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Impact of Design-Stage Decisions on Project Efficiency in Residential Developments

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Abstract

The initial design phase fundamentally dictates the time, costs, and overall scale of construction efficiency in residential projects. Numerous construction issues like delays, rework and cost overruns are identified as being directly related to decisions at the initial phase of the project. This research investigates the impact of design-stage decision-making on project efficiency in residential developments (i.e. to understand powerful factors that shape outcomes).

It is research carried out with a systematic review of previous studies and a qualitative evaluation of the best practices in residential construction. The analysis considers factors such as coordination between stakeholders, design information clarity, timing of decisions and involving various disciplines. The research reveals that coordination gaps, incomplete drawings and design changes are some of the highest contributors to project inefficiencies at execution.

The results show that decision taken at early stages have a significantly greater impact on project outcomes compared to those made during later phases. Projects with improved governance include better organization, evidence of coordinated design documentation and faster decision making is shown by tighter time and cost control. Conversely, poorly structured decisions generally result in recurring failures and interruptions during the construction phase.

The study emphasizes the need to take a more structured and agreed-upon view of decision-making at design time. Early-stage process strengthens from uncertainty, workflow and predictability as per project. In sum, this research shows that to attain the efficiency of residential projects and manage their process well those decisions which are made at the design stage should be useful for delivery.

Keywords: Design-stage decisions; Project efficiency; Residential construction; Time and Cost Performance; Decision-making

1. Introduction

1.1 Background and Context

Integrating multiple systems, raising performance expectations, and many more players coming to the table have made what was once a well-worn path to success in residential construction more complex with each

new project. Due to this complexity, project management becomes more difficult and therefore implementing time schedules and cost control (Agarwal & Halder, 2023).

This process requires several professionals, including architects, engineers, consultants and contractors to work together from the early stages. Stakeholder coordination is critical as communication breakdowns can cause problems in the subsequent phases (Project Management Institute 2021).

1.2 Role of Design-Stage Decisions

The design stage is an aspect of building a project. Layout, Materials, Structure and Services are the final decisions as they have a direct impact on how a project gets executed. By necessity, many of these decisions are made with limited information, but they have long-lasting consequences on efficiency (Schade et al., 2011). Better planning and certainty from well-informed decisions, needless problems carrying forward the course of the project lifecycle due to unplanned over-management can create poor decision. Better decision-making at this stage can lower wastages and increase the overall performance (Mahinkanda et al., 2023.)

Influence of Design-Stage Decisions

Design Decisions → Coordination Quality → Construction Process → Time & Cost → Project Efficiency

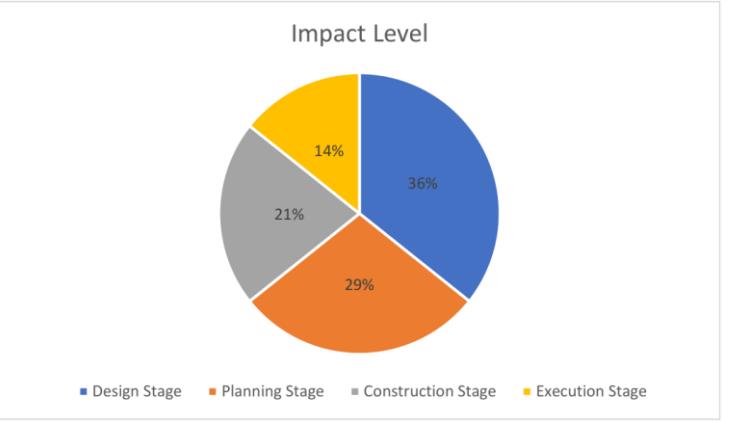

Figure 1: Relative contribution of project stages to time and cost impact

Source: Author's analysis based on qualitative analysis and literature review.

