



(RESEARCH ARTICLE)



## Evaluation of Design Process of Commercial Construction Project Based on Lean Design Concept

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### Abstract

To determine design reliability, this study paper evaluates the design process of commercial construction projects. To streamline design efforts, decrease needless design errors, and boost design reliability, a new design workflow will be developed using commercial building concepts. The suggested procedures will give team members input on the state of the design and enable ongoing development. One of the pioneering applications of the lean methodology to building project design will be the proposed processes. Labour overruns, inadequate monitoring, and control, a lack of competence on the part of the contractor's key staff, poor planning or scheduling, and poor planning and monitoring of the refurbishment project were the top 5 variables influencing the commercial construction design process.

**Keywords:** Lean production; Lean design; Design correctness; System dynamics; Construction industry; Project planning and design.

### 1. Introduction

The planning stages before design and construction begin are critical to prevent issues before they arise. The process also continues after the construction is complete to ensure the building is legally compliant and up to the client's standards. Experts in construction management understand how vital these planning steps are and take full advantage of them. In the commercial construction design process, 7 steps are taken. The 7 stages are the Development and planning phase, Pre-design phase, Design phase, Pre-construction phase, Procurement phase, Construction phase, post-Construction phase.(Alinaitwe, Nyamutale, and Tindiwensi 2014a)

Reduce the construction project's cost overrun, redesign rate, and delay duration in this study. through the lean design method. The use of lean design Lean concepts applied to design is increasingly being referred to as "lean design" by academics and industry professionals. (Shillaber, Mitchell, and Dove 2016)However, the meaning of lean design also differs because of how this context is used. Ward, Sobek, No, and Bauch all use the phrase "learning the procedures necessary to be completed for converting a market demand into a manufacturable device," however Baines et al. (2006) use the phrase "having the process of designing be executed in a lean way." Additionally, it can be used as a noun (as in Johansson and Sundin (2014), Dombrowski et al. (2014), and Gautam and Singh (2008)) to describe a slim item that can carry out several necessary tasks. (Ko and Chung n.d.)The principles of the lean philosophy, which encourage the elimination of non-value-adding activities (for processes) or sub-functions (i.e., pieces or components for products), serve as the foundation for all three definitions. The expected functions of the product or process are referred to as the value from the point of view of the consumer of the good or service, depending on the customer's willingness to pay.

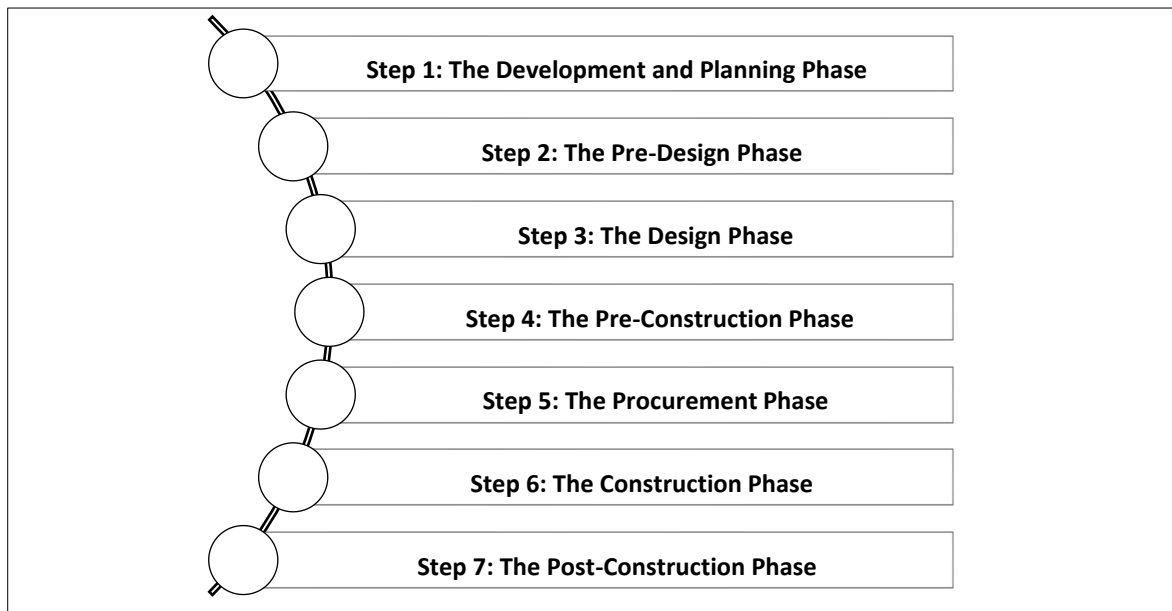
The Design for Lean Manufacturing takes into account a variety of perspectives, which are referred to as four value streams: customer, product design and test, production, and knowledge. Whatever the titles, concentrating on the four

