Improvement of methodological approaches to the management of organizational and technological design in construction

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Annotation: This article describes the methods used to improve the management of construction design; the difference between the traditional and modern method, the problems encountered by the design at the time of execution, their consequences but also the importance of modeling building information and automating design processes as an effective method of improving organizational and technological management processes of designing a residential building.
Keywords: construction design, collaboration, cooperation, coordination, design processes, design managers, improvement, productive, controlling, quality, asynchronous, synchronous.

The now vast body of design knowledge, beyond the capacity of any single individual to possess [1], has led to the division of the master builder role into dedicated specialized disciplines. Also considering the escalation in complexity of construction project delivery [2], a high level of collaboration, cooperation, and coordination within design and engineering processes has become inevitable [3].

The design process is often divided in several stages or phases. An example is the RIBA plan of work, which has divided the construction process into the seven stages where stages 1 through 4 include design work [4]. The flow of information, focus points, planning and managing differ in these stages. Design management was introduced to solve these problems [5]. A simplified definition is to say that design management is about managing people and information [6].People in this context are stakeholders in a building project and information being deliverables among stakeholders.

Many long-standing problems in the construction industry are, directly or indirectly, related to poor designs, design processes, and design management practices [7]. According to Love and Li [8] and Love et al. [9], design problems have been the primary “contributor to building and infrastructure failures as well as

project time and cost overruns" and to fatal accidents and injuries during the construction and operation of buildings [10].

To solve the problems and complexity of design project delivery, adherence to proper management practices and the provision of an environment for individuals to learn from mistakes have the most significant potential to improve building design [11]. To advance building design and design management practices, one must first understand the nature of design and design management activity [12, 13].

The productive nature of design activity and its embeddedness in a particular context means that design involves both technical and social activities, which address causality [14] and interpretation [15], respectively.

The aim of the present study is to use a new conception of design as the basis for the improvement of design processes and design management practices. Specifically, the intent is to focus on the instantiation and development of practical support for building design processes and design management practices [16].

In the field of construction, design has long lagged behind due to many problems it encounters during its execution. These problems are encountered depending on the specifics of the design including among others:

1. For experienced designers, engineers, and design managers: the most significant problems were related to lack of information/communication and late changes.
2. For design managers: technical IT solutions are considered important, and the main challenge for project managers is limited time resources.
3. For building services engineers: as their work depended greatly on the decisions made by clients, architects, and structural engineers, the main problems are related to late changes and poor

The consequences of these problems are the design and design management is underperforming. The main findings include:

- ✓ client's lack of timely responses ;
- ✓ unnecessary rework;
- ✓ uncertainty in information flows
- ✓ late changes;
- ✓ misalignment of designs across disciplines;
- ✓ wrong use of email;
- ✓ low proportion of value-adding activities;
- ✓ no concentrated effort to specify client requirements;
- ✓ lack of collaborative study and discussion of design alternatives;
- ✓ latency in information flows;
- ✓ project managers as the information bottlenecks
- ✓ lack of competencies to use BIM and information technologies
- ✓ unprofitable projects with more significant proportion of design fixes;
- ✓ high variation in the level of individual projects;

Design management has three functions [17]: design system design, design system operation, and design system improvement. To improve design processes, principles, methods, and tools to facilitate and support these functions are introduced in lean design management. These include, for example, cross-functional teams, a set-based design strategy, structured design work, the minimization of negative iterations, and the Last Planner System® (LPS) [18] and related technologies (e.g., BIM), which all serve to facilitate design processes [19]. Design system design must be approached from the three perspectives of production [20]—value generation (why), transformation (what), and flow (how). Principal design system activities include a proper start-up of the design project (e.g., decisions related to the physical layout of designers (co-location), and information and communication technologies, and contract forms); the preparation of project guidelines (e.g., decisions on standards, decision-making structures, validation and verification structures, and methods and tools), and the

