements was evaluated in this study using the Likert’s scale of four ordinal measurements, ranging from 1 to 4 (Allen and Seaman 2007)”. Seven Microsoft Excel sheets representing each of the delay factors mentioned previously were filled out with the data gathered for the study.

The same data was used to calculate Cronbach’s alpha value. Cronbach’s alpha is a measure of internal consistency, i.e. how closely related a set of items are as a group. It is considered to be a measure of scale reliability. Technically speaking, Cronbach’s alpha is not a statistical test but it is a coefficient of reliability (or consistency). It was calculated using **IBM SPSS Statistics (Version 28).** Table 1 gives the “internal consistency of Cronbach’s alpha Gliem and Gliem (2003)”. SPSS Statistics is a statistical software suite developed by IBM for data management, advanced analytics, multivariate analysis, business intelligence, criminal investigation. SPSS is a widely used programme for statistical analysis in social science. It is also used by market researchers, health researchers, survey companies, government, education

Table 2 Internal consistency of Cronbach's Alpha (Gliem and Gliem 2003)

S/N	Cronbach's alpha, α	Internal consistency
1	$\alpha \geq 0.8$	Excellent
2	$0.8 > \alpha \geq 0.7$	Good
3	$0.7 > \alpha \geq 0.5$	Satisfactory
4	$\alpha < 0.5$	Poor

researchers, marketing organisations, data miners, and others. The original SPSS has been described as one of "sociology's most influential books" for allowing ordinary researchers to do their own statistical analysis.

"In an effort to achieve the objective of the study, a relative importance index (RII) was selected as a suitable analytical method (Doloi et al. 2012)". "This was used to analyse the ratings received through the questionnaires and establish a mean rating point or rankings of degree of influence that represents the rating for each group contributors (Gebrehiwet and luo 2017; Taherdoost 2016; Taherdoost and Group 2017). Each calculation was carried out using RII formula in Eq. (1) (Doloi et al. 2012)":

$$\text{Relative importance index, RII} = \frac{\sum W}{A \times N} \tag{1}$$

where W, represents the rating given to each factor by the respondents. For factors that cause delay e.g. 4 is for very high contributing factor, 3 is for high contributing factor, 2 is for low contributing factor and 1 is for very low contributing factor. A is the highest weight (4 for this study) and N represents the total number of samples (250 for this study). In this study 4 represented strongly agreeing to the delay factor, 3 represented agreeing to the delay factor while 2 represented disagreeing to the delay factor and lastly 1 represented strongly disagreeing to delay factor. The study was conducted according to the ethical codes of Savitribai Phule Pune University and standard ethical practices required of any reputable academic research. Respondents were informed about the research work and its impacts on future measures regarding project delay controls before filling the questionnaires. It was made known to the respondents that their participation in the research survey was an exercise of their choice and were at liberty not to participate. They also were assured of confidentiality (Table 2).

4 Results and Discussion

4.1 Cronbach's Alpha Data Reliability Test

Cronbach's alpha data reliability results were produced after analysing the questionnaire survey results in order to assess the internal consistency of the respondents' Likert scale responses. According to the study's research purpose, the reliability test results were obtained for the variables that affect construction delays. Furthermore, using Table 1 and the Cronbach coefficient, the internal consistency of the delay is assessed. The internal consistency is quite good, as evidenced by the Cronbach's alpha reliability test results for the 48 factors, which indicate a Cronbach's alpha of 0.746. This shows that the respondents' answers to the 48 variables that affect construction delay have an outstanding reliability of 74.6%. Table 1: Internal consistency of Cronbach's alpha shows that (Gliem and Gliem 2003), the results obtained are good and satisfactory. It can be said that the information gathered is valid, reliable, and correlated for each of the seven categories of delay factors.

4.2 Analyses of Contractor-Related Delay Factors

According to Table 3, the three most important factors that respondents agreed on with respect to contractors are cited as one of the main reasons for project delays. These were contractor's incompatibility with new technology (RII = 0.845), contractor's slowness in site mobilisation (RII = 0.801), and lack of risk analysis and management by contractor (RII = 0.745). Along with significant degree of delay in building projects, respondents selected the contractor's incompatibility with modern technology far more significant cause than any other building projects that are delayed because of contractors in Nashik (RII = 0.845). Although it is estimated that the following factors contribute significantly to building delays: the three reasons are, in order of decreasing importance, contractor's paucity in judgement call (RII = 0.623), disagreements with the subcontractor (RII = 0.645), and the contractor's slowness in document preparation (RII = 0.654).