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areas encourages developers to consider the value of the proposed solution and the potential for waste to enter the system. (Freire and Alarcó n.d.)

Learning cycles by sub-teams working on sub-systems are tied together with integration events. Savings from applying lean to design are hard to predict. Lean measures both the process of design and the design results. Measures drive the design for lean manufacturing culture and promote continuous improvement. Far more happens during the process of building a commercial building than piecing together construction materials. The building phase is only one small step in the project. The planning stages before design and construction begin are critical to prevent issues before they arise. (Ko and Chung 2014)

Experts in construction management understand how vital these planning steps are and take full advantage of them to reduce problems during the construction project. The process also continues after the construction is complete to ensure the building is legally compliant and up to the client’s standards. Let’s walk through the construction process step by step.(Alinaitwe, Nyamutale, and Tindiwensi 2014b)



**Figure 1** Lean Design Process

Due to structural design changes, inventory management, scheduling work, etc., the construction sector may encounter delays that directly affect project delivery schedules and raise prices. Commercial buildings include more stakeholders than other forms of development, which can result in degraded building components and more paperwork, labour, staff wages, and other costs. (Kenley 2014a). The main objectives of this study are to identify the factors affecting critical scheduling in commercial construction. And to succeed improve the current construction practices and assesses the redesign ratio be in it in the commercial construction industry.

Additionally, the scope of the study is saying the research has been carried out based on the lean design process to improve the commercial construction process through a questionnaire survey and decrease the redesign ratio of the commercial construction project process. Additionally, Methodology

Data were gathered through a questionnaire survey. The questionnaire is related to general information for respondents. The contractors, architect, site engineer, consultant, distributor, retailer, and developer were further requested to answer questions about their experience in the construction industry and their opinions about the factors affecting commercial construction projects.

•Relative Importance Index

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

Where W = Weighting given to each factor by the respondent

A = Highest weight

N = the Total number of respondents.

In this study, W is the total value of the factor affecting fill by the expert. That will be divided by the multiplication of the A which is the highest total factor collected from all of the factors and the number of respondents which in this study is 81. This will apply to the entire factor.(A. Kassem, Azry Khoiry, and Hamzah 2020)

## 2. Results and discussion

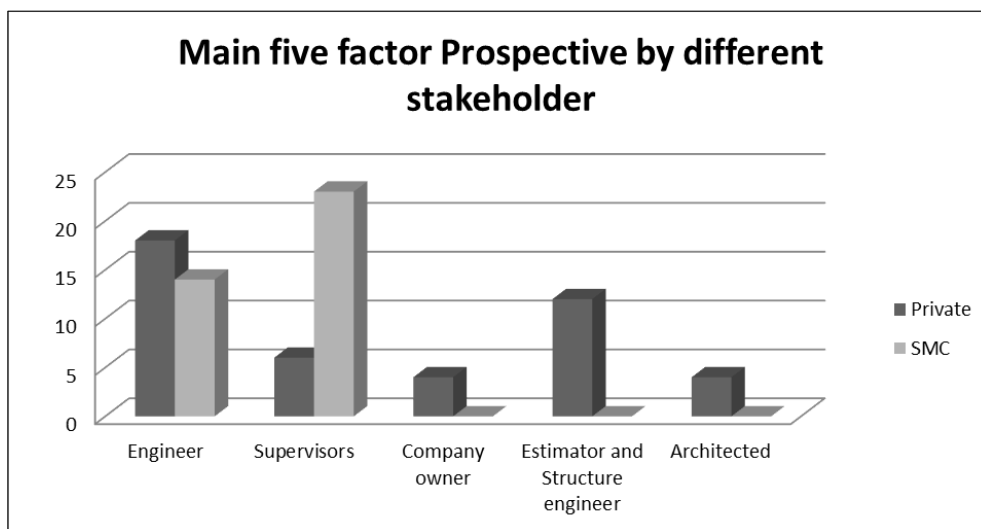
Now deals with the results obtained from the previous chapter. It includes a pairwise scale matrix for criteria and sub-criteria by the analytical hierarchical process.