Table 1. Cause of Delay and Cost Overrun

Factor	Impact
Design Changes	Rework, Cost Increase
Poor Coordination	Delays, Clashes
Incomplete Drawings	Execution Issues
Late Decisions	Schedule Disruption

Design-stage issues such as changes, poor coordination, and incomplete drawings directly lead to delays, rework, and execution problems. Late decisions further disturb project schedules, reducing overall efficiency.

1.3 Problem Statement

It is no secret that residential projects have a tendency to run over schedule and budget. Although these problems manifest themselves during construction, the causes actually start in early design! Inefficiencies resulting from incomplete drawings, gaps in coordination, design changes (Kim et al. 2019).

Even the most discreet design mistakes can have massive consequences in denser sieves of identical housing styles. The lack of planning and ambiguity in decision-making by the management creates hurdles in result-oriented work (Chaudhary & Patel, 2020).

1.4 Research Gap and Aim

Existing research is often concerned with construction-stage issues, while the impact of early design decisions has received less attention. This paper investigates the PCE of project operation (time and cost) relative to decisions made in the design stage.

Existing studies → Focus on construction stage

Missing link → Design-stage decisions → Efficiency

2. Literature Review

Design-stage decisions are mentioned in the literature as the most important for project performance. Evaluating design alternatives early enables the choice of more effective options before construction starts (Schade et al., 2011).

Difficulties in decision-making at this stage stem from the quality of information, coordination between stakeholders, and project constraints; Evidently inefficiencies are driven by ineffective communication and coordination (Zhong et al., 2022).

It is well known that a lot of issues on the construction stage stem from design-stage faults, such as incompleteness in drawings and frequent amendments (Kim et al., 2019). For example, it has been shown that in India late decisions taken at the earlier stages of projects reduce productivity and delay project completion (Chaudhary & Patel, 2020).

Stakeholders must also work closely together to ensure there is a level of consistency across the different design elements. Integrated decision-making approaches align all stakeholders and reduce conflicts (Kamari 2023). According to risk management studies, early detection of problems can strengthen the project outcome (Wani et al., 2019; Desai & Mehta, 2019).

In summary, the literature collectively examines the relationship between design-stage decision-making and project efficiency to a large extent, but these studies largely ignore any integrated analysis at a greater scale (i.e. residential).

Table 2. Literature Summary

Author	Focus	Key Contribution
Schade et al. (2011)	Design evaluation	Early decisions influence lifecycle
Zhong et al. (2022)	Decision factors	Info & coordination critical
Mahinkanda et al. (2023)	Waste	Design improves efficiency
Kim et al. (2019)	Time & Cost	Design issues cause delays
Kamari et al. (2023)	Stakeholders	Collaboration improves decisions
Desai & Mehta et al. (2019)	Indian Context	Delays linked to early planning
Wani et al. (2019)	Risk	Early identification improves outcomes

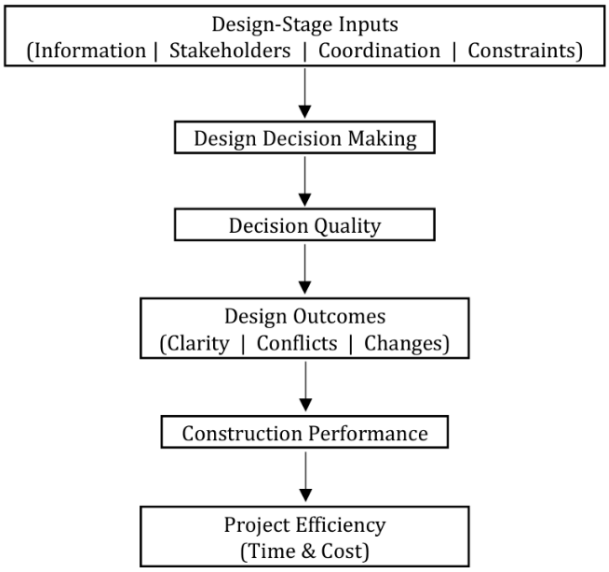

Figure 2: Flow of Design-stage decision-making and its impact on project efficiency

Source: Author's analysis based on literature review.

