

INVESTIGATION ON CAUSES OF DELAYS IN RESIDENTIAL BUILDING CONSTRUCTION PROJECT

Shreyash D.Desai¹, Renuka R.Purohit²

¹P.G Student(Construction Management), Department of Civil Engineering, Pimpri Chinchwad College of Engineering, Nigdi, Pune, India

² Assistant Professor, Department of Civil Engineering, Pimpri Chinchwad College of Engineering, Pune, India

Abstract - One of the most frequent issues with residential construction projects is delay. When work is completed after the contracted or anticipated time frame, the project is said to be delayed. Projects can be delayed for a variety of causes, including those caused by the client, the contractor, divine intervention, or a third party. They may happen alone or in conjunction with other delays, early or late in the project's development. Only after determining their reason can delays be minimised. This study's goals were to identify the main reasons for delays, classify and rank them to discover their root causes, and then offer a workable remedy. Based on a literature research and survey, this study was conducted. The purpose of this work was to identify and assess the relative importance of the significant factors influencing delay through a questionnaire survey. To improve project performance and reduce or eliminate delays, effective project planning, controlling, and monitoring should be implemented.

Key words : Residential Construction delays, Delay Causes, Relative Importance Index (R.I.I), Root cause analysis

1.INTRODUCTION

India's construction sector is expanding very quickly. There are numerous projects underway in India right now with important clients, but only 1 to 5 percent of them are finished promptly. The remainder of the projects either lag behind schedule or haven't been finished at all.

These projects are primarily the result of poor planning or different circumstances throughout project planning and implementation. This may be due to the fact that the working environment differs from what the designer or planner had anticipated, or it may be due to various obstacles, uncertainties, or risks associated with the current activity that are unknown to an amateur planner or engineer.

Both economically and politically, delays and cost overruns have a big impact. The people and the economy must wait longer than necessary for the provision of public goods and services as a result of delays in project implementation. As a result, delays reduce the economy's capacity for growth.

1.1 Problem Statement

Many factors might cause construction projects to be delayed. On residential construction projects, there are various sorts and categories of delays. When the causes of delays are found, they can be minimised.

1.2 Objectives of study

1. To identify the factors that are generating delays in the residential construction project
2. To find the impact of the identified factors on construction delay.
3. To analyse delays for residential construction project.
4. To make suggestions for corrective measures to reduce project delays

1.3 Limitations

The study is restricted to a sample interview for residential developments; infrastructure projects might differ. A analysis of infrastructure development initiatives might present a quite different image. Some restrictions depend on the site's location in relation to other parts of India. Additionally, the project's administrators typically resist disclosing the data. Given the limited quantity of resources in the city, more samples would provide a clearer picture. Smaller projects experience less delays than larger township projects, which would experience more serious delays.

2. LITERATURE REVIEW

[1] The risk categories in this study by Rao Aamir Khan et al. were ranked using the RII to identify the most significant risks that result in project delay and mitigate them as soon as possible. The study's conclusions were followed by recommendations.

[2] In order to create prediction models for analysing how these factors affect delay, Hemanta Doloi et al. study's first determined the crucial attributes that have the greatest impact on delay in the Indian construction industry. The

foundation of this research was a questionnaire and in-depth interviews.

[3] Ahmed El Sayed and colleagues look into the causes of construction project delays in Bosnia and Herzegovina and assess their importance. This study examines how management software is used during the project planning and execution phases, as well as how precisely inputs are determined.

[4] The essential elements that contribute to delays and their effects on project completion were identified by M.P. Venkatesh et al. More emphasis is placed on resource-related delays in the construction industry in this study. The investigation that produced the results was conducted at several ongoing and completed construction sites in the context of India. The reasons were elicited from diverse construction specialists in various firms using a standardised questionnaire survey.

[5] By using the Relative Importance and Importance Index technique, Ashish Chandu Pawar et al. identified the main causes of delays, the effects of delays, and methods/recommendations of minimising delays in Residential Construction projects.

[6] From the perspectives of contractors, consultants, and owners, M. E. Abd El-Razek et al [6] 's analysis of construction projects in Egypt found the primary reasons for delays.

[7] The most major causes of construction delays were found by Omid Abbasi et al, who then classified and ranked them to identify the root causes of delays and offered a workable remedy.