I have shared 110 questionnaires with different stakeholders. Also, I have received 81 responses. In that (Table 1, Figure2),

**Table 1** Number of stakeholders

Stakeholder	Private	SMC	Total
Engineer	18	14	32
Supervisors	6	23	29
Company owner	4	0	4
Estimator and Structure engineer	12	0	12
Architected	4	0	4
TOTAL			81

After collecting data, data analysis is done using the RII method. It is used to rank the different factors( Table 2). The figure represents the different perspectives of different stakeholders and the different factors given above. For better understanding, we take the example of the “shortage in labour” factor affected by the stakeholder as differently an estimator and structural engineer with the architecture are affected but low than another factor. Also, the Supervisor and owner are affected but not more than the engineers. Another hand the engineer is most affected by the shortage of labour.



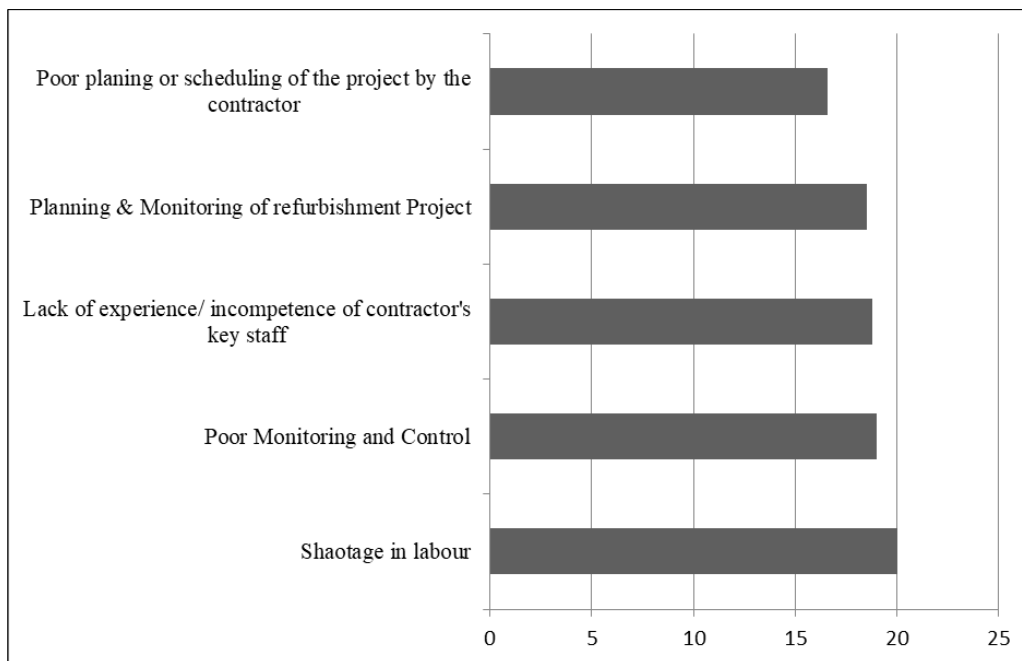
**Figure 1** Main five factors affected different stakeholder

**Table 2** Section of most affected factor by RII method

Sr.No.	Questionnaire Factors	RII
1	Shortage in labour	81.00
2	Poor Monitoring and Control	77.24
3	Lack of experience/ incompetence of contractor's key staff	75.48
4	Planning & Monitoring of refurbishment Project	75.48
5	Poor planning or scheduling of the project by the contractor	73.73

Of these 42 Factors, the five most effective factors are shown below (Figure 3). The most important factor influencing the construction redesign ratio is discussed in this study. Unskilled workers, subpar pay for subpar working conditions, and unpredictable work at times. Low-skilled laborers have driven construction workforce growth, leaving the industry in need of skilled workers.

