

# DESIGN PROCESS STANDARDISATION FOR BUILDING PROJECTS IN INDIA

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## ABSTRACT

*The effectiveness of the design process significantly influences the performance of a building construction project. In a complex design environment, the advent of compressed fast-track schedules can cause disruptions in construction. It is, therefore, imperative to allocate appropriate efforts during design to minimize these disruptions. Thus, a framework which guides organizations to develop a well-structured design process will ensure better project delivery.*

*A preliminary study revealed that design processes in Indian construction industry were generally unstructured. A more detailed study of the design processes of four Indian developer organizations mapped the current design processes as swim lane diagrams. Analysis of these processes showed that design at each organization was driven by certain priorities and the design stage durations varied significantly, especially in the concept design stage where these priorities have maximum influence. Based on the analysis, it is apparent that standardization within an organization/project type is required and more feasible, than a single industry-wide standardization of the process.*

*This paper also presents a preliminary SIPOC (Supplier, Input, Process, Output, Customer) methodology to internally standardize design process which is derived from the maturity levels recommended in the Capability Maturity Model framework. This methodology has been used to develop generic process charts from the design processes mapped for the organizations sampled. It is anticipated that the availability of these standards will enable better planning and monitoring of building design.*

**Keywords:** Design Duration; Variability; SIPOC Methodology; Standard Process.

## 1. INTRODUCTION

The design process involves identification of customer requirements and their translation into design specifications. As the design is complex, efficient management of design process is necessary to ensure that issues stemming from design have minimal impact on the construction process. Complexity in design arises from the fact it is iterative, interdisciplinary, and done by specialists from different teams.

Modern construction projects have challenging schedule requirements. To compress the schedule, strategies such as fast-tracking and concurrent engineering are adopted. These strategies put additional pressure on the design phase and this coupled with other issues such as inadequate technical knowledge (Gadhavi, 2010), poor information flow, need to generate multiple design alternatives (Gane *et al.*, 2010) deficient planning, omissions, erroneous information and design changes (Venkatachalam and Varghese, 2010) render ineffective design. Inadequate design result in delays, rework and variations impacting project time and costs (Tilley and Barton, 1997).

Based on industry inputs obtained from an exploratory review meeting with industry participants and subsequent discussions it was identified that developing a standard for the building design process would enable better management of design. Based on the exploratory study and detailed inputs from the participating organizations it was found that as project types and requirements varied widely, it was not practical to have a standardized building industry-wide design process. However, the process for a specific project type within an

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organization could be standardized. Further, the methodology to develop the standard could also be framed, thus making it applicable to develop a standard for any project type within any organization.

Application of this methodology to develop standards is also critical for the Indian building industry in light of recent developments such as Real Estate Regulatory Act (RERA). As shown in Figure 1, the Act requires design for sanction to be complete (with no changes permitted) before the start of sales. In comparison, the practice before RERA did not require design to be complete at this stage and hence as it can be seen from the Figure, that the cash flow risk in a project is reduced when design durations are predictable. To enable better management and estimation of design durations, design process standards are a necessity.