The key factors influencing design-stage decisions and their relationship with project efficiency are illustrated in figure 2.

3. Methodology and Qualitative Analysis

This study adopts a qualitative research approach based on literature review and practical observations. We selected relevant studies considering design decisions, project efficiencies, and housing.
A qualitative assessment of major design-stage factors was used to substantiate the findings This was based on their respective effects for time and cost performance.

3.2 Data Source and Selection

The research is conducted based on the selected academic studies; journal papers related to construction project management and design decision-making guidelines. The references were selected to address the different aspects like:

- Design-stage decision-making
- Project efficiency (time and cost)
- Coordination among stakeholders
- Residential project risk and performance

Due to its direct relevance to the focus of this research, our primary focus was on studies dealing with residential construction and early stages of project planning. Past studies have indicated that an analysis of such literature can lead to valuable observations regarding common project problems and their underlying reasons (Kim et al, 2019).

Table 3. Data Source Classification

Source Type	Purpose
Journal articles	Design decisions & efficiency
Standards (PMBOK)	Project management principles
Research studies	Risk, coordination, performance

3.3 Analytical Framework

Based on the literature review, a conceptual analytical framework is built to relate design decisions and project efficiency.

This framework draws on a set of important elements that have an impact, including:

- Information quality
- Stakeholder involvement
- Coordination
- Project constraints

These affect the quality of decisions within the design stage that directly impact on project efficiency in terms of time and cost.

This framework is underpinned by evidence, suggesting that informed and structured decision-making can lead to better project outcomes and avoid inefficiencies (Schade et al., 2011). In a like manner, improvement in coordination and information transfer at early stages lead to efficient decision-making (Zhong et al., 2022).

3.4 Method of Analysis

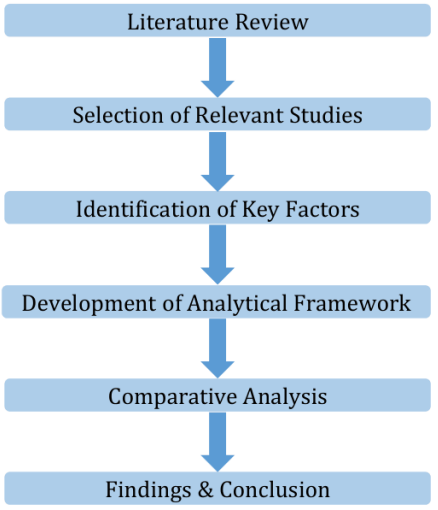

Figure 3. Research Methodology for Adopted Study.

Source: Author's analysis based on literature review.

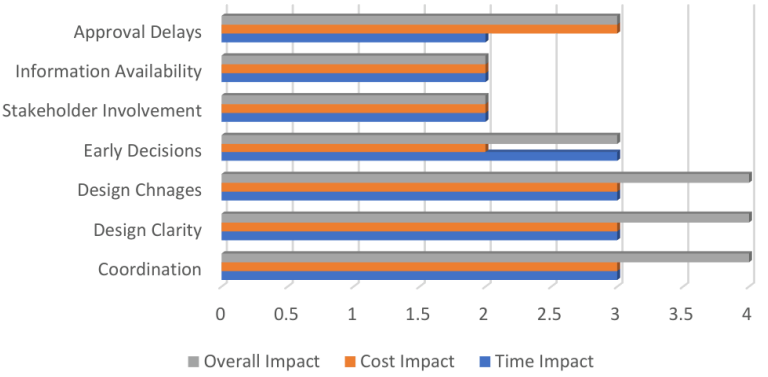

Figure 4. Qualitative Impact of Design-Stage Factors

Source: Author's analysis based on qualitative analysis and literature review.

The analysis shows that coordination, design clarity, and design Changes have the highest influence on project efficiency.