[8] Pei-Yuan Hsu et al.'s investigation of the elements influencing schedule deviation in building projects helped them comprehend the causal connections underlying the delays. Fault Tree Analysis (FTA) is a well-known method among the many root cause analysis techniques. FTA investigates the series of circumstances that led to the issue in-depth in order to determine its root cause.

3. METHODOLOGY

In order to determine the impact of several factors on delay in the Indian construction sector, a questionnaire survey approach has been used for this research, based on the numerous overseas researchers previously mentioned. A survey of industry experts representing different stakeholders in construction projects in India was carried out.

Following methodology was adopted:

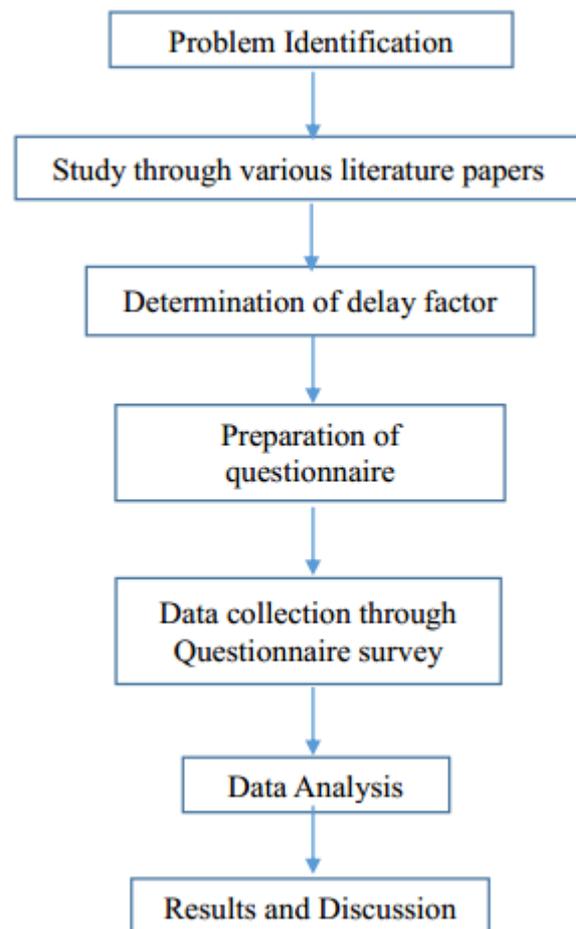


Fig-1: Detailed Methodology

3.1 Identification of delay factors and sources

A significant step in ensuring the effectiveness of the research is the identification of the study's critical qualities and the creation of the questionnaire. There has already been a significant amount of research done on the factors that contribute to construction delays, and the literature also has a collection of delay attributes that have undergone extensive peer review. The important delay attributes mentioned in the literature have been incorporated into the questionnaire for this study. Technical staff in the building industry were sent Google forms. Under five major headings—manpower related, equipment related, material related, design related, and authority related—a total of 23 delay features were found. Table 1 contains a list of the qualities. Respondents were asked to rank the significance of a certain attribute on delay in one of their chosen projects using a five point "Likert scale (1 very low, 2 low, 3 moderate, 4 high, and 5 very high)." [1].

Table -1: Identification of delay factors and sources

Sr. no	Category	Factors affecting delays	Source
1	Man power related delays	1) Shortage of skilled labours 2) Low productivity level of labours 3) <u>Unqualified Workforce</u> 4) Absentism of labours 5) Shortage of unskilled labours	Hemanta Doloi et al.(2012), Ashish Chandru Pawar et al.(2016)
2	Equipment related delays	1) Availability of equipment 2) Maintenance of equipment 3) Delay in delivery of machinery by suppliers 4) Frequent failure or breakdown of equipments	M.P Venkatesh et al.(2012)
3	Material related delays	1) Shortage of materials 2) Delivery of materials 3) Quality of materials 4) Procurement of materials 5) Damage of materials in storage	Ahmed El Sayed et al.(2020)