Table 3 Classification of RII

Scale	Level of contribution	RII
1	Very low	$0.0 \leq RII \leq 0.2$
2	Low	$0.2 < RII \leq 0.4$
3	Average	$0.4 < RII \leq 0.6$
4	High	$0.6 < RII \leq 0.8$
5	Very high	$0.8 < RII \leq 1.0$

Table 4 RII ranking for contractor-related delay factor

S/N	Contractor-related causes of delays	RII	RII ranking	Level of contribution
1	Contractor's inadequate planning and scheduling	0.711	5	High
2	Contractor's incompatibility with new technology	0.845	1	Very high
3	Contractor's paucity in judgement call	0.623	8	High
4	The sluggish site mobilization by the contractor	0.801	2	Very high
5	The contractor took too long to prepare the documentation	0.654	6	High
6	The contractor's subpar site monitoring and management	0.732	4	High
7	Disagreements with the subcontractor	0.645	7	High
8	Lack of risk analysis and management by contractor	0.745	3	High

4.3 Analyses of Consultant-Related Delay Factors

The findings of an analysis of the project site's causes and associated factors in Table 4. The three most significant delay causes connected to consultants, as perceived by the respondents, are financial difficulties affecting the consultant (RII = 0.827), errors in the consultant's drawings (RII = 0.803), and complexity of project design (RII = 0.763). The three criteria within the consultant-related category utilising the minimal substantial delays have a great degree of participation to construction delays, comparable towards the categorisation of delays linked to contractors. These include: the consultant's lack of experience (RII = 0.650), the contractor's delay in receiving the site (RII = 0.694), and the consultant's slowness in approving the drawing (RII = 0.707), respectively.

4.4 Analyses of Owner/Client-Related Delay Factors

The outcomes of a poll's interpretation of the variables that contribute to owner/client-related delays are exhibited in Table 10. Foremost likely, reason for project delays, as reported by the respondents, are delays in owner payments for finished work (RII = 0.832), according to Table 5's analysis of the most significant client-related component. In addition, the owner's poor coordination and communication (RII = 0.805) took second place in this discipline, besides that work is suspended because of the owner (RII = 0.791), third on the list. Despite being the least major owner/

Table 5 RII ranking for consultant-related delay factors

S/N	Consultant-related causes of delays	RII	RII ranking	Level of contribution
1	The consultant's procrastination in approving the drawings	0.707	6	High
2	Errors in consultant's drawings	0.803	2	Very high
3	Financial difficulties affecting the consultant	0.827	1	Very high
4	Consultant and contractor lack coordination	0.751	4	High
5	A delay in giving the contractor the site	0.694	7	High
6	Communication barriers faced by consultant	0.749	5	High
7	Consultant's inexperience	0.650	8	High
8	Complexity of project design faced by consultant	0.763	3	High

client-related causes of delay, the following three elements, respectively, conflicts between owners in a joint ownership (RII = 0.631), the owner's late revision and approval of pertinent documents (RII = 0.683), and owner contract modifications during construction (RII = 0.735).

4.5 *Analyses of Material Related Delay Factors Related to*

According to Table 6, the three most significant delay reasons connected to materials are inadequate material management (RII = 0.851), materials not being available when needed (RII = 0.814), and an increase in material pricing (RII = 0.791). (RII). Although contributing more to building delays than its equivalents in one of the other subcategories, which contribute significantly more, material management is recognised as is by far the most crucial materials concerning reason of delay in construction projects in Nashik from the respondents' points of view. Building delays are heavily influenced by the two aspects in the materials-related class that have the least relevant delay causes, comparable with any of the other delay classifications. These are, respectively, a material shortage (RII = 0.685) and the market's availability of certainties caused finishing material decisions to be delayed (RII = 0.721).