In this factor way effect factors are leaks of Communication between stakeholders, a Delay in daily and weekly reports, and improper management of the logbook. (M. Zhang and Fang 2013) This research aimed to evaluate the most common factors affecting the stakeholder management process in construction projects. Eighty-one questionnaires were received, with a 74% response rate. The main factors affecting the process were hiring a project manager with high competency, transparent evaluation of alternatives, effective communication, setting common goals, and exploring stakeholders' needs and expectations.



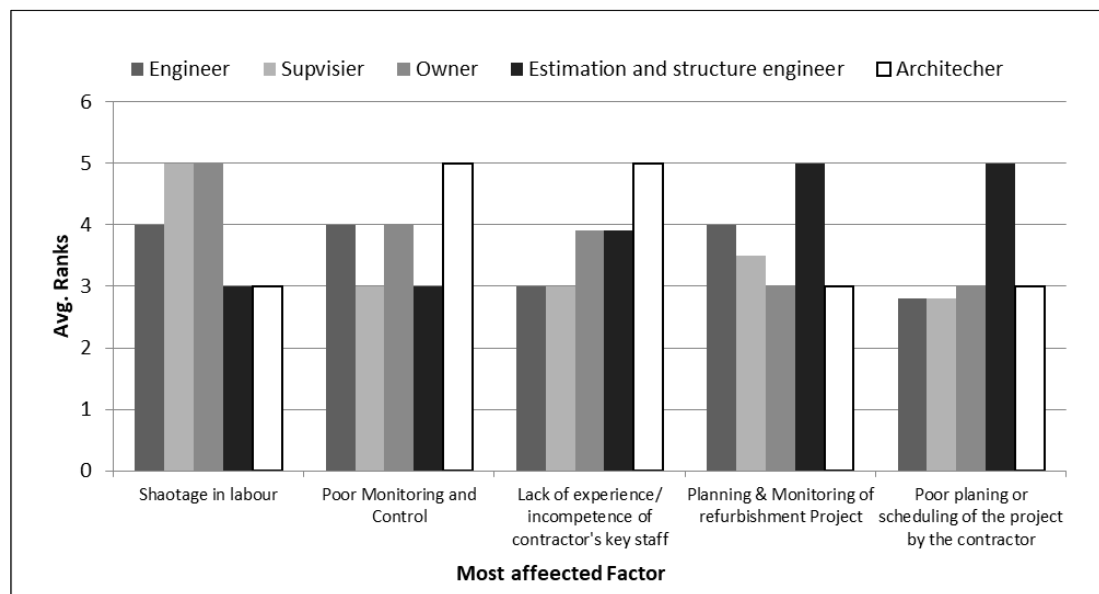
**Figure 2** Section of most affected factor by RII method

Construction management can lead to delays due to poor planning, scheduling, communication, and resources. (M. Zhang and Fang 2013)To minimize these delays, it is important to develop a detailed project plan and schedule, communicate with stakeholders, anticipate and plan for unforeseen circumstances, and ensure all necessary resources are available. (Kenley 2014b)

It is important to establish clear procedures for logbook management in the construction industry to avoid negative consequences such as accidents, cost overruns, compliance issues, disputes, and legal issues. (Gambatese et al. n.d.)Technology can be used to streamline the process and ensure all relevant information is recorded accurately and consistently. (M. Zhang and Fang 2013)

**Table 3** View Five Various Stakeholder

Sr. no.	Stakeholder	Shortage in labour	Poor Monitoring and Control	Lack of experience/ incompetence of contractor's key staff	Planning & Monitoring of refurbishment Project	Poor planning or scheduling of the project by the contractor
1	Engineer	4	4	3	4	2.8
2	Supervisor	5	3	3	3.5	2.8
3	Owner	5	4	3.9	3	3
4	Estimation and structure engineer	3	3	3.9	5	5
5	Architected	3	5	5	3	3
	Total	20	19	18.8	18.5	16.6
	Ranking	1	2	3	4	5



**Figure 3** Main five factors Prospective by different stakeholder

After the second one Lack of experience/ incompetence of the contractor's key staff is affected mostly in commercial construction. (Moore and Dainty 2001) In this factor way, effect factors are in proper management, proper material order, and Reasons can't follow the schedule of the activity in the construction site.