4	Architectural/Structural Design related delays	1) Architectural/Structural design not completed in time 2) Change in design in drawings 3) Insufficient detailing 4) Rework due to errors in drawing 5) Delay in receiving corrections and revisions of design and instructions.	Rao Aamir Khan et al.(2017)
5	Authority related delays	1) Obtaining permission from local authorities 2) Changes in government regulations and laws 3) Lack of funds 4) Delay due to slow decision making	Hemanta Doloi et al.(2012), Ashish Chandru Pawar et al.(2016)

3.2 Respondent's profile

Respondents are chosen from a diverse group of professionals working in India's construction industry (contractors, clients and engineers). All of the identified respondents have knowledge of reasonably sizable engineering construction projects in the setting of India. Project managers, contract administrators, design managers, and construction managers were among the sample's owners, architects, structural engineers, service engineers, and architects. A brief summary of the respondents' professional roles and experience is provided in Table 2 for those who took part in the study.

Table-2 : Respondent’s profile

Nature of work	Experience (years)			Total
	< 5	5-10	10-15	
Owner	1	-	1	2
Contractors	3	-	-	3
Designers/Architects	2	1	-	3
Engineers	19	8	1	28
Total	25	9	2	36

Table-3 : R.I.I ranking for Man power related delays

Sr.no	Description of Delay Factor	R.I.I	R.I.I In (%)	Rank
1	Delays due to Shortage of skilled labours	0.65	20.56	1
2	Delays due to low productivity of labour	0.65	20.56	1
3	Delays due to Unqualified workforce	0.65	20.56	1
4	Delays due to Absenteeism of labour	0.63	19.93	2
5	Delays due to Shortage of unskilled labours	0.58	18.35	3

Due to the respondents' strong knowledge of the questionnaires and relevant industrial experiences, even if the sample size is small, the quality of the responses was thought to be highly reliable for the analysis.

4. ANALYSIS AND RESULTS

4.1 Ranking of delay attributes

The rankings of the various delay factors had been determined using the Relative Importance Index (RII) ranking approach. It is able to determine the most important delay factors based on the rankings given to each cause of delays.

The relative importance index for each cause was calculated using the formula below.

$$RII = \Sigma W / (A*N)$$

W is the weightage given to each factor by the respondents (ranging from 1 to 5),

A is the highest weight (i.e. 5 in this case), and

N is the total number of respondents.

The attributes are ranked from highest to lowest impact on delay, with the highest RII or rank 1 having the greatest impact on delay and the lowest rank having the least impact on delay time.

Table-4 : R.I.I ranking for Equipment related delays

Sr.no	Description of Delay Factor	R.I.I	R.I.I In (%)	Rank
1	Delays due to availability of equipment	0.73	26.93	1
2	Delays due to Frequent failure or breakdown of equipments	0.68	25.09	2
3	Delays due to Maintenance of equipment	0.65	23.98	3
4	Delay in delivery of machinery by suppliers	0.65	23.98	3

Table-5 : R.I.I ranking for Material related delays

Sr.no	Description of Delay Factor	R.I.I	R.I.I In (%)	Rank
1	Delays due to Shortage of materials	0.73	21.53	1
2	Delays due to delivery of materials	0.70	20.64	2
3	Delays due to Quality of materials	0.66	19.46	3
4	Delays due to Procurement of materials	0.65	19.17	4
5	Delays due to damage of materials in Storage	0.65	19.17	5

Table-7 : R.I.I ranking for Owner related delays

Sr.no	Description of Delay Factor	R.I.I	R.I.I In (%)	Rank
1	Delays due to slow decision making	0.78	25.49	1
2	Delays due to obtaining permission from local authorities	0.77	25.16	2
3	Delays due to changes in government regulations and laws	0.77	25.16	2
4	Delays due to lack of funds	0.74	24.18	3

Table-6 : R.I.I ranking for Architectural/Structural related delays

Sr.no	Description of Delay Factor	R.I.I	R.I.I In (%)	Rank
1	Delays due to Change in design in drawings	0.69	20.59	1
2	Rework due to errors in drawings	0.68	20.29	2
3	Delays in receiving corrections and revisions of design & instructions	0.68	20.29	3
4	Delays due to architectural/ structural design not completed in time	0.66	19.70	4
5	Delays due to Insufficient detailing in drawings	0.64	19.10	5

