

Exploring Digitization in Construction Management

(Role of digitization in pre-construction stages in construction management)

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Abstract — *The research explores digitization with respect to available software applications in design and planning stage in construction management.*

The research evaluates individual software applications that are used in the construction management industry and identifies the functions that are applicable to the drawings for clients/statutory approval stage as mentioned by the Council of Architecture. It is conducted by exploring fifteen software that are used by project managers in the construction industry. The research method involves literature review and tabulation of primary data to identify the gaps.

The paper aims at identifying gaps in digitization in the statutory approval stage.

The result of this research will aim to provide insights to organizations to explore the identified gap and work towards solutions that help digitize it further.

Keywords— (construction management, software, Pré-construction, digitization, software applications)

I. INTRODUCTION

The construction industry has long excelled in making on-site decisions, analysing real-world challenges, and executing strategies effectively. Recently, the industry has been undergoing a transformation with the adoption of digitization; however, certain processes still lack digital integration. One such process is the statutory approval stage for architectural drawings. Studies indicate that nearly 70% of delays in construction projects arise from inefficiencies in pre-construction activities, including approvals and compliance procedures. This highlights the need to bridge the gap and streamline this process. This study looks into various construction management approaches to better understand the methodologies employed during the design and planning phases. It places particular emphasis on the processes outlined by the Council of Architecture. By examining fifteen software tools commonly used in construction management, the research seeks to identify gaps in digital adoption within the pre-construction stages. The methodology involves a combination of literature review and analysis of primary data, employing tabulation to uncover connections between these stages and the software applications. The ultimate goal of this research is to provide valuable insights that enable companies

to digitize and enhance the statutory approval process, encouraging improved workflows and efficiency.

II. RESEARCH METHODOLOGY

The research employs an approach that combines literature review with primary data collection to identify gaps in digitization during the statutory approval stage in construction management. The methodology involves the following steps:

1.Literature Review: Exploration of existing software, articles and publications conducted to understand the current state of digitization in the construction industry, with respect to pre-construction. This review identifies the functions required during the pre-construction stage and assesses how well existing software tools address these requirements.

2.Software Analysis: Exploration of fifteen widely used construction management software applications with respect to the process mentioned in the schedule of services as per the Council of Architecture is undertaken. The features, functionalities, and limitations of each tool are documented and tabulated to analyse their applicability in the statutory approval stage.

3.Gap Identification: By analysing findings from the literature and primary data, the research identifies gaps in digital adoption and explores opportunities for streamlining the approval process.

III. LITERATURE REVIEW

The literature review focuses on the following key areas:

1.Digitization in the Construction Industry: Existing studies highlight the increasing reliance on digital tools for design, planning, and execution in construction management. Research emphasizes the benefits of digitization in enhancing productivity, reducing errors, and improving communication. However, the statutory approval stage remains relatively underexplored in terms of digital transformation.

2.Role of Software Tools: Previous research examines the capabilities of various construction management software applications. Tools like Builder trend, Zoho are widely adopted for design and planning, but studies reveal their limited focus on specific requirements for statutory approvals.

3. Gap in Existing Research: While significant advancements have been made in digitizing other stages of construction, the lack of research on statutory approvals highlights an area for improvement. This review establishes the need for targeted solutions to enhance digital adoption and streamline workflows.

4. Quantitative research: Insights from site visits and guest lectures from various leading organizations to various offices like Oberoi, JP infra, TATA projects, Chicago, Sobha Realty, L&T realty, Billimoria & Co. understanding various software used by the respective organisations.

IV. APPROACHES TO CONSTRUCTION MANAGEMENT

Construction management can be approached through different methodologies based on the complexity and context of the project. Certain approaches to construction management include the following:

1. Traditional Design bid build (DBB): Design first approach followed by bidding and construction.

2. Design Build (DB): Single entity focuses on both design and construction aiming to achieve smooth deliverance of projects.

3. Construction Manager at Risk (CMAR)

Cost and schedule are discussed at an early stage enabling the construction manager to complete the project within GMP (guaranteed maximum price).

4. Integrated Project Delivery (IPD)-collaboration: Focuses on collaboration of various stakeholders for efficiency and innovative ideas.

5. Lean Construction management: Lean construction is a project management approach designed to enhance stakeholder value while reducing waste.

6. Agile construction management: Focuses on adaptability and flexibility. It encourages shifting approaches based on project requirements.

7. Owner builder project management: Responsibilities of a general contractor are taken by the property owner to oversee the project execution.