Effective management in the construction sector is essential for the timely, cost-effective, and client-satisfying completion of projects. (J. Zhang, Xie, and Li 2019) Planning, communication, budgeting, quality control, safety, risk management, project monitoring, and reporting are important variables to consider. (A. Kassem, Azry Khoiry, and Hamzah 2020) Setting realistic deadlines, outlining project goals, recognizing risks and difficulties, and creating a clear plan of attack are all part of planning. (Olawale and Sun 2015) Budgeting is essential to prevent cost overruns and ensure the project is finished within budget. Security should come first on every building site.

Materials are typically arranged in the construction business according to their significance and the sequence in which they will be employed in the project. (Ghanbarizadeh et al. 2019) Foundations include masonry, steel, and concrete, framing components such as engineered wood, steel, and timber, roofing supplies such as metal roofing, tiles, and

shingles, exterior building materials such as brick, stucco, and siding, plumbing materials such as pipes, valves, and fittings, electrical components such as switches, outlets, and wiring, and interior components such as flooring, insulation, and plasterboard.(Mohammed and Hassanain 2010) It is important to remember that depending on the particular project and the building design, the sequence in which these materials are employed might change. Other components and stages, such as HVAC installation or landscaping, could also be used.

Effective planning, communication, and resource management are essential to keep construction projects on schedule and reduce delays caused by unforeseen delays, inadequate planning, poor communication, resource limitations, modification orders, and safety considerations. (Nath et al. 2015a)

The Planning & Monitoring of Refurbishment Projects is the fourth most affect take factor in commercial construction practices. In this factor, ways to affect factors are increasing the project time limit, Changes in the planning and scheduling of the project, and changing remaining activity.(J. Zhang, Xie, and Li 2019)

In the construction sector, extending the project deadline can have both advantages and disadvantages. The advantages include higher quality, lower prices, and increased safety.(Saunders et al. 2016) Cons include higher expenses, longer completion times, and a negative impact on the neighborhood. The choice ought to be made in light of the particular requirements and conditions of each project.

The construction industry is constantly evolving, with new technologies, collaborative approaches, lean construction, agile project management, and sustainability being key drivers of change. These changes include the use of technology, collaborative planning, lean construction, agile project management, and sustainability. These changes help to improve accuracy and reduce errors in the planning and scheduling process.

The construction industry is constantly evolving with new technology, materials, and processes being introduced. These changes include increased use of automation, adoption of sustainable practices, implementation of Building Information Modeling (BIM),(Bynum, Issa, and Olbina 2013) increased use of prefabrication, and use of drones. These changes are likely to continue in the future, as the industry needs to adapt to new technologies, materials, and processes to remain competitive and efficient.

For this study last we talk about the Poor planning or scheduling of the project by the contractor. This factor way to affect factors that do not follow the planner's planning and scheduling of the work, Unavailability of the material project, Water supply, and electricity shortage.(Thyssen^ et al. n.d.)

Planning and scheduling are essential components of construction management, as they can lead to delays, budget overruns, reduced quality of work, poor project management, and negative impacts on stakeholder relations. (Vilasini, Neitzert, and Rotimi 2014)

Construction companies should plan, work with reliable suppliers, diversify suppliers, optimize material usage, and consider alternative materials to mitigate the unavailability of materials and ensure project success. Construction companies need to implement measures such as water-efficient practices, renewable energy sources, energy-efficient practices, contingency plans, and engagement with local communities to mitigate the impact of water supply and electricity shortages on the construction industry.

Now on words talk about the solution of the affected factor Start with the sequence effect which is given above. These are Shortage of labor, Poor Monitoring and Control, Lack of experience/ incompetence of contractor's key staff, Planning & monitoring of refurbishment Project, and Poor planning or scheduling of the project by the contractor.

