# Individual Competence Requirements for Digital Technologies in Construction Management

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## SYNOPSIS

*Digitalisation is an important change driver in the construction industry. However, most of its potential can be lost as the industry professionals lack the required competences. This paper presents part of a larger research in progress, where the aim is to facilitate construction management professionals' development regarding the use of digital technologies to respond to the changing competence requirements in construction management created by digitalisation. In the part presented in this paper the research objectives have been to define the core terminology, to define what digital technology means in construction management context, and to identify the current demand for digital technology competences within the construction management discipline. The research as a whole is a multi-method qualitative research relying on the constructivist paradigm. The research design has some exploratory features, but is mostly descriptive. Research methods are a combination of literature reviews, document analyses, interviews and focus groups to inform the different stages of the framework development. In this part of the research state-of-the-art and systematic literature reviews, and document analysis have been used. Concepts of digital technology, construction management and competence have been defined. The nature and type of digital technologies in construction management has been discussed and digital technology related competences have been explored.*

Keywords: Digital Technologies (DT), Construction Management (CM), Competences, Continuous Professional Learning (CPL)

## INTRODUCTION

Digitalisation is changing both our personal and our professional lives. This change is continuous and fast paced, and it has many names: 4th industrial revolution, Industry 4.0 or Digital revolution ((Roblek, Meško, & Krapež, 2016; Schwab, 2016; Vogel-Heuser & Hess, 2016, Zezulka et al., 2016). Oesterreich and Teuteberg's (2016) systematic literature review and a case study showed that Industry 4.0 has not gained much attention yet in the construction industry compared to other industries. Friedrich et al. (2011) and Leviäkangas et al. (2017) argue that construction industry is the least digitalised industry sector. This is supported by a range of research, which shows the limited amount of investment in research and development in the sector (Barlow, 2012; Hernández et al, 2014: Morrison, 2001; Winch, 2003).

Even though lagging behind other sectors, digitalisation is emerging also in the construction industry, Building Information Modelling (BIM), cloud computing and mobile computing being the most mature technologies (Azhar et al., 2012, Oesterreich & Teuteberg, 2016). Due to digitalisation, jobs are changing and disappearing ((Degryse, 2016; Ford, 2015; Frey & Osborne, 2013; Roubini, 2015). New competences are required not only to use digital technology (DT), but also to cope with the change itself. For a construction management (CM) professional, the change involves construction technology, manufacturing technology, technology on site and the technology for the project management and communication itself.

Digitalisation has the potential to revolutionise the construction industry. However, most of its potential can be lost if the industry professionals lack the required competences. Changes are

needed both in formal education, but also when thinking what continuous professional learning (CPL) would look like.

## RESEARCH AIM AND OBJECTIVES

The aim of the larger research in progress is facilitation of CM professionals' development regarding the use of DT to respond to the changing competence requirements in CM created by digitalisation. To create the framework, CM tasks will be connected with enabling and supporting DTs, the competence requirements for these DTs will be mapped and at the end these competence requirements will be addressed with appropriate CPL methods.

The objectives for the part presented in this paper have been to define the core terminology, to define what DT means in CM context, and to identify the current demand for DT competences within the CM discipline.

## RESEARCH METHODS

The larger study in progress is a multi-method qualitative research relying on constructivist paradigm. The research design has some exploratory features, but is mostly descriptive, describing the identified problem more in detail, to answer the 'what' and 'how'. Research methods are a combination of literature reviews, document analyses, interviews and focus groups to inform the different stages of the framework development. For the part presented in this paper, traditional state-of-the-art literature review, systematic literature review and document analysis have been used.

Traditional state-of-the-art literature review was used to define the terms 'digital technology', 'construction management' and 'competences'.

Systematic literature review can be described as explicit and reproducible, quantitative, comprehensive and a structured process (Pickering and Byrn, 2014). During this process a selection of relevant (CM) quality assured publications with high international status were looked at to investigate

- longitudinally how often DT was discussed in the selected publications from 1985 to 2018 and through that defining the pace of change, and
- what DT were mentioned in the selected publications and how often each was mentioned, to define what DT means in the context of CM.

Document analysis using job advertisements was used to identify the current demand for DT competences within the CM discipline. This method has been used for example by Succar et al. (2013) and Barison and Santos (2011) to investigate BIM roles and required competences. The analysis was qualitative focusing on explicitly expressed DT related competences in 295 job advertisements from Finland, Singapore, UK and US. These job advertisements will also be used to define and understand the CM tasks in-depth.

At a later stage of the research document analysis with state-of-the-art literature review will be used to investigate the current CPL methods. Interviews will be used to inform and confirm the framework development and focus group to further develop and finalise the framework.

## PRELIMINARY FINDINGS

For the purposes of this research, the key concepts of the research, 'construction management', 'digital technologies', and 'competences' have been defined through state-of-the-art literature review in Puolitaival, Davies and Kähkönen (2019):

- *"Construction management addresses the forecasting and planning, organising, communicating, coordinating, monitoring, and controlling functions required to manage time, cost, quality, health, safety, security and environmental aspects of a construction project"*
- *"Digital technologies include all types of electronic equipment and applications that produce, store or use information in the form of numeric code"*
- Work of McConnell (2001) and Winterton, Delamare-Le Deist & Stringfellow (2006) have been used to define 'competence'. *"Competence refers to an individual's capacity to perform job responsibilities. 'Competence' is used as a summary term to include cognitive competence (knowledge and understanding), functional competence (skills), social competence (behaviours and attitudes) and meta-competence (facilitating learning)"* (p. 4)

Through the systematic literature review approximately 100 different examples of DT in CM context were identified. The most discussed examples were BIM, digital imaging and extended reality (Puolitaival, Kestle & Kähkönen, 2018). When the DTs were investigated further, it was noticed that their nature is relatively complex including hardware and software, most often in various combinations; DTs sit at different levels, some are enabling and generic, where others are specific or applied; DTs can also mean different things to different people; and they are in constant change (Puolitaival et al., 2019).

The findings from the job advertisement analysis show that for most roles the companies *"do not identify any CM specific or advanced DT competences; rather, the expectation is that employees will be proficient in general computer and office software use"* (Puolitaival et al., 2019, p. 7). Digital hardware related competences were even more rarely seen. More work will be needed to understand the competence requirements fully.

The diversity of the CM tasks needs to be understood to address them appropriately in the framework. This is currently in progress and the findings will be submitted to a journal in early 2020.

The research will continue with an in-depth look into CPL methods through document analysis and literature review. The first draft of the framework will be developed after that. It will be further informed and confirmed by interviews and focus groups.

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