establishment of a shared project vision (e.g., decisions on design project targets) [21]. Design system operation is divided into planning, supervising, and correcting management activities. These managerial activities recur throughout the different design project stages and at different levels of resolution (phase, look ahead, weekly, and daily). Structure matrix, collaborative planning, and strategies for managing must be introduced. The LPS, which embodies the principles of social processes for design production system control, must also be proposed. As a collaborative approach, it was devised to make design production reliable and predictable by improving work flow, building trust, and reducing waste. In design system improvement, the focus is on the gathering of contextual information for the improvement of design system design and operation throughout the different stages of project delivery and at the end of the design project [19, 19]. To prevent the reoccurrence of breakdowns, a root cause analysis of deviations is conducted, and action is taken in the future projects. The LPS was devised to ensure reliable design process flow by enabling the right conversations and establishing a network of commitments. Thus, means must be established to facilitate both technical aspects (designing the design process) and social aspects (conversations between, project parties) of design process management.

From the design perspective, the flow from one milestone to the next requires completion of activities and deliverables that form a baseline for the subsequent phase. Two types of standardized second level process descriptions are developed based on the high-level framework, one for project briefing and the other for the remaining design phases. The managerial and design activities in the project briefing stage are mostly related to strategic aspects of the project, such as assessment of the need for a technology project, surveys, research, resources, and trade partners. Activities also included the development of a project program and establishment of a shared understanding of project objectives, working methods, collaboration practices, and expected behaviors through team and start-up

meetings. Second level process descriptions must be also developed for other project delivery phases. Standardized phase descriptions must be developed on the assumption that each phase would involve a similar process. Of course, in reality, processes are never the same, and it is the skill and experience of project managers, lead architects, and engineers that determines which activities are necessary or not in a given phase. The design model also became the basis for the development of further improvements, including but not limited to the following: checklists, a new classification system for design activities, a BIM execution plan, and visual control tools. Key tasks from the common design management framework are included on the checklists for design managers.

A typical approach to project management is to master a process in terms of time-cost-quality [22]. Value and waste are important for both the project as a whole and its design process. Likewise, processes and decisions are important vis-à-vis creating value [23]. Project culture, clear responsibilities, real time information and transparency become increasingly important as complexity increases in projects. The main purpose in a design phase is the exchange of information and the transformation of information to ideas and solutions to be presented to others. With a more effective information management, some of this time can be reduced and used in more value creating activities. Synchronous communication is an efficient design tool. The use of Building Information Model (BIM) in the construction industry is increasing and this is a powerful tool for asynchronous communication but also as a tool to use in synchronous communication as ICE. Moum [24] has described the use of collaborative design and the participants' reflection of how a BIM could ease the difficulties to understand the complex problems and solutions. The benefits of communication is good [25] and possibilities to increase quality by an early clash detection can save much money in projects [26]. In order to properly manage a design process, it is important to set up the metrics of processes. Even if it is

important to measure the project outcome of time and cost, it is also important to set up metrics controlling the quality of design and the exchange of information. Using metrics to follow up the quality and efficiency, e.g. in ICE sessions, is important in order to improve design process [27]. A comparison towards innovation and product design gives alternatives to conduct building design development, e.g. the Innovation Diamond [28] and IDEO [29]. Discussion Planning, coordinating, executing and controlling might be key tools of project management.

Even if there is much more research to be done concerning building design management, the last years have witnessed some new research and efforts in order to improve building design methods. This paper reports on the different interdependencies that occur in the design phase and how to coordinate them. The interdependencies vary throughout the design phase and sometimes the design phase consists of all the four types. It is important for a design manager to be aware of this, so the use of management tools can be managed properly. Even if new building design management approaches can be used for all dependencies, using the same approach to handle both reflective and sequential dependencies might be contra productive. By identifying which processes are sequential (and can be planned in detail) and which processes are reciprocal or intensive (and cannot be planned in detail), a design manager can prioritise and free a focus on the effective process. Hopefully, this paper gives some new insights to design managers and stimulates to further academic research in the field of building design management.

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