The labour shortage on building sites can be addressed through a variety of measures, such as wage increases, training, and education, creating a secure and comfortable workplace, using technology, and collaborating with nearby colleges and universities. Wage increases are one of the most effective strategies to get more people into the construction sector, while training and education are another strategy.(Tsubasa and Ai 2021) Safety gear and safety equipment should be provided, and technology should be used to improve productivity. Collaborating with nearby

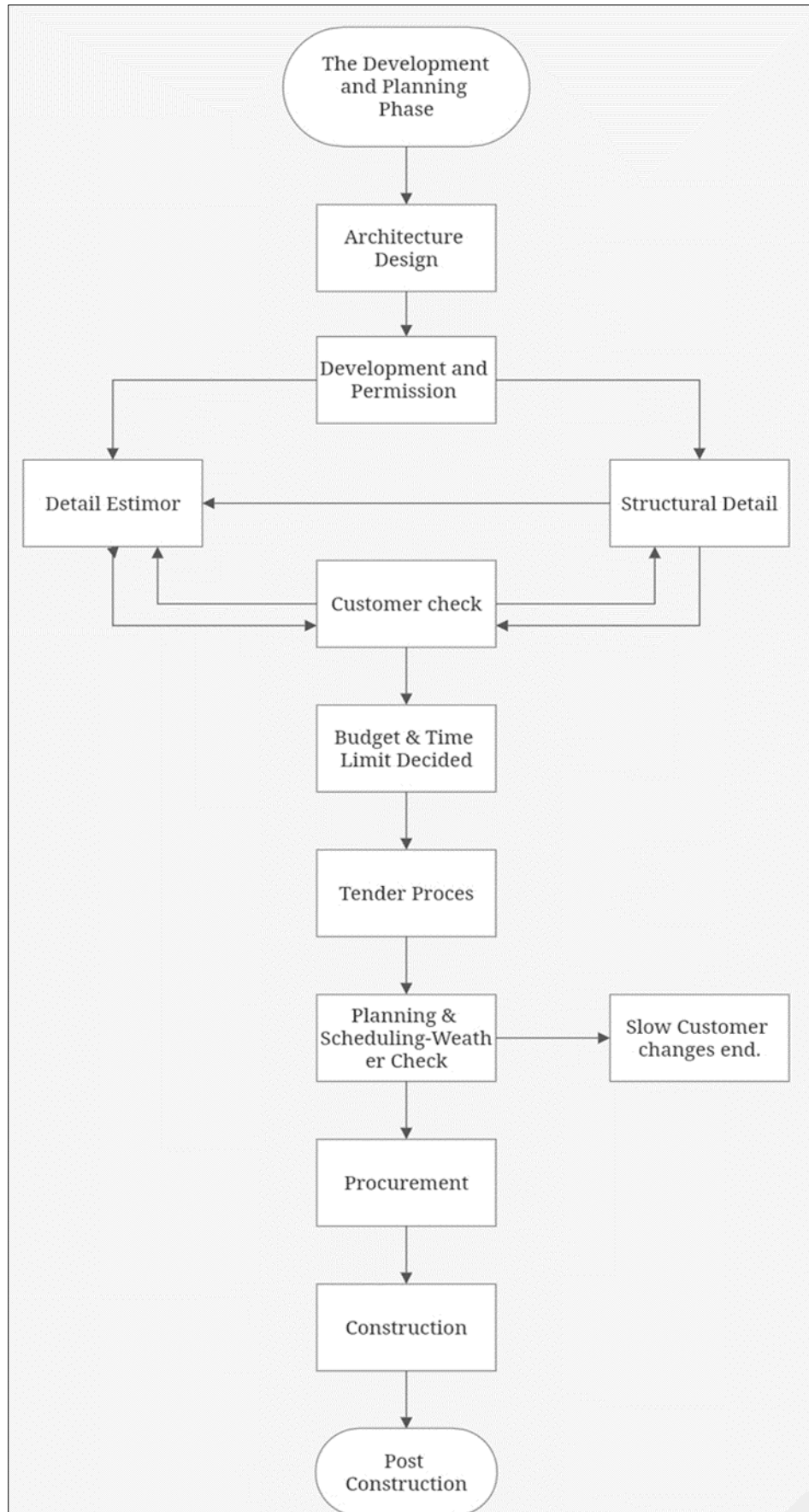


Figure 5 Propose Design Process

colleges and universities can also help to supply the construction sector with talent. These recommendations can help construction businesses reduce the labour shortage and ensure they have the resources they need.

Establish open lines of communication between the project manager and the contractor, implement a platform or software for project management, set up a regular reporting schedule for the contractor, do routine site visits and inspections, and apply penalties for subpar performance or missing deadlines.