Table 6 RII ranking for owner/client-related delay factors

S/N	Owner/client-related causes of delays	RII	RII ranking	Level of contribution
1	The owner's late revision and approval of pertinent documents	0.683	6	High
2	Owner delays in paying for finished work	0.832	1	Very High
3	Owner's poor coordination and communication	0.805	2	Very High
4	Owner disputes when there is joint ownership	0.631	7	High
5	Technical miscommunications with suppliers and contractors	0.786	4	High
6	Suspension of work due to owner	0.791	3	High
7	Owner contract modifications during construction	0.735	5	High

4.6 Analyses of Labour and Equipment Related Delay

The findings of a survey analysis of the causes causing consultant-related delays are given in Table 7. According to the respondents' perspectives, disputes in labour and labour strikes (RII = 0.855), poor labour supply and labour productivity (RII = 0.836), and an ineffective safety inspection and accelerated visitation project (RII = 0.806) seem to be the three key reasons for the delay caused by the labour and equipments on the work site. The three aspects that experience the fewest major delays under the equipment and labour-concerning classification does not have that much significance to construction delays, much like the contractor-related delay categories as well as the consultant and owner related delay categories. These are, respectively, failure to use the checklist (RII = 0.666), expensive or time-consuming equipment is not delivered as requested (RII = 0.704), and lack of equipment listings and associated design data (RII = 0.714).

4.7 Analyses of Project Related Delay Factors

The findings of an analysis of the project site's causes and associated factors. The three aspects consultant-related delays are provided in Table 8. According to that experience the fewest major delays under the project- to the respondents' perspectives, changes in site concerning classification does not have that much circumstances (RII = 0.768), inadequate data gathering and significance to construction delays, much like the any other survey (RII = 0.812), and accidents on site (RII = 0.840) are

Table 7 RII ranking for material-related delay factors

S/N	Material-related causes of delays	RII	RII ranking	Level of contribution
1	Shortage of material	0.685	7	High
2	Frequent unexpected modifications in specifications of material during construction	0.774	4	High
3	Poor material management	0.851	1	Very high
4	Escalation of material prices	0.791	3	High
5	Insufficient turnover and start-up resources makes project slow	0.727	5	High
6	Lateness in finalising finishing material due to availability of certainties in market	0.721	6	High
7	Materials not in right place when needed	0.814	2	Very high

Table 8 RII ranking for labour and equipment-related delay factors

S/N	Labour and equipment-related causes of delays	RII	RII ranking	Level of contribution
1	Poor labour supply and labour productivity	0.836	2	Very high
2	Disputes in labour and labour strike	0.855	1	Very high
3	Shortage of recent technology of equipments	0.732	5	High
4	Unavailability of equipment lists and related design data	0.714	6	High
5	Shortage of equipment operators	0.762	4	High
6	Lack of safety effective inspection and expediting visits on project	0.806	3	Very high
7	Large or long lead-time equipment not received as requested	0.704	7	High
8	No use of checklist	0.666	8	High

the categories presented in this investigation up until now. These three most significant delay reasons connected to are, respectively, issues brought on by pre-existing structures (RII = 0.683), access restrictions on the job site (RII = 0.712), and rework brought on by construction errors (RII = 0.746).

Table 9 RII ranking for project-related delay factors

S/N	Project- related causes of delays	RII	RII Ranking	Level of contribution
1	Changes in site conditions	0.768	3	High
2	Insufficient data collections and survey	0.812	2	Very high
3	Accidents on site	0.840	1	Very high
4	Problems due to existing structures	0.683	6	High
5	Rework due to error in construction	0.746	4	High
6	Restricted access on site	0.712	5	High

Table 10 RII ranking for external-related delay factors

S/N	External factors- related causes of delays	RII	RII ranking	Level of contribution
1	Inclement weather effects	0.836	1	Very high
2	Inaccurate cost estimates	0.735	3	High
3	Restriction due to site location	0.696	4	High
4	Changes in government regulation and laws	0.744	2	High

4.8 Analyses of External Related Delay Factors

According to the respondents' points of view, Table 9 gives that inclement or adverse weather effects (RII = 0.836) and modifications and changes to government regulations and legislation (RII = 0.744) seem to be the two key reasons for the delay influenced by outside factors in the same vein as the other delay types, site location restrictions (RII = 0.696), seems to be the least contributing delay causes among external or outside factors, having any significant impact on construction delays (Table 10).