8. Job order Contracting (JOR): A procurement method that streamlines construction projects through long-term contracts for a wide range of repair and renovation tasks.

9. Public-Private partnerships: Collaboration between public and private entities sharing resources, risks and rewards to provide service or infrastructure

10. Turnkey project: Contractor takes the responsibility of the project from design to execution, delivering finished product to the client.

11. Waterfall Project management: This approach focuses on the concept that the project execution should flow like water with respect to setting timelines, deliverables while meeting client expectations

12. Project Lifecycle management: It involves managing a project's phases—initiation, planning, execution, monitoring, and closure—to achieve defined goals effectively.

13. Critical path method: Critical tasks are emphasized timeline works around the tasks identified on the critical path.

V. UNDERSTANDING THE PRE-CONSTRUCTION PROCESS AS PER SCHEDULE OF SERVICES PROVIDED BY THE COUNCIL OF ARCHITECTURE

Schedule of Services	Services as per Council of Architecture
Sr.no	Stages of schedule
01	Concept Design
02	Preliminary Design and Drawings
03	Drawings for client's/statutory approvals
04	Working Drawings and Tender documents
05	Appointment of Contractors
06	Construction
07	Completion

Table 1: Schedule of services as per Council of Architecture

The table outlines the seven stages of work as defined by the Council of Architecture, with emphasis on **Stage 03**, which is identified as the research and study phase.

Drawings for clients/statutory approval [STAGE 3]: COA

2.07 Prepare drawings necessary for Client's/ statutory approvals and ensure compliance with codes, standards and legislation, as applicable and assist the Client in obtaining the statutory approvals thereof, if required. [1]

VI. SOFTWARE EXPLORATION

Fifteen software solutions were explored based on parameters aligned with the stages of construction, considering the **Integrated Project Delivery (IPD) method**, which involves collaboration among various stakeholders.

The following table identifies the process with the use of software for each of the steps an analysis was conducted on 15 software tools commonly utilized by various organizations and construction managers to identify gaps in digitization during the pre-construction stage.

Software	Users and key functions		
Al.no	Software	Used by	Key Features
A	AutoCAD, Revit	Architects, Planners, Interior Designers, Civil Engineers	Detailing and drawings
B	Float	Construction managers	Resource management
C	Builder trend	Commercial Contractors	Project management, sales
D	Construction Online	Contractors, Construction managers	CRM, Estimation
E	Contractor Foreman	Residential Contractor	Cloud based Construction management
F	Plan Swift	Architects, Contractors	Construction Estimating
G	Built Xact	Builders, Contractors	Estimation, Project Management
H	QuickBase	Construction managers	Project Management
I	Co-Construct	Contractors	Bidding
J	Monday.com	Construction managers	Work management
K	MSP	Construction managers	Resource allocation
L	Procore	General Contractor	Drawing management
M	Primavera	Architects, Construction managers	Portfolio management
N	Navisworks	Construction managers	Review integrated models
O	Aconex	Construction managers	Cost management solutions

Table 2: Use of softwares , Users and key functions of software

The table provides a comprehensive overview of various software tools used in the pre-construction stage of construction projects, with a focus on their primary users and key functionalities. Each row lists a different software solution (from A to O), identifying the type of professionals or stakeholders who commonly use the software (e.g., architects, contractors, construction managers) and the core features it offers (such as detailing and drawings, estimation, project management, or resource allocation). This table is useful for understanding how different digital tools are specialized to support specific tasks during the early phases of construction.

It highlights the fragmented nature of software use in the industry—where no single tool covers all essential functions—and shows that teams often rely on a combination of platforms to manage design, estimation, planning, coordination, and documentation. The table serves as a foundation for analyzing gaps in current digital solutions and emphasizes the opportunity to create integrated or more versatile platforms to streamline pre-construction workflows.

The listed tools serve a variety of roles across different pre-construction activities:

- Design and detailing tools like **AutoCAD and Revit (A)** are mainly used by architects and civil engineers.
- Project and resource management tools such as **Float (B)**, **MSP (K)**, and **Primavera (M)** are employed by construction managers for efficient scheduling and allocation.
- CRM and estimation tools like **Builder trend (C)** and **Construction Online (D)** help in project tracking and sales.
- Other tools like **Navisworks (N)** and **Aconex (O)** offer model review and cost control capabilities respectively.