Do a comprehensive evaluation of the contractor's credentials and expertise, include requirements for education and job history, provide mentorship or training programs, and establish open lines of communication between the project manager and the contractor. The following actions can be performed to solve the problem of poor planning and monitoring of a renovation project:

Before work starts, define the project's objectives, schedule, and completion dates. Create a comprehensive project plan that details tasks, deadlines, and resource needs. Review the plan.

Regularly and make any necessary updates. (Zeng, Lou, and Tam 2007) Monitor the development of the plan using project management tools or software. Designate a designated person or group for project monitoring. (Hwang, Leong, and Huh 2014)

The following actions can be performed to resolve the issue of the contractor's inadequate project planning or scheduling:

Check the contractor's timeline to ensure it is feasible and reasonable, and make any necessary updates to reflect changes in scope, timing, or resource availability. Track progress using project management tools and apply penalties for subpar performance. (Kagioglou et al. 2000)

In present pasties, the commercial construction process gives the above flow chat. (Zhou et al. 2020) In the flow chart, I take the 7 stages to define the commercial construction process flow. The 7 stages are the Development and planning phase, Pre-design phase, Design phase, Pre-construction phase, Procurement phase, Construction phase, Post-Construction phase. Any commercial building started with the design and planning, for that we get the knowledge about the customer requirement list of faculty in the project. After that, Selected the site for a suitable project. In the check soil bearing capacity, ground level, etc. In the design phase, we provide the planning stricter, and that planning estimated cost and time to the customer. Then we take the changes we schedule the material, time, planning stages, money, machines, etc. (Willems and Vanhoucke 2015)In procurement, we deal with dealers of material, machines, manpower, and money to select there and select the transformation root. Also, they provide the construction site layout. After all things are done we start the casting activity. All activity completes then we look at all things and check. If that is any default there, then we provide a suitable treatment. Then provide the bills of the 4's M.

After seeing factor affect points and their solution study presents the workflow chart which can be helpful in commercial construction practices.(Gunawan and Ahsan 2010) In that Starting is the same as per contract practices up prices of material, manpower, rate or expansive of machinery can be increased. That will check till then the estimate and drawings are approved(Nath et al. 2015b). That so why we decided on the budget of the project and the required time, material, machines, and method aurally. After all, things complete we go for the tender publication, filling and, the section is not completed. (Ko 2011)Onwards Planning and scheduling work start to consider future weather forecasted current scenario. That planning and scheduling check by the customer with final changes. That further activity same as the current practices.

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### 3. Conclusion

Commercial construction is increasing in cities along with the construction industry, very quickly. However, none of the upkeep on these commercial buildings is done appropriately or according to the right protocol. Maintaining it on schedule is crucial to lower the state of the redesign ratio and make it less expensive.

A total of 42 factors affecting the commercial construction design process have been identified. Out of the 42 top five elements that have an impact on the commercial construction design process most was assessed using the Relative Important Index (RII). (A. Kassem, Azry Khoiry, and Hamzah 2020) These are Shortage of labour, Poor Monitoring and Control, Lack of experience/ incompetence of contractor's key staff, Planning & Monitoring of refurbishment Project, and Poor planning or scheduling of the project by the contractor.



Additionally, all of these elements must be taken into account throughout the design phase of a commercial construction project. They can utilize this information to provide appropriate guidance for the design process to agencies because the manner that commercial construction projects are designed in India is undoubtedly changing. We suggested the following solutions for a proper and acceptable design process for a commercial construction project based on the findings of this study.

When we construct the workforce, the ideal labour force is used to get the best results in the shortest amount of time. In the second factor, we adhere to and accurately submit the daily, weekly, and monthly reports. Therefore, reducing the likelihood of labour error. Other one the contractor hires or appoints the employee, who is then given an assignment based on that employee's qualifications. Either teach them the necessary allocation. Also, when redesigning a design, consideration should be given to previous planning and scheduling. The majority of the earlier work has also been finished. Decide on fresh plans after that. When we are organizing and planning, we should check the weather before casting. Regardless of which season is active during the project's time frame. Someone should take the weather information into account before creating the planning chart and timetable charts.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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