4.9 Rating the Ten Important Consequences that Influence Infrastructure Project Delays in Nashik

See Table 11.

Table 11 RII ranking for the ten most significant factors that causes construction delays in Nashik

S/N	Top ten significant factors	RII	Category
1	Disputes in labour and labour strikes	0.855	Labour and equipment-related
2	Poor material management	0.815	Material-related
3	Contractor's incompatibility with new technology	0.845	Contractor-related
4	Accidents on site	0.840	
5	Inclement weather effects poor labour supply and labour productivity	0.836 0.836	External factors labour and equipment-related
6	Delays in payments for completed work by owner	0.832	Owner/client-related
7	Financial difficulties affecting the consultant	0.827	Consultant-related
8	Materials not in right place when needed	0.814	Material-related
9	Insufficient data collections and survey	0.812	Project-related
10	Lack of communication and coordination by owner	0.805	Owner/client-related

4.10 Systematic Processing Framework for Overcoming Delay in Construction Projects

A schematic representation of a framework often known as a "flowchart". This study used a systematic processing framework, which frequently follows a particular logical sequence. The schematic is especially helpful in figuring out the rationale of the operation since it permits the presentation of a flow chart flowing from one phase to another. The created framework flowchart, showcased above in Fig.1, aids in analysing and evaluating the concerns for construction project delays, just as demonstrated by the scenarios provided further in this explanation. The first step served as the framework process's starting point. The following step was to compile a set of potential project delays for infrastructure projects in Nashik which are intended to be incorporated into the desired questionnaire after carefully examining the relevant prior studies. A questionnaire was created as the next stage. In the section on the survey questionnaire, the structure of the questionnaire and relevant information are covered. The feedback from the questionnaire is considered while selecting further step of flowchart. Throughout this instance, the reasons contributing towards infrastructure project delays were investigated for their importance and their implications on the entire time frame of the endeavour. Choosing whether it is necessary to modify the delay reasons should be the next stage. If the answer is no, move on to the next step; if the response is yes, we need to determine the more likely causes of construction delays; for this purpose, undertake the literature review procedure again. The next step's objective is to construct a prototype employing the BIM network's functions and functionality. This 3D model should serve as the starting point for future BIM functionalities namely 4D and 5D modelling. After the model is finalised, all functionalities must be recognised and grouped into the proper specialities, e.g. shuttering, concreting, and finishing. The next step is to utilise one of the computerised scheduling software to plan out a timetable for the listed activities. This timetable helps establish approximately how lengthy it is to complete the project by using basic arithmetic and rational thinking to explain the connections, interconnections, and sequencing of all the project's activities. At this point, the 3D BIM model was linked to the project regular schedule to generate a 4D BIM model. The time schedules for the projects typically do not include all the levels of information necessary to do certain process analyses. Additionally, by simulating a hypothetical infrastructure project, 4D modelling offers a number of choices in this field. This relevance of all this stag stems from the fact that the 5D modelling featured the expense component as the fifth dimension, whereas the 4D model featured the fourth dimension of "duration" for enhancement of the appraisal of a development's building potential and operational strategy. At around this juncture, the fifth-dimension incorporation shall make it conceivable to illustrate the value for every operation in the BIM model. This will make it simpler to subtract quantities, rapidly produce cost budgets, and emphasise how the model's economic depictions connect to time. The next step is to design a client-friendly software/application on a computer or mobile device allowing the user/client to input the real start and end dates of the activity as part of the analytical process for construction. The client must then enter the real duration or start and end dates for each of the chosen activities. A decision node was used to symbolise the following step and show the potential for different approaches. The client-friendly software/application will use the user-inputted data to check for delays after the client's inputs. It is possible to establish if there is a delay or not by employing a pragmatic delay evaluation approach. The delays can be overcome by using SCL delay and disruption protocol which helps into this investigation using few delay analytical techniques. The choice of the most reliable delay analysis methodology is influenced by a number of factors, including the accessibility of information, the scope of the study, the technical capabilities, the available time, and other factors. In the light of the findings of the strategy that has been used, two choices were established: most likely a paucity of delay, meaning the schematic process being completed, if not then there must be some existence for the concerning delay in the project for the selected option, resulting the client to move onto the further step.

