Guest editorial

Rethinking construction productivity theory and practice

Background

The construction industry makes a significant contribution to the gross domestic product of many countries. Boosting construction productivity is thus important for the sustained growth and competitiveness of any economy. However, there have been allegations of stagnant or even reduced productivity in the construction industry *vis-à-vis* other industries (McKinsey Global Institute, 2017; Zhan *et al.*, 2016). There is thus a need for a fundamental review of the underpinning body of knowledge, along with a systemic exploration of the future productivity narrative, including its core concepts, system boundaries, evaluation protocols and applications. Increasing challenges such as climate change, resource scarcities, rising societal aspirations and systems complexities should be considered alongside opportunities arising from emerging technologies such as automation, robotics, virtual reality and visualisation.

Many metropolises witness fast development of construction and infrastructure in the past and today, whilst they face severe challenges for the future. An example of that is Hong Kong where the construction industry faces challenges such as an ageing workforce, skill shortage, cost escalation and systems complexities (Pan *et al.*, 2016). Learning from and exploring the basis of productivity assessment and improvement initiatives in more progressive regions could provide valuable examples for othes, given rapid worldwide urbanisation. Such drilling down and in-depth comparisons could contribute significantly to a step-rise, if not a paradigmatic improvement in the body of knowledge on productivity, apart from direct benefits from its deployment in practice. The Centre for Innovation in Construction and Infrastructure Development of The University of Hong Kong is one of the leading research units in the world which pursues a better understanding of the nature and feature of construction productivity and develops solutions for its enhancement. The Centre has conducted a number of studies of construction productivity covering the industry appraisal, project-level measurement and workers training and skills, as well as innovative construction technologies such as modular construction and robotic and automatic technologies. The Centre in collaboration with the Construction Industry Council organised two international productivity forums in Spring 2017 (CICID, 2017a, b) to enable the sharing of the state-of-the-art research and practice of construction productivity enhancement within the complex socio-technical context.

Theoretical approach

This special issue was initiated within the development context of both theory and practice of construction productivity. A fourfold theoretical systems approach was proposed to rethinking construction productivity (Figure 1): ontology denoting what construction productivity is and will be; epistemology denoting how knowledge on construction productivity is created; methodology denoting how construction productivity is researched at different levels and in various processes; and axiology denoting what socio-technical values construction productivity embraces. This fourfold theoretical approach was adopted in the literature of studying complex multi-project environments of construction (Blismas, 2001), of examining the dialectics of strategic alliances (De Rond and Bouchikhi, 2004), of addressing the dialectics of sustainable buildings (Pan and Ning, 2014), of exploring the system boundaries of zero-carbon buildings (Pan, 2014), and of investigating the system

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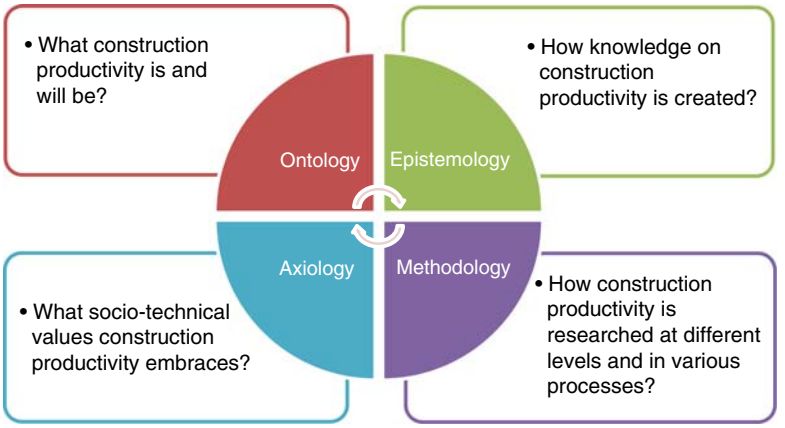

Figure 1.
A fourfold theoretical systems approach to rethinking construction productivity

boundaries of life-cycle carbon assessment of buildings (Pan, Li, and Teng, 2018). This special issue seeks to explore and also validate these four theoretical aspects drawing on evidence of research into construction productivity.

An outline of the papers

In this special issue, the first paper by Arshad Javed, Wei Pan, Le Chen and Wenting Zhan reports on "A systemic exploration of drivers for and constraints on construction productivity enhancement" at the industry, project and activity levels. It is based on the combination of a critical literature review, an interview-based survey with 32 industry experts and five focus group meetings participated by 109 representatives of a wide range of industry stakeholder groups in Hong Kong. The paper conceptualises and validates a systemic framework for examining construction industry productivity, and develops three causal loop diagrams (CLDs) for illustrating the dynamic structures that underpin the complex systems of the drivers and constraints. The paper contributes to knowledge by supporting the systems thinking of industry stakeholders in the formulation of holistic strategies for long-term construction industry productivity enhancement. It also provides empirically supported CLDs to facilitate future investigations into the complex system of construction productivity.

The second paper by Tillmann Böhme, Alberto Escribano, Emma Heffernan and Scott Beazley examines "Causes and mitigation for declining productivity in the Australian mid-rise residential construction sector". It is based on two in-depth case studies conducted with a builder and developer which both are significant entities of the Australian mid-rise residential construction network, with the data collected through a five-stage process including semi-structured interviews and archival information. The paper identifies drivers for declining construction productivity under the categories of industry, firm and project-level productivity, as incomplete documentation, design changes, inefficient project management, and supply chain fragmentation among others. The paper identifies that the sub-structure and super-structure are the construction phases during which most productivity losses occur. This paper echoes the first one of the issue in advocating a multi-level approach to examining construction productivity.