Table-8 : R.I.I ranking of delay categories

Sr.no	Categories of Delay	R.I.I	R.I.I In (%)	Rank
1	Owner related delays	0.76	22.28	1
2	Material related delays	0.68	19.94	2
3	Equipment related delays	0.67	19.64	3
4	Architectural / Structural Design related delays	0.67	19.64	3
5	Manpower related delays	0.63	18.47	4

4.2 Root cause analysis of identified delay attributes

Using a tree diagram, the root cause analysis of the 23 delay attributes was performed. In the Pimpri Chinchwad region, three study locations were chosen for this purpose. The first site was chosen for the excavation stage of construction, the second for the intermediate stage, and the third for the final

stage of construction activity. By witnessing building activities at various phases, engaging in brainstorming sessions, and speaking with construction experts at the relevant sites, the underlying reasons of delay attributes were found.

The details of the sites are as follows:

1) Vastu udyog colony, Ajmera (Excavation stage)

Address :- 68, Ajmera Main Rd, Kalewadi Phata, Ajmera Housing Society, Pimpri Colony, Pimpri-Chinchwad, Maharashtra 411018

Building type – Residential building (G+6)

2) Shantai Classic, Ravet (Intermediate stage)

Address - DP Rd, near S.B.Patil Public School, Ravet, Pimpri-Chinchwad, Maharashtra 412101

Building Type – Residential Building (B+G+6)

3) RKH Pride, Nehrunagar (Finishing stage)

Address - New Telco Rd, Nehru Nagar, Pimpri Colony, Pimpri-Chinchwad, Maharashtra 411018

Building Type – Residential Building (G+5)

4.2.1 Root cause analysis of Manpower related delays

Fig.2 shows three common root causes found for the factors (shortage of skilled labours, low productivity level of labours, unqualified workforce, absentism of labours, shortage of unskilled labours) namely:

- i. The contractor's failure to provide decent working conditions for workers.
- ii. Ignoring the project site's distance from the locations of human resources and their accessibility throughout the execution phase
- iii. Late wage payments

4.2.2 Root cause analysis of Equipment related delays

From Fig.3 it can be seen that three common root causes were identified for factors (Delay in delivery of machinery by suppliers and Availability of equipment) namely :

- i. Reliance on a single vendor.
- ii. Picking the incompetent supplier.
- iii. Failure to pay suppliers on time.

Also for factors(Maintenance of equipment and Frequent failure or breakdown of equipments) three common root causes were identified namely:

- i. Using equipment that is rented.
- ii. Using outdated equipment
- iii. Improper machine handling and operation.

4.2.3 Root cause analysis of material related delays

Fig 4. shows root causes for the following factors :

1) Shortage of materials

Following are the root causes:

- i. The negligent usage of materials by the contractor.
- ii. Poor material storage in the warehouse.
- iii. A delay in placing the order.
- iv. A delay in estimating

2) Delivery of materials

Following are the root causes:

- i. Not paying the supplier in advance for the materials.
- ii. Long travel time between the site and the suppliers
- iii. Delay in placing material orders.
- iv. A lack of the requested materials.

3) Quality of materials

Following are the root causes:

- i. Lack of quality control over materials during shipping and delivery to the project site.
- ii. Giving procurement limited funds.

4) Procurement of materials

Following are the root causes:

- i. Not enough storage space is available.
- ii. Insufficient funding to purchase materials on schedule.
- iii. Increased material costs and inflation.

5) Damage of materials in storage

Following are the root causes:

- i. The contractor's negligent usage of materials
- ii. The warehouse's improper material storage

4.2.4 Root cause analysis for Architectural / Structural related delays

Fig 5. shows root causes for the following factors :

1) Design not completed in time and insufficient detailing

Following are the root causes:

- i. Employing a design team that is unqualified
- ii. Insufficient coordination across design units.
- iii. Not allotting enough time for design

2) Change in design of drawings

Following are the root causes:

- i. Planning and execution occurring at the same time.
- ii. The inability of the design units to coordinate.
- iii. Providing the project site with an unfinished drawing.
- iv. Utilizing an amateur design team.

3) Rework due to errors in drawing

Following are the root causes:

- i. The absence of frequent meetings to enhance coordination between units.
- ii. A lack of supervision and a wider perspective on the project

4) Delay in receiving corrections and revisions in design

Following are the root causes:

- i. Using inexperienced employees based on the severity of the project.

