Chapter 65
Total Quality Management in Smart City Development

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ABSTRACT

Wastes and pollution are associated with an uncoordinated urbanization trend. This exploratory study investigates total quality management's (TQM) role in smart city development. It delineates smart cities and its conjoined relationship with digital cities. It submits to the complementary relationship between TQM and quality function deployment (QFD) and highlights stakeholder engagement as central to smart city development strategy, underpinned by social theory. It distils that stakeholders and built environment professionals need to work collaboratively to maximize the benefit of smart cities as being an innovation value chain, leading to the use of IT-enabled platform such as building information modelling (BIM). This culminates in the design of an integrative framework with ICT (focusing on BIM) and TQM serving as the information architecture and the ideological premise respectively. It then presents the close-loop (front-end) and open-loop (back-end) approaches to smart city development, discusses future research directions and concludes with implications.

INTRODUCTION

Urbanization rate has exceeded 50% in all countries globally and over 70% in various European and Asian countries (Kourtit, Nijkamp, & Arribas, 2012). Smart cities are nurtured by information and communication technology (ICT) (Allwinkle and Cruickshank (2011). Consequently, it is possible to define a smart city based on its ICT, which has been concluded as being a meta-factor in smart city initiatives due to its overarching influence on other factors (Chourabi et al., 2012). The construction industry is infamous for its waste generation, low ICT adoption, and mounting stakeholders' dissatisfaction. Total Quality Management (TQM), being an organization-wide approach, is poised to address this dissatisfaction attributable to construction industry's fragmentation along its supply or value chain (Conti, 2010) to derive the maximum economic benefit (Garcia-Bernal & Garcia-Casarejos, 2014). Conversely, as of date, no study has investigated the role of TQM in developing smart cities. Hence, the aim of this chapter is to investigate the role of TQM in smart city development. Smart cities contribute to sustainable

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developments through their networked infrastructures (i.e. ICT) and, by so doing, minimize urban waste and pollution (Schaffers et al., 2011). This can also be supported by an IT-enabled construction environment's "ability to develop visual representation of the building and, as a result, manage the construction process by visualizing the process and the product at any time" (Chartered Institute of Building [CIOB], 2014, p. 137). This allows project participants to increase productivity and reduce waste by identifying potential problems earlier and resolving such a problem collaboratively.

While there are socio-cultural, economic, and environmental benefits to smart city development, conceptualizing and implementing a smart city can and do pose challenges to stakeholders (including the clients) and built environment professionals. As such, the term "smart cities" often connotes developments with high ICT component, whereas the conceptualization of real smart cities requires a holistic view of changing cultures and behaviors in addition to providing enabling technology (Allwinkle and Cruickshank, 2011; Deakin & Al Waer, 2011a, b). Smart city development strategies can either be at the national or local level (Angelidou, 2014) while smart city approaches can either be front-end (i.e. business models precede information architecture) or back-end (i.e. information architecture precedes business models) (Kuk & Janssen, 2011). This underscores the need for stakeholder engagement as supported by increasing realization of the role of social theory in the built environment (Goss, 1988; Hillier, 2008). On the flip side, conflicting technical and behavioral variables are a common feature of stakeholder engagement and which can be constructive or destructive in nature (Leung & Yu, 2014). This underscores the use of IT-enabled collaborative construction project environment, unlike the adversarial traditional (i.e. face-to-face) project environment (Xu, Shen, Fan, Li, & Fan, 2012). As an IT-enabled platform, building information modelling (BIM) plays an important role in information system to supporting a collaborative and integrated construction approach, where all stakeholders edit and/or retrieve information from commonly shared models (Merschbrock & Munkvold, 2012). BIM can, thus, serve as the information architecture to operationalize smart cities' innovation value chain construct (Cosgrave, Aarbuthnot & Tryfonas, 2013). This value chain involves stakeholders (i.e. the non-built environment professionals with vested interests in smart cities) and built environment professionals (i.e. the construction practitioners explicating smart cities).

TQM's role both in public administration (Tomaževič, Seljak & Aristovnik, 2015) and in service organizations (Calabrese & Corbò, 2015) is brought to bear considering BIM's need for changes to well-established processes, organizational roles, contractual practices, and collaborative arrangements. This ensures that a consideration for the well-being of people is ingrained in the strategic decision for smart city development. Consequently, problems and challenges related to urban waste and pollution are addressed from project inception by creating the necessary harmony between the physical city and social city (Hirtle, Richter, Srinivas, & Firth, 2010; Vaughan, 2007). This systemic thinking can, in turn, help to create better urban environmental quality and human well-being for a more sustainable urban development (Panagopoulos, Duque, & Dan, in press). TQM emerged in parallel with environmental consciousness, which means that it is possible (and logical) to construe total quality environmental management (TQEM) (Borri & Boccaletti, 1995). Quality function deployment (QFD) has also emerged in parallel with TQM (Akao & Mazur, 2003) making it possible for the two concepts being able to also work in a conjoined manner so much so that there is the concept of total QFD (TQFD) (Devadasan, Kathiravan, & Thirunavukkarasu, 2006). Consequently, similar to TQEM, QFD can also be applied to environmentally conscious design to derive "QFD for environment" (QFDE) (Masui, Sakao, Kobayashi, &Inaba, 2003). But while there are many benefits of QFD as there are of TQM, including environmental

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