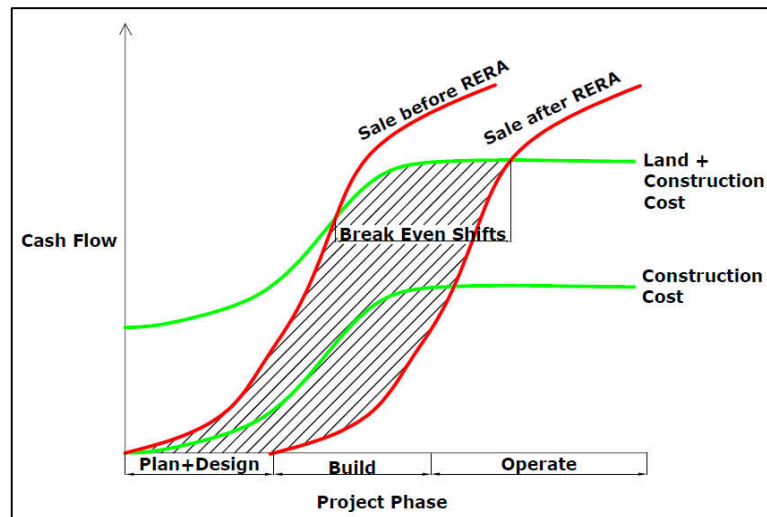


Figure 1: Impact of RERA on Project Cash Flow

Based on the need identified above, preliminary data collection and analysis was done towards developing a standard. This revealed that standardization for building process could be done at 3 levels- process mapping, duration assessment and methodology formulation. The overall objectives of this study were defined based on these levels and are (i) develop a generic process template based on type of project, (ii) determine average duration of different design stages based on project data (iii) develop a methodology by which an organization could map a standard process, gather data for specifying stage durations and continuously improve its design process performance. The third level was identified based on the observation that both the process template and the durations can vary based on the specific needs of an organization and project type. Of these objectives, the first one is discussed in detail in this paper, the approach to the other two objectives are also presented.

The scope of the study is limited to the (i) Design process for building projects. (ii) The generic templates are developed only for residential and commercial projects. (iii) Data from 13 projects are used to derive the stage duration standards (iv) The proposed methodology is validated through expert opinion.

## 2. LITERATURE REVIEW

Several studies have identified the influence of design management on the overall success of a project. These studies have revealed issues such as poor planning and management and ineffective communication leading to inefficiencies in the design process. (Koskela *et al.*, 2002; Williams *et al.*, 2013). Design processes are subjected to variation in time, cost, scope and design construction interface (Anderson *et al.*, 2005). Most of the research has been focusing on improving design from a designer's perspective with minimal incorporation of organizational and project specific issues (Tzortzopoulos *et al.*, 2007). Mapping of the design process has been attempted in the past with the aim to apply rational models of decision-making and systems engineering methodologies to the process of design (Hughes, W., 2003).

The construction industry is found to be deficient in developing a systematic scheme to improve design management practices (Tzortzopoulos *et al.*, 2007). Lack of conceptual base is the major reason for the poor level of design management. Further, application of tools and techniques for design improvement call for the development of an appropriate framework of the design process (Formoso *et al.*, 1998). Through the development of standards, failures attributed to errors and omissions in design can be reduced (Williams *et al.*, 2013).

The RIBA plan of work in the UK (RIBA Plan of Work, 2013), for example, provides a framework for building design and construction process and a guideline to define the role of an architect (Alsaadani and De Souza, 2016) through the entire lifecycle of the project (Hughes, 2003). However, such plan of work have been criticized due to the lack of 'systems' view of management and therefore offering little more than a checklist and due to lack of control and boundary features (Hughes, 1991). A company-specific standard can aid in efficient design management and effective use of available resources (Chhabra and Rathore, 2011).

Design management in India can be characterized by the lack of a standardized plan of work and hence the inability to provide the necessary framework for the activities in the various project phases. Several standards such as RIBA Plan of Work, CIC Scope of Services and CIA-India standards are available and widely used in international practice. There is an absence of similar standards in the Indian context and in addition to developing broad process standards, there is a need to customize the standards for specific project types or organizational objectives. To address this need, a study to address specific design process issues in the Indian context was required.

### 3. METHODOLOGY

The area of design management was identified and reported as an action area in the first meeting with industry representatives (Ci3 India, 2016a). Based on this a team was formed to identify and prioritize the areas to be studied under design management. Standardization was a key area identified by the action group. The study methodology followed by this action group is illustrated in Figure 2 below and each of the steps is described in further detail:

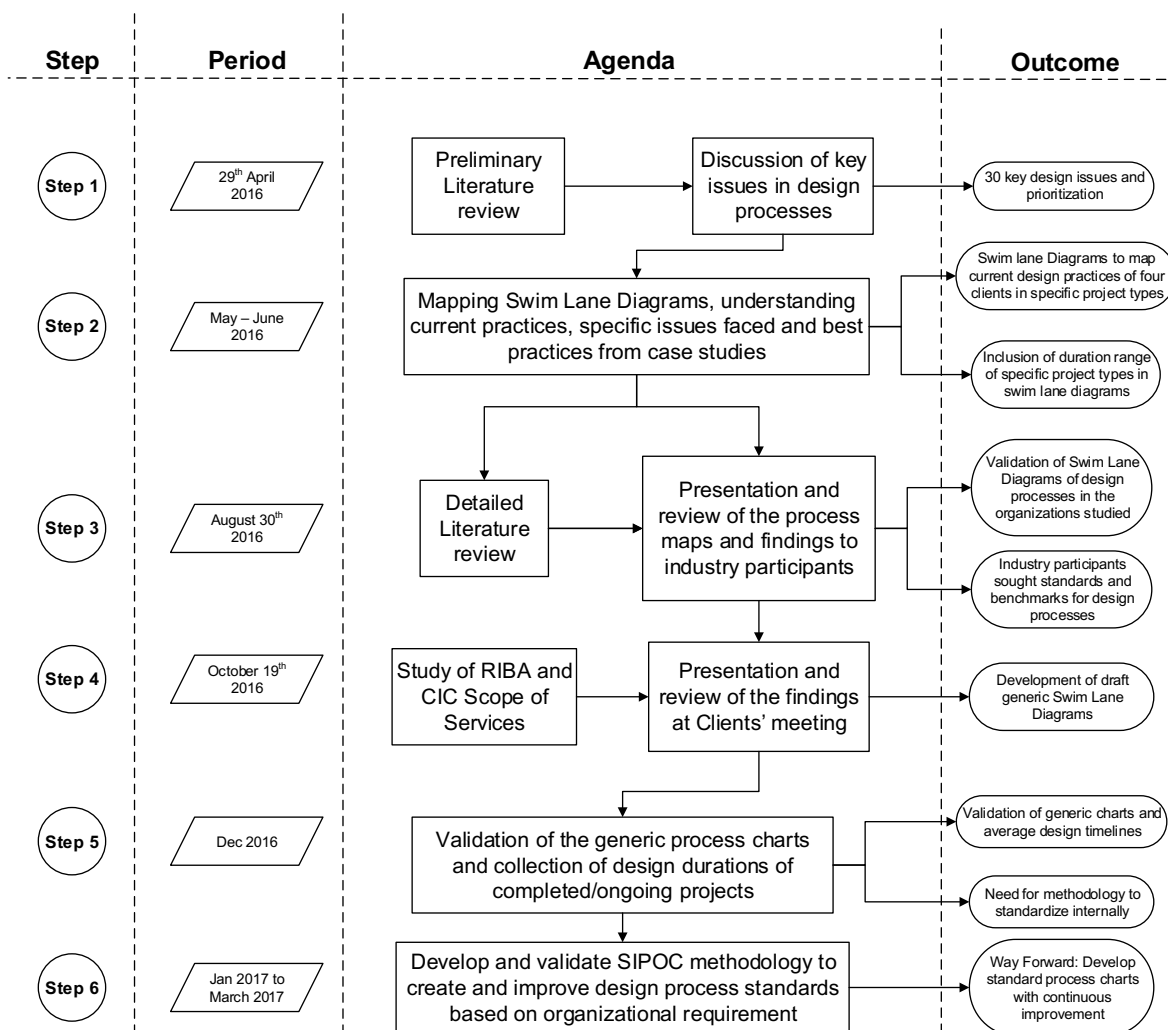


Figure 2: Study Methodology

**Step 1:** A focus group of 5 industry representatives and 3 academics discussed the key issues in design processes, faced by the industry in the Indian context specifically. Several points were discussed and 30 key issues were identified (Ci3 India, 2016b).