Table 4. Qualitative Risk Impact on Project Efficiency

Risk Category	Impact on Time	Impact on Cost	Key Effect on Project
Design Risk	High	High	Design changes lead to rework and material variation.
Coordination Risk	High	High	Drawings conflicts and service clashes.
Approval Risk	High	Medium	Delays in approvals affect scheduling.
Execution Risk	Medium	Medium	Inefficiencies in site operations.
Dependency Risk	High	Medium	External dependencies impact progress.

Table 5. Frequency-Based Observation of Issues

Issue	Occurrence Level	Effect
Design changes	High	Rework, delay
Coordination clashes	High	Execution issues
Incomplete drawings	Medium	Site confusion
Late decisions	Medium	Schedule disruption
Approval delays	Low-Medium	Time impact

4. Analysis and Discussion

4.1 Influence of Design Decisions

Project performance is heavily influenced by decisions made at the design stage. It all begins with early decisions about how to execute the project efficiently. Structured evaluation of alternatives improves the outcomes (Schade et al., 2011).

4.2 Key Factors Affecting Efficiency

Two factors: Identified are information quality and coordination. Poor information leads to incorrect decisions, while lack of coordination results in conflicts during execution (Zhong et al., 2022).
Stakeholder influence consultation enhances decision quality; however, project constraints are a trade-off decision that must be managed relative to performance versus feasibility considerations (Project Management Institute, 2021).

4.3 Impact on Time and Cost

According to (Kim et al., 2019) design-related problems like missing drawings and changes delay the construction process and create reworks which consumes time and cost.

Table 6. Influence of Design Issues on Project Performance

Issue	Time Impact	Cost Impact
Incomplete drawings	Delay	Rework cost
Design changes	Schedule disruption	Material cost
Poor coordination	Execution delays	Repair cost
Late decisions	Workflow disruption	Overhead increase

4.4 Coordination and Risk

Coordination leads to fewer clashes and a better work experience. Integrating decision-making allows for multi-disciplinary alignment (Kamari, 2023).
Project risks also rise at the level of early-stage decisions. Identifying risks in this early stage leads to more favourable project outcomes (Project Management Institute, 2000).

5. Key Findings and Conclusion

5.1 Key Findings

- There is a well-established and strong relationship between design-stage decisions and time and cost performance.
- The key factors are design clarity and coordination.
- Problematic decisions early on lead to many projects' issues.
- Stakeholder involvement improves decision quality.
- Identify risks as early as possible in projects to increase efficiency.

5.2 Conclusion

During the design stage, decisions have such a large impact on the efficiency of residential construction projects that very few factors or tasks can compensate. The delays and cost overruns that sometimes attract attention during construction are typically the symptom of an underlying cause; decisions made in planning, design or finance. The results emphasize that improving decision-making at this stage of the project is not just additive but essential to better project performance.

One of the main findings of this study, The overall progression of a project is closely influenced by coordination, clarity of design information, and timely decision-making. As these aspects are implemented correctly, projects face fewer interruptions, lesser re-doing work & more managed time and cost. Whereas in the execution, bugs like hazy drawings, procrastination in decision making and lack of synchronisation between stakeholder's trigger recurrence.

The research likewise stress that holistic design-stage decision-making needs to be treated not as regular utilization, but rather a crucial time period where long-run project affect is being molded. A more structured, collaborative environment—where everyone is involved from the start and decisions are made based upon facts—can significantly make things run smoother overall.

It is also crucial to go from addressing issues as they arise on site, to making considerations in the planning of the construction process while still in design. Taking into account possible problems in advance minimizes risks, resulting in more precise delivery of the project.

The results presented here are based on qualitative analysis, but show exactly how early-stage decisions affect project performance. Future research can reinforce these findings by integrating case studies or quantitative data. In sum, a better-established design stage can help make residential developments smoother, faster and more effective.

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Declaration of Conflicting Interests

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