This table shows the variety of software used in the early stages of construction projects, along with who uses them and what they are mainly used for. Most tools focus on helping with design, cost estimation, and project management—areas where digital solutions are well-developed. However, the table also shows that no single software covers everything, especially tasks like getting approvals, meeting regulations, and handling licenses. These are important for moving a project forward but don't have enough digital support. This means that construction teams often need to use several tools together, which can make things complicated. It also highlights a chance to create better, more integrated software to simplify early planning and approval processes.

VII. USE OF SOFTWARES AGAINST SCHEDULE OF SERVICES AS PER COUNCIL OF ARCHITECTURE

The table provides a detailed overview of how various software tools are used across different stages of the pre-construction process. It focuses on three main phases: **Concept Design, Design and Drawings, and Statutory Approvals**, further broken down into specific tasks within each phase. The table evaluates 15 different software solutions, analyzing their relevance and application in supporting these key pre-construction activities.

The software is mentioned as alphabets in Table 2.

Process	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1. Concept Design															
1.1 Ideation															
1.1 Feasibility study															
1.2 Initial discussion and Planning															
1.3 Development															
2. Design and drawings															
2.1 Detailed Drawings															
2.2 Structural Integration															
2.3 HVAC integration															
2.4 Presentation boards															
2.5 3D Visualisation															
3. Statutory approvals															
3.1 Client Approvals															
3.2 Codes and compliances															
3.3 Permits and licensing															

Table 3: Use of software against schedule of services

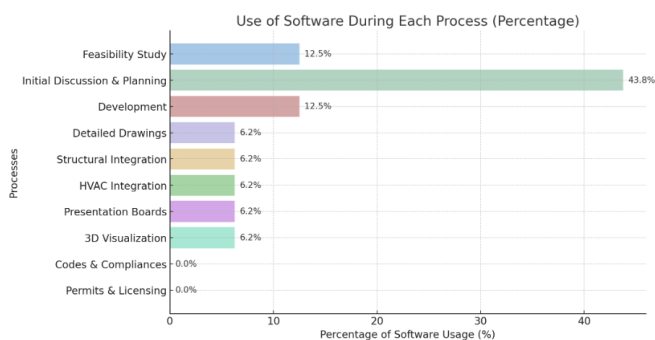


Fig 1: Graph explaining use of software in percentage against pre - construction process

The graph shows how often different pre-construction processes use software. It clearly highlights that **Initial Discussion & Planning has the highest software usage (43.8%)**, followed by **Feasibility Study and Development (each at 12.5%)**. Other processes like **Detailed Drawings, Structural Integration, and 3D Visualization** have lower but **equal usage (6.2%)**. **Codes & Compliance and Permits & Licensing show 0% usage**, pointing to a major gap in digitization for regulatory processes.

VIII. USE OF SOFTWARE IN ORGANIZATIONS: CASE STUDY THROUGH SITE VISITS AND GUEST LECTURES

Site visits to offices such as Oberoi realty, JP infra, Sobha realty, TATA projects, L&T realty, B.E Billimoria & Company

Below is the list of various software used by organizations

Blue highlights software specific to each organization

1. Oberoi Realty

Software	Purpose
Primavera	Planning
Autodesk Cloud	Collaboration
Autodesk AutoCAD	Drafting and Design
Autodesk Revit	BIM, 3D modelling
SAP	Enterprise Resource planning
QR code	Labor Identification

Table 4: Oberoi Realty : Software and uses

2. Sobha Realty

Software	Purpose
PlanGrid	Construction Productivity
Autodesk Cloud	Collaboration
Autodesk AutoCAD	Drafting and Design
Autodesk Revit	BIM, 3D modelling
HR4U	Admin updates
Elevation Excel Matrix	Digitizing façade progress
Mobile Application	Daily work management
QR System	Tracks mason and work
MSRA	ACP QR Code access

Table 5: Sobha Realty : Software and uses

3 .JP Infra

Software	Purpose
Microsoft projects	Planning, Scheduling, Resource allocation
Autodesk Cloud	Collaboration
Autodesk AutoCAD	Drafting and Design
Autodesk Revit	BIM, 3D modelling
SAP	Enterprise Resource planning
Microsoft Teams	Collaboration, Co-ordination

Table 6: JP Infra : Software and uses , Highlighting unique softwares

4. TATA projects

Software	Purpose
Microsoft projects	Planning, Scheduling, Resource allocation
Autodesk Cloud	Collaboration
Autodesk AutoCAD	Drafting and Design
Autodesk Revit	BIM, 3D modelling
SAP	Enterprise Resource planning

