Available online at www.sciencedirect.com

ScienceDirect

Procedia Economics and Finance 21 (2015) 374 – 382

Procedia Economics and Finance

www.elsevier.com/locate/procedia

8th Nordic Conference on Construction Economics and Organization

Strategies for representation and analyses of 4D modeling applied to construction project management

Douglas M. Brito[a] and Emerson A. M. Ferreira[b]*

[a]*Department of Urban Development, Salvador- BA – 41.745-004, Brazil*
[b]*Federal University of Bahia, Salvador-BA – 40.210-630, Brazil*

Abstract

The application of Information Technology (IT) to construction project management (CPM) has become crucial to the completion of projects in accordance with the specifications of time, quality and costs. However, there are difficulties in visualising the planning and work progress in space and integrating information between stakeholders. Building Information Modelling (BIM) can gather necessary information at different stages of a project's lifecycle, including production management. This study aims at discussing strategies for the representation and analyses of a building construction 4D Model for planning and control and evaluating the importance and applicability of 4D Modelling to CPM, based on the survey conducted with the professionals from the Brazilian construction sector using a Google Docs questionnaire. The survey questions comprise the evaluation of potentialities, strategies for representation and analyses, such as the colour use for the differentiation of internal activities and alternatives of physical advance monitoring through the Planned x Realized schedule simulation or visualisation of them on split screen, ending with the evaluation of the 4D Modelling adoption. The results indicate the degrees of importance and applicability of the 4D Modelling regarding the aspects analysed based on professionals vision of construction industry.

Selection and/ peer-review under responsibility of Tampere University of Technology, Department of Civil Engineering

Keywords: 4D modeling; building information modelling; construction project management; information technology; virtual construction

1. Introduction

Conclude a project in accordance with the specifications of time, quality and costs is, increasingly, associated with an appropriate management process and support of Information Technologies (IT), which generate a

* Corresponding author. Tel.: +55 71 3283-9462.
E-mail addresses: ferreira.eam@gmail.com (E. Ferreira), douglas_ssa@hotmail.com (D. Brito).

Selection and/ peer-review under responsibility of Tampere University of Technology, Department of Civil Engineering
doi:10.1016/S2212-5671(15)00189-6

collaborative environment and integrated communication, minimizing structural inefficiencies and increasing the delivered value (International Council for Research and Innovation in Building and Construction, 2012).

Building information modelling (BIM) consists of an improved process to plan, design, build, use and maintain an installation from a standardized information model that contains all the appropriate information for its entire lifecycle (National Institute of Building Sciences, 2008; Eastman et al., 2011), which acquires more importance and applications in the current scenario of the construction industry.

One of the biggest problems that organizations are experiencing, is the difficulty in visualize correctly the construction planning in space, generating abstract interpretation schedules. 4D Models can improve the schedule reliability and reduce interpretation differences, minimizing communication problems (Koo & Fischer, 2000; Hartmann et al., 2008). The capacity to communicate effectively progress information and schedule deviations is considered strategic for project management, allowing taking corrective actions in time. During construction, 4D Modelling for control occurs by colour changes to represent the activities advance over time and the colours choice is essential for understanding (Chang et al., 2009; Chen et al., 2013).

Some challenges to 4D models use on a larger scale involve the need of mechanisms to visualize the internal activities progress, interferences detection limitations by users due to the level of knowledge, individual experience and the lack of analysis of some model data, as teams and equipment size, workspaces and security zones requirements, hindering the conflicts resolution of space and time (Koo & Fischer, 2000; Russell et al., 2009).

This research aims at discussing strategies for the representation and analyses of 4D Modelling to construction management developed in a case study and evaluating the importance and applicability of those strategies. The evaluation was conducted with the Brazilian construction professionals with the issues about 4D Models potentialities, colour differentiation for internal activities representation and alternatives for control of Planned x Realized schedule.

The literature on the theme is reviewed in Section 2. The research methodology is described in Section 3. Section 4 relates to the application and evaluation of the strategies for the representation and analyses of 4D Model as well as to the observed results. Finally, some conclusions and considerations for future works are put forth in Section 5.

2. Literature Review

2.1. Strategies for Representation and Analyses of 4D Modelling

BIM facilitates a process of design and construction more integrated, which generates higher quality projects with lower cost and durations. However, the models development that will allow the project information sharing needs to be suited to the level of detail of its use (Eastman et al., 2011; Moon et al., 2014). According to Koo and Fischer (2000), 4D Models connect, intimately, temporal and spatial aspects of the project, allowing users to view construction process, better schedule understanding and errors detection before execution. Other benefits reported by Eastman et al. (2011) involve improved communication, easier logistics management, comparison of execution plans and control of construction advance. Olde Scholtenhuis et al. (2014) consider that 4D coordination process allows focus on operational interdependence, potential conflicts detection, detailed views and development of containment strategies, reinforcing the level of mindfulness, capacity of detect errors and adopt corrective action.

Some researchers present the development of several advances, such as: automatic generation of schedules less dependent on experience and human subjectivity (Tauscher et al., 2014; Anderson et al., 2013), structure of schedules optimization in accordance with the objectives and constraints of the project (Griffis et al., 2013), automatic measurement of construction progress using 4D BIM associated with data of remote sensing and 3D point cloud (Son et al., 2013), verification systems of workspace conflict of activities (Moon et al., 2014; Su & Cai, 2014) and quantitative analyses of 4D Model for space and resources management (Jongeling et al., 2008).

4D Modelling often use colours to represent different constructive states and an ideal colour scheme is essential for understanding and model analyses. This colours choice is still personal, despite its importance for process interpretation and representation. Thus, systematic procedures were developed by Chang et al. (2009) and Chen et al. (2013) to selection and evaluation of ideal colour scheme for 4D Models. One of the biggest 4D Models