At this point in time, before moving on to the following decision node, the client will select the reason for the delay using the user/client-friendly software or application. Out among the existing choices concerning delay reasons, the client would be requested to provide us with the delay source for the selected activity. Because it offered various paths, a decision node also represented this stage. The first choice related to the delay reason "change of scope during construction" will be presented to the client. Depending on his or her preference, the second alternative can be tied to other reasons for the delay. The first alternative suggests that the selected reason

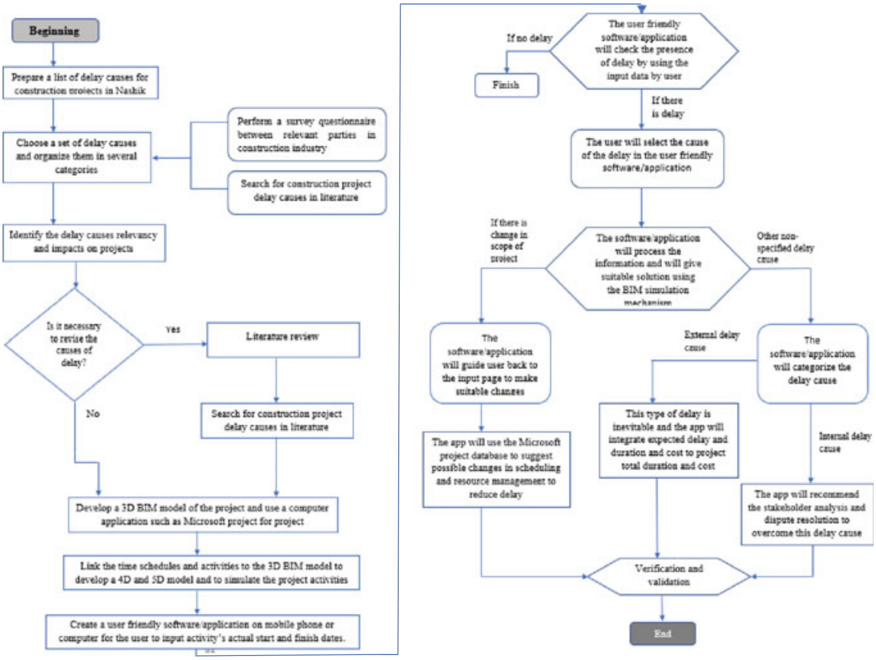

Fig. 1 Systematic processing framework

for the activity's delay was a change in scope or variation demands during construction. It is evident that the alterations were made after the project paperwork were approved, the bids were opened, and work on the workplace started. This reason for the delay will require more effort on the job site because it isn't included in the BIM model. The software/application will direct the client back to the input page in this stage so they can make the necessary modifications, and it will utilise the Microsoft project database to recommend potential scheduling and resource management adjustments to minimise delay. Reaching this step in the second alternative, nevertheless, implies that perhaps the event's specified delay reason was associated to additional delay reasons. It offered two possibilities in conjunction with the delay categorisation, thus a decision node was used to represent it. The two groups utilised to categorise delay reasons were extrinsic and intrinsic. (Intrinsic delay are the ones those inherent to participants involved and managing the particular project such as owner/client, consultant, and/or contractor-subcontractors.) But on the contrary, unforeseen factors like force majeure that impose delays outside of the participants' control are known as external delay reasons. The client will indeed be prompted to the next level of action again for internal delay reason categorisation in this scenario. Based on the selected delay reason, the user/client-developed model will provide stakeholder analysis and conflict resolution to address it. In contrast, the user will be led through the sub-step for the category of external delay cause. When determining the project's cumulative timeframe and expenditure, this type of delay reason must always be put into consideration because, contrary to internal delay reasons, it is often inevitable. A decision node served as a representation for the final stage, which included all of the earlier courses. To demonstrate the integrity of the generated model and, consequently, the framework for systematic processing was to corroborate and validate, which in turn is the key objective of all the data collected. The last phase same as the first, showed the framework process's termination node.

5 Research Implications

The report's distinctiveness aside, the ramifications of its discoveries are very substantial, noteworthy, relevant, and pertaining to socioeconomically, ethical, legislative, and intellectual aspects.