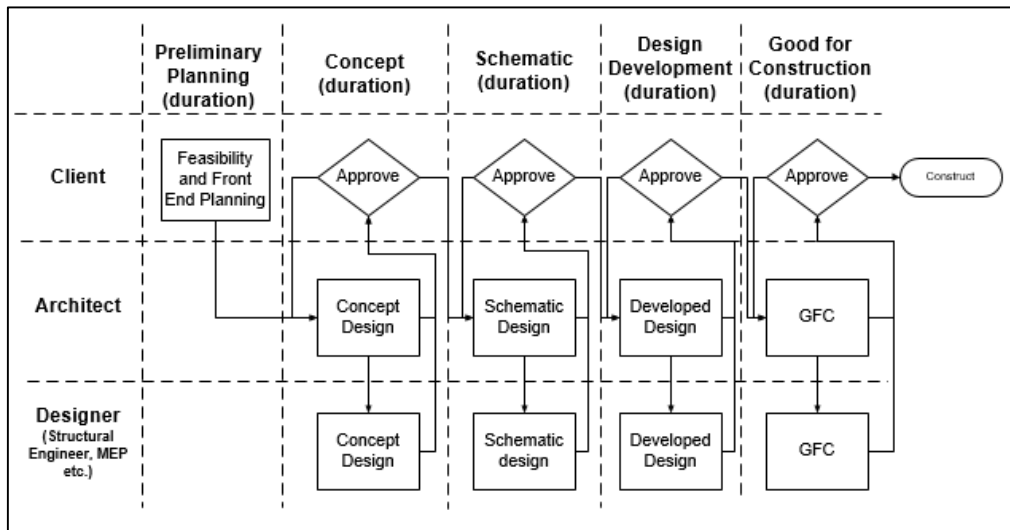


Figure 3: Format of the Generic Process Chart

**Step 2:** In order to establish current design procedure, identify specific design issues and best practices, four client organizations were visited and the process charts of specific project cases were mapped using swim lane diagrams. The stage wise design duration ranges of specific project types of these organizations were also incorporated in the swim lane diagrams. The format of the swim lane diagrams mapped is presented in Figure 3.

**Step 3:** Findings from literature and the developed swim lane diagrams were presented at a review meeting, to the 4 organizations which participated in the data collection process. During this meeting, the diagrams were reviewed, validated and the industry representatives sought standards and benchmarks for design processes. (Ci3 India, 2016c)

**Step 4:** The results from the review meeting and findings from earlier stages were presented and reviewed at a Clients' and Consultants' meeting. With reference to the process charts of the organizations, draft generic process charts were formulated. (Ci3 India, 2016d).

**Step 5:** Client organizations were revisited at their corporate offices to validate the generic swim lane diagrams and collect the design timeline data for completed and ongoing projects. Suggestions on the generic charts from the industry participants were incorporated and design duration of 5 residential projects and 8 commercial projects were collected. As seen in Figure 2, the outcome of this step was average timelines for design durations and a procedure to develop standard processes on swim lane diagrams.

**Step 6:** This step proposes a methodology to develop and continuously improve the design process standards, based on organizational requirements. This methodology is discussed in the "Way Forward" section of this paper.

## 4. RESULTS AND INFERENCES

The key results from the study are presented in this section and the inference drawn from these results are discussed. With reference to Figure 2, the results presented in this section are outcomes from Steps 2 and 3.

### 1. Priority-driven process charts in organizations

At Step 2 and 3 of the methodology, shown in Figure 2, it was observed from the processes mapped in the form of swim lane diagrams, that invariably every organization (or types of projects done by organizations) had a specific design objective and strategies to achieve those objectives.

Table 1: Key Attributes of Organizations Visited

Organization	Type of Organization	Type of Projects	Design Objective	Strategy for Achieving Objective
1	Real Estate developer	Residential, Commercial, Hospitality	Timely design and project delivery	Concurrent design stages for fast track
2	IT firm	IT offices	Landmark structure with operational efficiency	Collaborative approach to design with emphasis on operational efficiency from initial phases
3	Real Estate and Infrastructure	Mixed use	Maximize return on investment	Evaluate more concept options based on changing market trends
4	Real Estate developer and redevelopment	Mixed use and redevelopment	Meet planned budget	Check budget/revenue compliance after each design stage

The key attributes of each of the organizations are presented in Table 1. Organisation 1 attempts expedited project delivery through concurrent design. Organization 2, which is a renowned IT firm looks to design and develop iconic projects for their own use, with an impetus to life cycle cost. Organization 3 has a design approach which is flexible to incorporate demands of changing market trends, even midway through the design. Organization 4 targets to achieve the budget proposed at commencement by ensuring compliance at every stage of design. It is inferred from the above Table that each organization has its own priorities. Therefore, developing standards with design activities to suit their type of need is more relevant than following an industry-wide standard.

