Chapter 65
Integration of Industry 4.0 for Advanced Construction Project Management

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ABSTRACT

The construction industry is facing the increasing process of integration of Industry 4.0 in all phases of the construction project lifecycle. Its exponential growth has been detected in research efforts focused on the usage of the building information modeling (BIM) as one of the most breakthrough innovative approaches in the construction (AEC) industry. BIM brings many advantages as well as changes in the existing construction practice, which allows for adjustment of processes in the most automated possible way. The goal in the design phase is to create a comprehensive BIM model that combines the data of all project participants and represents a digital model of a future building. In the construction phase, the monitoring and controlling the work progress is one of the most important and difficult tasks, and it is today still mostly done manually. Currently, more research and actual implementations are oriented towards the introduction of the automated construction progress monitoring (ACPMon). All of this is the basis for advanced construction project management (ACPMan).

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INTRODUCTION

Integration of the Industry 4.0 is, as in many other industrial sectors, also important for the construction industry. Actually, exponential growth has been detected in efforts focused on the usage of the Building Information Modeling (BIM), which can significantly contribute to all phases of the construction project lifecycle (Borrmann, König, Koch, & Beetz, 2018; Eastman, 2011). First, it allows digitalization of the construction project resulting in adjustment of processes in the most automated possible way. Thus, the implementation of BIM is important already in the early design phase for reaching the highest possible level of digitalization, especially in Construction Project Management (CPMan). The first step is to create 3D BIM model in terms of 3D geometry, such as architectural, structural and mechanical, electrical and plumbing (MEP). The design phase introduces modern BIM approach techniques, which include the possibility to integrate data about the necessary time and cost for the construction of the building. 3D BIM, upgraded with the construction schedule plan, provides the 4D BIM, while the upgrade with estimated construction costs results in the 5D BIM model. The created 3D, 4D and 5D BIM models include all relevant information for the successful project implementation. Anyway, the goal in the design phase is to create a comprehensive BIM model that combines the data of all project participants and represents a digital or virtual model of a future building. Furthermore, the BIM approach provides knowledge sharing and interoperability between project participants; therefore, it brings together different expertise and achieves the optimal designs of BIM models. The BIM approach achieves the bidirectional connected information provided in one place, which means that in the case of a modification of the model elements (e.g. geometry changes), the information related to these elements will be changed accordingly. In this way, even higher level of quality information and better accessibility to every participant from the construction projects is assured in all phases. Integration of the Industry 4.0 with advanced modern techniques combined by the BIM approach represents Advanced Construction Project Management (ACPMan), which ensures the highest possible degree of harmonization of the three factors of project effectiveness (quality, cost and time).

In the construction phase, during construction works, various causes lead to frequent discrepancies between planned and actual performance. Therefore, monitoring and controlling the progress of works are very significant factors and also among the most important and difficult tasks. These include the measurement through inspections on the construction site and the comparison with the project plan. However, the progress monitoring is carried out mostly manually as a visual observation, which is time-consuming, error-prone, and infrequent. The quality of data highly depends on the surveyor's experience and the quality of the measurements. Therefore, more research and actual implementations are oriented towards the introduction of Automated Construction Progress Monitoring (ACPMon) using BIM technology. Such automated monitoring of the work progress has not yet reached the desired level of development, so the researchers strive to develop the method which would enable continuous construction monitoring in real time without additional preparatory woks and in a complete automatic way.

The chapter initially presents a literature overview and current situation in the integration of Industry 4.0 for the construction project management. Then it leads the reader step by step into the ACPMan approach, which includes a combination of existing methodological approaches such as CPMan, BIM and ACPMon, the last two representing the technologies or methodologies of the Industry 4.0. In terms of the ACPMan approach, various software is used for building designing, time scheduling and cost estimation in the design phase and construction progress monitoring in the construction phase, which also requires additional and specialized skills. BIM approach as a process, known as a process model,