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Process Integration Framework for the Design Phase of a Residential Building

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Abstract

In Peru, the design phase of construction projects is frequently plagued by inefficiencies and poor coordination. These include clients' failure to communicate project goals; architects' and designers' frequent lack of understanding of said goals; and the failure to communicate learning loops from previous projects promptly to improve design quality. As such, it is argued that Building Information Modeling (BIM) helps to improve communication and visualization during the design process and opens a door to continuous improvement. However, the transition from traditional tools to a BIM-enabled process in the design phase is a challenging task. Many organizations are not prepared at the operational level to deploy BIM in synergy with current practices in the context of multiple stakeholders such as clients, designers, key suppliers, and constructors. The aim of this research is to develop a process-integration framework to improve visualization and communication in the design phase, aligning BIM, Project Management Book of Knowledge (PMBOK) areas (including scope, communication, and stakeholder management), and the learning loops of the Lean Project Delivery System (LPDS). The data collection is done by means of a case study in a residential building in Lima. Direct observation during the design phase will help to understand the process alignment. Lessons learned, barriers, opportunities, and guidelines for future research are discussed.

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Keywords: BIM; design management; PMBOK; LPDS; residential buildings.

1. Introduction

Experts in Building Information Modeling (BIM) claim that the use of this approach in construction has a positive impact on a project's costs [1], schedule [2], and building performance [3]. Fisher et al. [4] have argued that the

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earlier the decision makers and downstream stakeholders get involved, the better the performance in terms of cost, quality, constructability, and end-user satisfaction. During the design stage, information is shared by a number of stakeholders, including architects, designers, contractors, subcontractors, and potentially, users, in a looped fashion. When it comes to learning loops from previous projects, Lean Project Delivery System (LPDS) [5] offers an insight into how this information can be utilized as key inputs for both the project-definition and the design stages in a continuous value-added improvement process. Fisher et al. [4] have presented a framework of process integration in which knowledge from the construction and operations phases must be included early in the design stage to achieve a high performance building. However, in practice, teams struggle to integrate knowledge and information in a timely fashion early in the design stage. This lack of coordination within the construction industry is triggered by structural problems such as fragmentation, adversarial relationships, mistrust, and contractual relationships [6].

The Project Management Book of Knowledge (PMBOK) is a powerful framework that allows for control of all the relevant dimensions of the management of projects [7]. Through a series of tools and processes, PMBOK gives directions for project success. We argue that visual and communication management in design can be seen through the PMBOK lenses of scope, stakeholder, and communication management. On the other hand, Building Information Modelling (BIM) is a digital and managerial tool that is used to improve project visualization, information flow, system federation, planning, costing, and in general any prediction that relates to a project's goals [8]. However, incorporating these new tools into concomitant work processes appears to be difficult for design managers. Additionally, the transition from a CAD environment to a truly BIM design that includes all the relevant stakeholders appears to be a long-term process. With a number of exceptions, the literature on construction management lacks detailed research on the use of BIM in developing countries [9], and is almost totally devoid of information on Peru. This research intends to fill this gap. The objectives of this research are to (1) outline the results of a survey among AEC professionals on the relationships and characteristics of design management in a Peruvian context; and (2) develop a framework which integrates and aligns the main constructs of BIM with PMBOK's scope, stakeholder, and communication-management areas and the learning loops of LPDS. To achieve these objectives, first, we present the results of the survey depicting the current stage of design management. Second, we develop a framework for integration. Third, we conduct a qualitative case study by means of a residential project in Lima, Peru to gain insights on the proposed integration. Fourth, the results from the case study and lessons learned are discussed, and paths for further research are proposed.

Nomenclature

BIM	Building Information Modeling
PMI	Project Management Institute
PMBOK	Project Management Book of Knowledge
AEC	Architecture, Engineering, and Construction
LPDS	Lean Project Delivery System

2. Design Management in a Peruvian Construction Context

2.1. Stakeholder Communication Network

In the construction supply chain, the design phase consists of the network of first-tier stakeholders, including client, architect, designers, project manager, and contractor [6]. However, knowledge and information in the supply chain should also be shared with downstream stakeholders such as subcontractors, suppliers, and end-users to be fully effective [4]. To provide a picture of the communication network in a developing country, such as Peru, a questionnaire was designed to capture such relations during the design stage. Its questions had to do with the frequency of both virtual and face-to-face meetings, the means of communication, and the information-flow relationship. To collect data, one of the researchers, as part of her thesis, surveyed 122 AEC professionals in Lima, Peru that were working on residential, commercial, and retail projects. Figure 1 shows the communication network. Lines of different thicknesses depict the level of communication (tight ties, moderate ties, and loose ties). Especially