## 2. Variability in design durations across organizations

Duration ranges of the different design stages for specific project types in each of these organizations were also assessed as a part of Step 2 of the methodology. This assessment was based on the need to explore the effect of the specific design activities catering to organization/project priorities, on the duration of design stages.

The duration of the design process is largely dependent on the priority of the organization/project needs. The architect may use art as a medium to meet various organizational/project priorities and may develop different numbers of concept options, thus causing variability.

Figure 4 graphically represents the comparison of organizational averages of the stage duration (derived as the mean value of the range). As observed in the chart, among the 5 stages in design, the maximum variation in duration between the 4 organizations is found to be in the concept stage. The implementation of the specific design objectives presented in Table 1, seems to have a significant impact on the conceptual stage of design. This reinforces the need for organizations to standardize the durations of the design stages based on organization/project objectives.

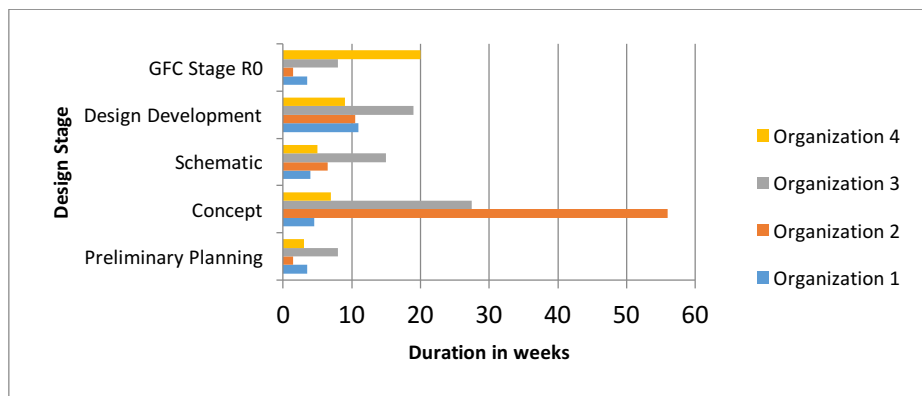


Figure 4: Graphical Comparison of the Duration of Design Stages

### 3. Range of stage wise design durations within organizations

The range of design time taken by different organizations for their specific project types, collected at Step 2 and confirmed through discussions at Step 4 of the Methodology, is presented in Table 2. It is inferred from this that that significant variability exists within an organization for similar project types. Availability of design standards with defined activities and expected durations can enable organizations to reduce this variability.

Table 2: Range of Stage Durations in Organizations (Duration in weeks)

Organization	1	2	3	4
Preliminary Planning	2 to 5	1 to 2	8	2 to 4
Concept	3 to 6	52 to 60	21 to 34	6 to 8
Schematic	3 to 5	4 to 9	13 to 17	4 to 6
Design Development	6 to 16	8 to 13	17 to 21	8 to 10
GFC drawings	3 to 4	1 to 2	8	16 to 24

At Step 4 and Step 5 of the methodology, the above findings were presented to the participating clients. The forum participants were of the general opinion that the mapping of the design process and timelines would be of value in enabling better planning and monitoring of the design phase. As specific organizations requirements vary, generic process charts templates for residential and commercial projects were developed in the format shown in Figure 3.

## 5. WAY FORWARD

Participating organizations are expected to use the above references as a base to formulate their own process charts, aligned with the priorities. Standards will have to be made based on classifications of the targeted customer pools for different project types.