5.1 Socio-Economic Implications

To lessen or avoid the possible negative consequences of building project delays on the construction sector, legislators, venture owners, authorities, lawmakers and other prominent industry participants certainly are inspired by identifying the key elements that affects the delays in Nashik infrastructure sector. After that, the construction industry's practices and operations will be enhanced, enabling the timely completion of subsequent projects to build homes, offices, hospitals, schools, and other crucial infrastructure for the community.

5.2 Ethical and Legislative Implications

This study's recommendations will be beneficial towards building owners, suppliers, corporate entities, consultancies, governmental entities, and all other major agencies related to infrastructure sector in Nashik and surrounding districts. The builders and developers can take inspiration from the findings of this study to incorporate into their own worksites and projects resulting in timely and cost-effective project delivery to their respective clients. These could empower such relevant parties to promptly identify the first indications of delays in construction projects. The findings of this research may potentially be used as a guide for developing necessary temporary and lengthy scientifically proven policies and procedures required to drastically decrease or eliminate the effects of building project delays. The study's findings will also allow governments, legislatives, and construction managers comprehend the necessity of first identifying delay reasons when analysing potential dangers in the early stages of building projects, since these delay concerns are typically ubiquitous.

5.3 Research Limitations and Constraints

A total of 250 respondents have undergone structured questionnaire to provide the necessary input to fulfil this investigation's preliminary objective which was to identify and assess the key delay concerns in building and infrastructure projects in Nashik, India. But it's important to keep in mind that evaluating a larger sample size could be challenging and produce murky results. Nevertheless, this investigation seeks to fulfil a knowledge void regarding the examination of infrastructure project delays in the Indian construction industry. Consequently, it gives a logical and comprehensive report that serves as a benchmark for studies regarding construction delay and management contracting, especially in poor and developing countries. If potential researchers seek to further investigate in the regions surrounding India or any other neighbouring nations, they could be able to corroborate their findings by drawing on the incisive result of this research.

5.4 Significance/Originality of the Research

This investigation or research work is significant and relevant to the developing country like India and surrounding neighbouring countries because presenting relevant data that could assist aspiring building contractors that try to expand in the construction sector in Nashik, India. This research expands our expertise in the field of infrastructure project delays and concerns related to such endeavours.

6 Conclusion

We hereby summarise that this investigation examined the critical factors that affect infrastructure project delays within the context of the Indian construction industry especially in Nashik district. The intrinsic circuitry and consistency of the factors that impact infrastructure project delays was confirmed and affirmed by Cronbach's alpha test and it was found out to be 0.746. Top three most important concerns that lead to delays in the building industry in Nashik indicates labour disputes and strikes (RII = 0.855), inadequate material management (RII = 0.851), and contractor incompatibility with new technology (RII = 0.845). The highest delay causes containing seven categories were displayed in easier manner in the Ishikawa diagram for reader understanding. To address the delays in building projects with thorough justification, a systematic processing structure was designed.

Through a thorough examination and recorded reports, this study's major objective is to provide a better understanding of delays in the Indian construction sector. Therefore, important players and participants in the worldwide construction business should pay attention to the study's conclusions. This is due to the investigation's potential to oversee the design and development of scientifically proven strategies helpful in removing the adverse consequences of infrastructure projects' delays and then improve the procedures and activities of the construction industry.

The following suggestions are important according to the results of the research and even to ensure that the handling of such harmful delays in infrastructure projects has enough improvement:

- It's crucial to look into labour disputes, poor material management, and financial weaknesses of the consultant and owner in order to prevent or eliminate the delays from infrastructure projects;
- It's crucial for contractors to effectively apply project management concepts, utilising the right tools and procedures to manage construction projects in order to reduce delays and improve their managerial skills;
- Since consultants work as a liaison between clients and contractors, it is crucial that they provide effective communication and coordination among all parties involved in the project. This would assist in preventing delays brought on by improper communication on building sites;
  - The municipal corporation of Nashik should heavily spend on developing the facility to train and instruct construction workers with the required competencies to improve their skillset required for the designated job. This process should be done in collaboration with MNC's partnered NGOS and institutions of higher learning to become beneficial and productive; in other words, the labour force should be examined in order to reduce delays.

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