The third paper by Rex Ugulu and Stephen Allen examines "Using learning curve theory in the investigation of on-site craft gangs' blockwork construction productivity". It is based on quantitative observation of seven craft gangs' blockwork with an average of five members in each gang, using the learning curve model application in a 17-storey tri-tower

government office building located in Abuja, Nigeria. The paper reports that the overall blockwork craft gangs learning observed at the site level shows an average learning rate of 94.21 per cent resulting in 5.79 per cent improvement gains. The paper imposes the implications for the development of on-site blockwork craft gangs learning. The significant impact of learning rate improvement in the paper can be used in the planning to fast-track the productivity of construction craft gangs. This paper represents a focussed study of productivity at labour activity level with clearly defined metric and value.

The fourth paper by Florence Ling presents "International comparison of performance of public projects" in Beijing, Hong Kong, Singapore and Sydney to uncover which areas project managers should focus on when managing public projects in different countries. It is based on a structured questionnaire that led to the collection of 244 sets of data of completed public projects. The paper finds significant cost and schedule overruns in all four cities, with Hong Kong's public projects having the highest cost and schedule overruns, Singapore's public projects having the lowest cost overrun and Beijing's projects having the lowest schedule overrun. Public projects in all four cities recorded significantly good project quality. The value of the paper is that it discovers which areas project managers should focus on when managing public projects in different countries. In laissez-faire or free market economies, more attention should be paid to managing the project cost and schedule. When a country has a lower transparency index, more attention should be paid to controlling project quality. Project team members should focus on delivering public projects to the highest level of quality in developed countries.

The fifth paper by Chukwuka Ohueri, Wallace Enegbuma, Ngie Wong, Kuok Kuok and Russell Kenley develops a "Labour productivity motivation framework for Iskandar Malaysia" (IM) construction projects. It is based on two sets of questionnaire with 40 skilled labourers and 50 construction professionals selected using purposive sampling technique. The paper finds that the factors ranked hierarchically using relative importance index including effective management, viable construction practices, financial incentives, continuous training and development and safe working environment were the most significant motivation strategies that positively influence IM construction labourers. The paper develops and validates a framework that can be used to boost the morale of IM construction labourers and their productivity. This paper has the same focus on labour productivity as the third paper does, but uncovers the complex systemic influencing factors to that.

The sixth paper by Bruno Tanko, Fadhlin Abdullah, Zuhaili Mohamad Ramly and Wallace Enegbuma, develops "An implementation framework of value management in the Nigerian construction industry" by establishing the effect of critical success factors on current construction practices to aid stakeholders to improve productivity. It is based on self-administered questionnaires from 344 registered construction professionals in Nigeria. A structural model validated the requirements of applying value management on current construction practices. The established requirements (environment, people, government and information/methodology) can be used by decision makers and stakeholders to improve the productivity of the current construction practices in the Nigerian construction environment.

The seventh paper by Abid Hasan, Abbas Elmualim, Raufdeen Rameezdeen, Bassam Baroudi and Andrew Marshall reports on "An exploratory study on the impact of mobile ICT on productivity in construction projects". It is based on a focus group session involving ten experienced construction management professionals from different organisations of the South Australian construction industry, moderated by a group of four researchers to gather data on mobile ICT usage and its implications for construction productivity. The paper finds that despite noticeable advances in mobile ICT, differences in usage style and user attitude have limited their overall impact on productivity. The paper highlights the importance of strategising the use of mobile ICT to achieve the desired productivity rates through policy, training, work-life balance and deeper and wider understanding of these technologies.

Summary

The seven papers in the special issue together address construction productivity at industry, project and activity levels, with the use of a range of methods including document analysis, case study, questionnaire survey, interview and focus group. Also, the papers together examine the various factors influencing construction productivity in the social, political, economic, technological, cultural and legislative aspects bearing value of different stakeholder groups. Furthermore, the papers collectively draw on both empirically collated productivity performance data and measured productivity perceptions in examining the factors and forming the productivity enhancement strategies. All these features of the papers in the special issue help to validate the fourfold theoretical systems approach to rethinking construction productivity. Nevertheless, none of the papers aimed to produce systemic metrics of construction productivity of single, partial and total factors, and to elaborate how knowledge of construction productivity is created and performance can be benchmarked consistently. Thus this is recommended for future researchers to explore in depth. Room for future efforts is also suggested in the area of exploring innovative technologies such as robotic and automatic technologies, and offsite and modular construction (see Pan *et al.*, 2008; Pan, Linner, Pan, Chen, and Bock, 2018) for productivity enhancement.

Hand in hand with theory is practice for rethinking and enhancing construction productivity. However, the link between theory and practice is normally weak in the construction society and community, with notoriously poor data sharing often hampered due to perceptions on commercial sensitivity and privacy. This is worsened by a typical cost-driven mentality in the construction industry, contributing to narrowly defined cost-driven measurement of construction productivity. Inspired by the fourfold theoretical systems approach, there is a strong need to reconceptualise and measure construction productivity systemically taking the whole project life-cycle perspective and multi-factor metrics of safety, quality, sustainability, cost-competitiveness into consideration. Construction productivity is also dynamic that is underpinned by interactions between the attributing factors and stakeholder groups and their institutional contexts.

This special issue should not only facilitate the sharing of the state-of-the-art knowledge of construction productivity and the debating on various approaches and techniques drawing on evidence, but help to identify the gaps in literature and knowledge. These implications should make an important contribution to furthering the pursuit for a better understanding of construction productivity as a very complex socio-technical system and its continuous enhancement in the construction industry.

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