As these standards will require being assessed and improved periodically, further work in this area focuses on approaches to achieve this continuous improvement cycle. The CMMI (Capability Maturity Model Integration) suggests process benchmarking at 5 maturity levels – Chaotic, Repeatable, Standardized, Quantitatively measured and Optimizing (CMMI, 2010). Based on this, a preliminary SIPOC (Supplier, Input, Process, Output, Customer) methodology for developing a standard process chart is illustrated in Figure 5 below.

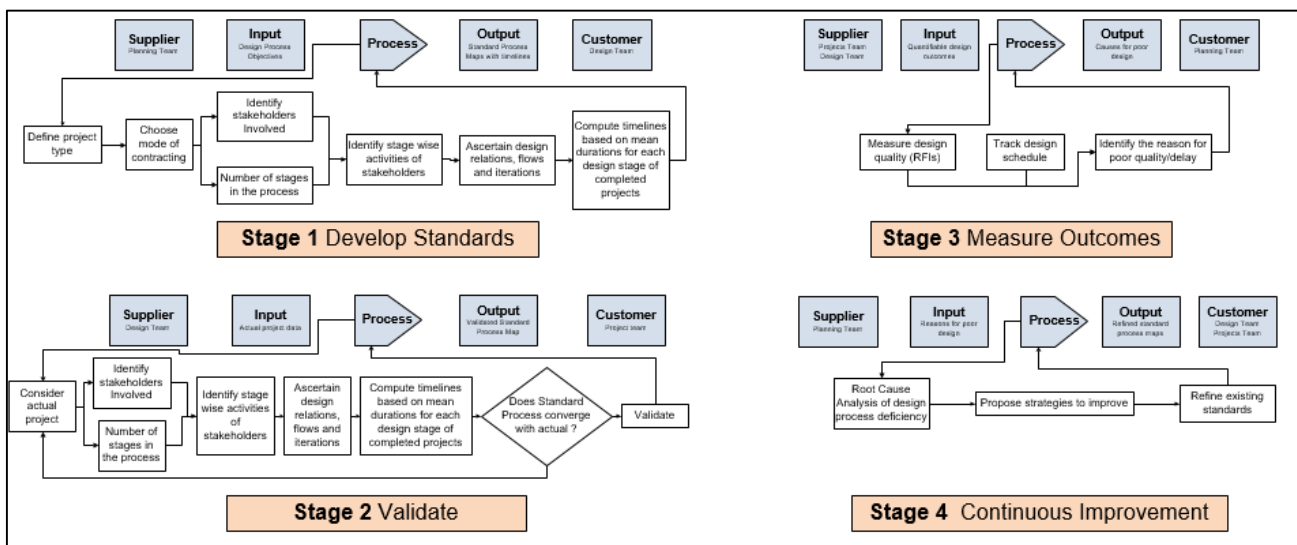


Figure 5: Stage-wise SIPOC Methodology to Develop Standard Process Chart

Each stage in the methodology represents a transition from one CMM level to the next. Therefore, organizations need to first benchmark the level of design process maturity within the organization and then choose the relevant stage in this methodology to move up the maturity ladder. This proposed methodology has been validated through interviews and other industry interactions.

## 6. SUMMARY

An exploratory study was carried out to identify design issues faced by Indian construction industry. Analysis of detailed design data collected from four Indian construction clients, by mapping the current practices on swim lane diagrams, revealed certain fundamental differences across the organizations. Proposals to address these differences and to improve design processes have been recommended in this paper and have been validated. The following are the key conclusions from this study:

1. Design development in different organizations/project types is driven by specific organizational and project priorities. There are variations in the process stage relationships based on the organization's strategy to achieve its objectives.
2. These priorities also had an influence on the design durations, especially the duration of concept stage, where the influence of priorities was high.
3. The generic process charts developed as a part of this study can be used by an organization to develop a more specific process based on their requirements.

Based on the feedback from several respondents, the development of these standards is expected to enable better management of the design phase. The validation of the SIPOC methodology by implementing in actual projects will form a part of the future work.

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