4.2.5 Owner related delays

Fig 6. shows root causes for the following factors :

1) Obtaining permission from local authorities

Following are the root causes:

- i. The local authority's delay in document approval.
- ii. At different phases of development, multiple clearances are needed.
- iii. Lack of departmental coordination.

2) Lack of funds

Following are the root causes:

- i. The owner's bad financial performance.
- ii. Being the owner of several projects.

3) Delay due to slow decision

Following are the root causes:

- i. Poor communication between contractors and owners..

- ii. Frequent change in orders
- iii. A lack of thorough analysis before providing instructions

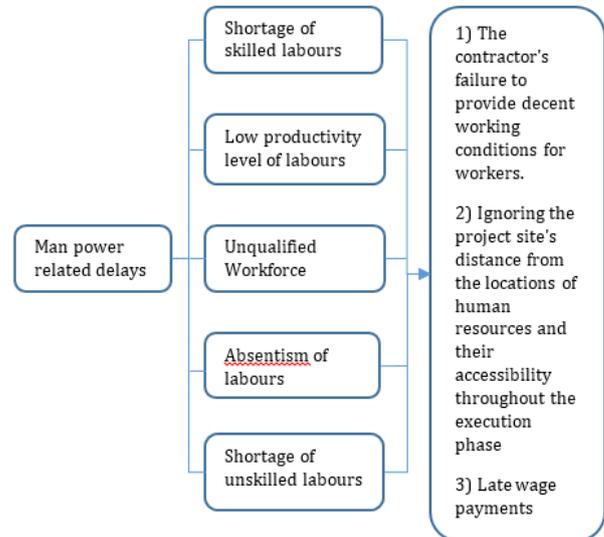


Fig-2: The delay finder tree diagram for manpower related delays

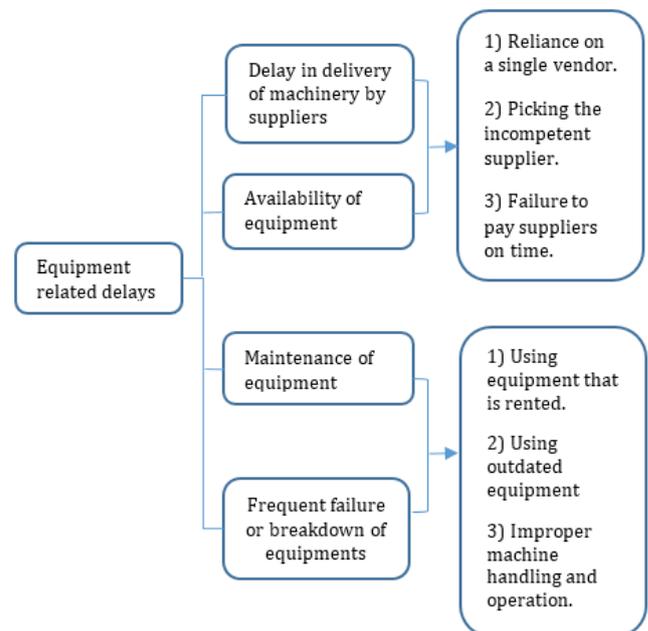


Fig-3: The delay finder tree diagram for equipment related delays

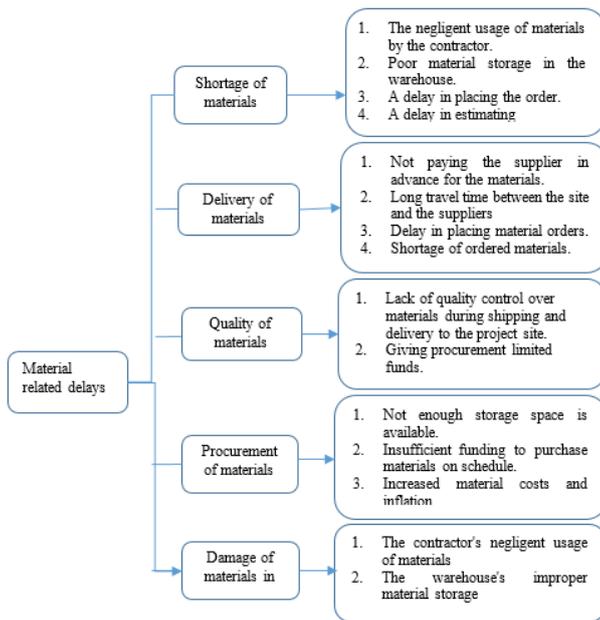


Fig-4: The delay finder tree diagram for material related delays

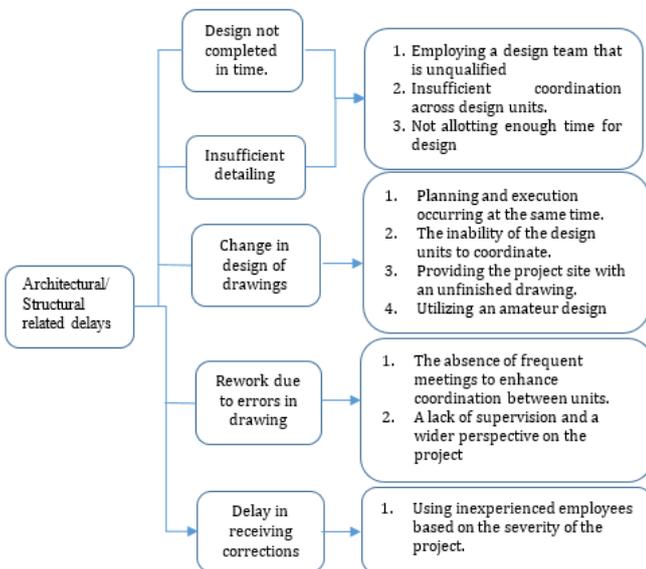


Fig-5: The delay finder tree diagram for architectural / structural related delays

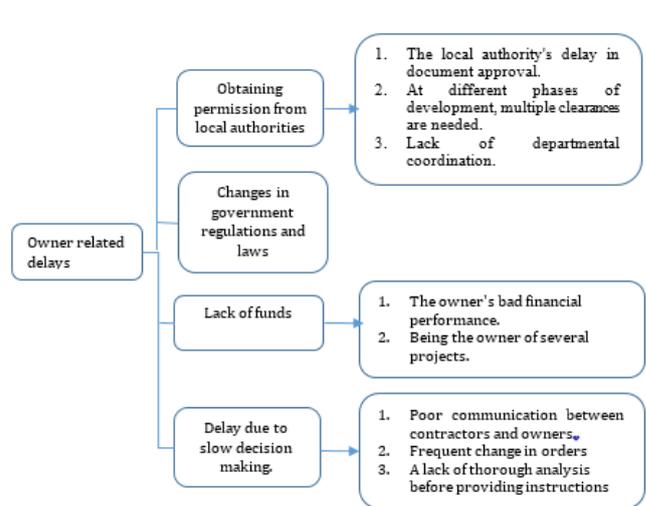


Fig-6: The delay finder tree diagram for owner related delays

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion

From the above results conclusion may be given as follows:

- 1) After Literature Review, Site visits, and brainstorming, 23 Delay attributes under 5 broad categories namely (Man power, Equipment, Material, Architectural/Structural, Owner) have been found as most common in small residential building construction projects.
- 2) The results received from google survey forms and RII analysis revealed that owner related delays has maximum impact among all delays.
- 3) Root causes of 23 delay attributes were found by root cause analysis technique using tree diagram by studying 3 sites in Pimpri Chinchwad area.
- 4) Corrective measures were proposed for the above found 23 delay attributes to minimise delays caused by them in the near future in the building construction field.

5.2 Recommendations to minimize delays

5.2.1 Man power related delays

- 1) Hiring a enough amount of experts domestic staff.
- 2) Having effective administration of human resources.
- 3) Offering competitive pay for available roles.

5.2.2 Equipment related delays

- 1) Having 2 to 3 standby suppliers .
- 2) Choosing an appropriate supplier who is ready to supply machinery on credit.
- 3) Making use of new and modern equipments.
- 4) Having an effective system for managing your machinery.