Table 7: TATA projects : Software and uses , Highlighting unique softwares

5. L&T Realty

Software	Purpose
Microsoft projects	Planning, Scheduling, Resource allocation
Autodesk Cloud	Collaboration
Autodesk AutoCAD	Drafting and Design
Autodesk Revit	BIM, 3D modelling
SAP	Enterprise Resource planning
Microsoft Teams	Collaboration, Co-ordination

Table 8: L&T Realty : Software and uses , Highlighting unique softwares

6. B.E Billimoria & Company

Software	Purpose
Microsoft projects	Planning, Scheduling, Resource allocation
Autodesk Cloud	Collaboration
Autodesk AutoCAD	Drafting and Design
Autodesk Revit	BIM, 3D modelling
SAP	Enterprise Resource planning
Microsoft Teams	Collaboration, Co-ordination
Monday.com	Project planning and Scheduling

Table 9: B.E Billimoria & Company: Software and uses , Highlighting unique softwares

Software used by organizations mainly focus on the concept and ideation stage, planning and budgeting stage. Statutory approval is mostly overlooked and no tracking or monitoring for this stage can be noticed according to the functions listed for each organization.

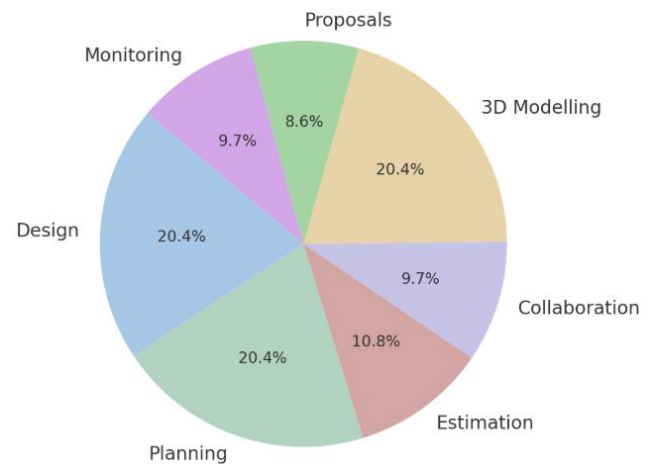


Fig 2: Pie-chart depicting use of softwares in pre-construction stage

The data indicates that software utilization is highest during the design, planning, and 3D modeling stage, comprising 20.4% of overall usage. This is followed by estimation (10.8%), monitoring (9.7%), and collaboration tools. Notably, the use of software for proposal development represents the lowest proportion, at only 8.6%.

IX. CONCLUSION AND INFERENCES

Technological advancements are rapidly transforming every field, including construction management, which often involves complex processes requiring both human expertise and technology. Digitization plays a crucial role in bridging these gaps, enabling smoother and more efficient workflows.

This research highlights the gaps in digitization during the statutory approval stage, focusing on the tasks involved and the software currently in use. Permits and approvals are major causes of project delays, emphasizing the need for digitization to streamline these processes. However, organizations have yet to adopt specialized software powered by AI and machine learning to effectively track and manage approvals.

The findings of this research highlight the potential for digitization in the statutory approval stage, allowing organizations to streamline and efficiently track this process, ultimately accelerating the achievement of organizational goals.

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4. Which software, if any, do you currently use for managing statutory approvals?

Statutory Approvals

5. How do you currently manage permits, licenses, and statutory approvals during the pre-construction stage?
6. Are there any software tools you use to streamline or track approvals? If not, why?

Challenges

7. Have you explored or adopted any workarounds for digitizing aspects of statutory approvals? If yes, please elaborate.
8. What are the main barriers to digitizing the statutory approval process (e.g., lack of government infrastructure, standardization issues, etc.)?

Future Needs

9. Would you consider adopting AI-powered tools to ensure better workflow in pre-construction stages?
10. What benefits do you think digitizing the statutory approval process would bring to pre-construction workflows?
11. What features would you like to see in a software solution designed to digitize statutory approval processes?

ANNEXURE A- SURVEY QUESTIONNAIRE

The following questionnaire was asked to project managers from various organisations to understand the use of software in pre-construction stages in construction projects.

Challenges

1. What type of projects does your organization primarily handle (e.g., residential, commercial, infrastructure)?
2. Which software tools are you currently using in the concept design, design, and planning stages of pre-construction?

Software Usage

3. What software solutions do you currently use for:
 Concept and ideation
 Planning and budgeting
 Collaboration and communication