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The Impact of Field Data Capturing Technologies on Automated Construction Project Progress Monitoring

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Abstract

Accurate and timely information of construction project progress in a regular repeated basis is one of the critical stages of construction management. The purpose of this study is to investigate the impact of field data capturing technologies (FDCT), in combination with building information modelling (BIM) on automated construction project progress monitoring (ACPPM). The research is based on a survey of contracting and engineering consulting firms operating in the Middle East, Mid-Asia, Europe, North America, and Far East. Based on an evaluation of the findings, 3D Laser Scanning (LS), Image-based, and Radio Frequency Identification (RFID) technologies in combination with BIM were found as the most used technologies for ACPPM. At the end, a conceptual framework is illustrated and managerial implications are highlighted with a sample statement focusing on requirements, processes and benefits. The study confirms the importance of using BIM-based FDCT in enhancing ACPPM factors performance. It also highlights the need for further exploration of the role of the BIM-based FDCT in improving ACPPM.

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Keywords: field data capturing technologies; automated construction project progress monitoring; BIM;

1. Introduction

Construction industry realized the urgent need for providing the opportunity to understand the current project status easy, rapid, and accurate [1]. Rapid project assessment further identifies discrepancies between the as-built and as-planned progress, and facilitates decision making on the necessary remedial actions [2]. Currently, manual visual observations and traditional progress monitoring based on field personnel's interpretation are time-consuming, error-prone, and infrequent [3] [4]. Consequently, investigation on new methodologies that allow automatic recognition of as-built performance and visualization of construction progress is vital. In response to this need, significant progress towards automating detection and visualization of as-built status of a project has been achieved in recent years. The advancement in automatic field data acquisition systems will enable more accurate collection of data and knowledge

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about processes and operations on site. These technologies include Image-based technologies, Laser Scanning (LS), Radio Frequency Identification (RFID), Ultra-Wideband (UWB), Global Positioning System (GPS) and wireless sensor networks (WSN). The purpose of this study is to investigate the impact of FDCT, in combination with BIM on ACPPM.

2. Literature Review

2.1. BIM in Project Progress Monitoring

BIM is a rich source of information for performing ACPPM. It describes the as-planned project shape in terms of 3D geometry and combines it with the as-planned construction schedule. The resulting 4D model combines all relevant information for the complete construction process [2] [5]. Application of these models during the construction phase can be increased if further potential added values from integrating BIMs with as-built models [6]. Therefore, the planned state at any time can be derived and compared with the actual construction state. Consequently, BIM can serve as a powerful baseline for progress tracking and in the visualization of discrepancies.

2.2. Field Data Capturing Technologies for ACPPM

In the last decade, the capabilities of FDCT for ACPPM have significantly increased. Early detection of performance deviations in field construction activities with minimum human input is critical as it provides an opportunity for project management to avoid them or minimize their impacts [7]. Integration of BIM-based models and real-time field data acquisition systems can increase the degree of automation in all parts of project progress monitoring and control such as architectural, structural and MEP. Furthermore, updates, analysis and reporting can be made more frequently, regularly, and accurately along the work progress. Table 1 shows the summary of the previous researches which used the integration of different FDCT and BIM for ACPPM.

Table 1: Advanced Automated BIM-based Data Capturing Technologies.

Operation	Approach	Technology	Definition	Resources
Automated Construction Project Progress Monitoring	Building Information Modelling (BIM)	Image-based modelling	Registering site digital pictures and the project 3D Computer-Aided Design model in a common coordinate system- Comparing the site digital pictures to the project model	[3]; [8]; [9]; [10]; [11]; [6]
		3D Laser Scanning(LS)	Capturing data within three coordinates of longitude, latitude, and elevation of different objects	[2]; [12]; [13]; [14]; [15]; [16]; [17]; [18]; [1]
		Radio Frequency Identification (RFID)	Facilitating the control of various processes at different stages of a building lifecycle, especially for construction projects progress control monitoring	[19]; [20]; [21]; [17]; [1]
		Barcodes	Capturing and transmitting data from a tag embedded or attached to construction products, and such data can be used to capture construction progress	[22]; [23]; [21]
		Ultra-Wideband (UWB)	The 3-D location of each tag can be recorded on a computer and the location and movement of each tag can be visually shown on a screen	[24]; [17]; [1]
		Global Positioning System (GPS)	Space-based satellite navigation system providing location and time information in all conditions, anywhere that there is an unobstructed line of sight to GPS satellites and can use as a location tracking tool in construction industry.	[25]; [26]; [3]; [27]
		Wireless Sensor Network (WSN)	Spatially distributed autonomous sensors with a communications infrastructure to remote environmental and physical monitoring (temperature, humidity, sound, pressure, speed, direction, size, and etc. - Capable to collecting, storing, processing environmental information	[28]; [29]; [30]; [31]