5.2.3 Material related delays

- 1) In order to reduce waste and rework, examining and managing the material quality at the point of entry to the project site.
- 2) Keeping an eye on the warehouse and material organisation.
- 3) Setting aside enough money and creating an acceptable purchasing plan to enable timely material purchases.
- 4) Creating an effective risk plan for funding and risk estimation.

5.2.4 Architectural/Structural related delays

- 1) Employing qualified personnel.
- 2) Organizing regular meetings to strengthen communication between the technical office and the design teams.
- 3) Creating a system that is effective for quick decision-making and information flow to complete the drawings.
- 4) Giving the design process enough time.
- 5) Making use of new tools and software, and techniques like BIM.

5.2.5 Owner related delays

- 1) Establishing a financial plan for payments while taking into account the delivered work at different phases of the project.
- 2) Being knowledgeable about emerging project management tools and techniques like BIM.
- 3) Choosing a reliable contractor with solid financial and technical capabilities.

- 4) Creating a proper risk management strategy and correctly allocating risks.

REFERENCES

- [1] Khan, Rao Aamir, and Warda Gul. "Emperical study of critical risk factors causing delays in construction projects." In *2017 9th IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications (IDAACS)*, IEEE,,vol. 2, ,pp. 900-906,2017
- [2] Doloï, Hemanta, Anil Sawhney, K. C. Iyer, and Sameer Rental. "Analysing factors affecting delays in Indian construction projects." *International journal of project management* 30, no. 4 : 479-489, 2012
- [3] El Sayed, Ahmed, Emad Mamoua, and Adnan Novalić. "The Lack of Techniques Used in Management as a Factor Causing Delays in Construction Projects in B&H and Other Delay Factors Detected." In *International Conference "New Technologies, Development and Applications"*, pp. 728-735. Springer, Cham, 2019.
- [4] M.P.Venkatesh, C.Umarani, S.M.Renuga and Balasubramanian Malathi " Analysis and Identification of Critical Factors of Delay in Construction Projects." NICMAR-Journal of construction management, Volume-XXVII, No.2 &3, 2012.
- [5] Ashish Chandu Pawar, S.V.Wagh and Nikhil V. Bhalerao "Factors causing delay and Methodology of Ranking for Residential Projects." *International Journal of Engineering Research & Technology (IJERT)*, Vol.5 Issue 8, 2016.
- [6] Abd El-Razek, M. E., H. A. Bassioni, and A. M. Mobarak. "Causes of delay in building construction projects in Egypt." *Journal of construction engineering and management* 134, no. 11 : 831-841,2008
- [7] Abbasi, Omid, Esmatullah Noorzai, Kobra Gharouni Jafari, and Mahmood Golabchi. "Exploring the causes of delays in construction industry using a cause-and-effect diagram: case study for Iran." *Journal of Architectural Engineering* 26, no. 3, 2020.
- [8] Hsu, Pei-Yuan, Marco Aurisicchio, and Panagiotis Angeloudis. "Investigating schedule deviation in construction projects through root cause analysis." *Procedia computer science* 121 : 732-739, 2017
- [9] Yiu, N.S., Sze, N.N. and Chan, D.W.," Implementation of safety management systems in Hong Kong construction industry–A safety practitioner's perspective". *Journal of safety research*, 64, pp.1-9,2018

- [10] Benny, D. and Jaishree, D., "Construction safety management and accident control measures". International Journal of Civil Engineering and Technology, 8(4), pp.611-617, 2017.
- [11] Solís-Carca, R.G. and Franco-Poot, R.J., "Construction workers' perceptions of safety practices: A case study in Mexico". Journal of Building Construction and Planning Research, 2014.
- [12] Hassanein, A.A. and Hanna, R.S., "Safety Programs in Large-Size Construction Firms Operating in Egypt". Journal of SH&E Research, 4(1), pp.1-31, 2007
- [13] Toole, T.M., "Construction site safety roles". Journal of construction engineering and management, 128(3), pp.203-210, 2002
- [14] Jaselskis, E.J. and Recarte Suazo, G.A., "A survey of construction site safety in Honduras". Construction Management and economics, 12(3), pp.245-255, 1994
- [15] Winge, S., Albrechtsen, E. and Arnesen, J., "A comparative analysis of safety management and safety performance in twelve construction projects". Journal of safety research, 71, pp.139-152, 2019