The Impact of the Internet of Things on Mobile Workers

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Introduction

Ongoing developments in digital, computer, and communication technologies are likely to have profound long-term consequences for the nature of work and employment (Brynjolfsson & McAfee 2016). One significant area of development concerns the Internet of Things (IoT). The IoT can be described as everyday objects, such as cars, fridges or watches, having internet connectivity allowing them to send and receive data. The IoT is predicted to be a major IT-enabled business trend over the next 10 years. Peppet (2014) suggests the potential for 200 billion connected devices by 2020 and a trillion by 2025, and Mishra et al. (2016) note that according to McKinsey (2013), IoT has a potential global economic impact of $36 trillion. A recent Computing (2016) report indicates that in the UK, applications of the IoT in work settings are most likely to involve the use of tracking devices for internal deployment to achieve cost optimization. For example, an English county police force are deploying an IoT platform to create connected vehicles and 4G streaming cameras that are lightweight and wearable and can stream high definition video. Internet-connected police cars allow police officers to use laptops, mobile phones and tablet computers in their vehicles giving them access to important information while working remotely (Palmer, 2015). Thus, the IoT has the potential to have significant impacts on the organization and management of mobile workers. This study will examine the impact of IoT technologies on mobile work in UK organizations. The main emphasis of the project is to develop user-centric considerations of digital technologies to counterbalance techno-centric research on this topic: the users in this study are defined as both organizations and individual workers. This is partly because various concerns have been raised regarding surveillance implications of these technologies for workers (O'Connor, 2015). This exploratory study has two aims: 1) to understand organizational drivers for the adoption of IoT for mobile work; 2) to explore how IoT technologies impact on mobile workers.

The Internet of Things

A range of definitions has been proposed for IoT. It has been defined as 'the inter-connection of devices (sensors and actuators) capable of information sharing between different platforms, through a unified framework, forming a common basis for innovative applications' (Gubbi et al., 2013, p.1647). Examples of such 'things' include smartphones and their applications, employee smart cards, automobile black boxes, home monitoring devices and smart grid sensors, and health and fitness sensors (Peppet, 2014). Some authors note that the constituent technology is not new (Botta et al., 2016),

acknowledging that whilst the devices themselves might have limited storage and processing capability, it is their interconnectedness via cloud computing which enables 'virtually unlimited capabilities in terms of storage and processing power' (ibid, p.2). Mishra et al. (2016) frame the IoT more specifically as one of four contemporary cyber-physical systems (CPS), alongside the automation of knowledge work, advanced robotics, and autonomous/near-autonomous vehicles. Dutton (2014) notes that IoT vision is beyond person-to-person (P2P) internet application, it also affords person-to-machine (P2M), M2P and M2M scope. People and 'things' thus become incorporated within a larger CPS. Thus, the nature of human-machine interactions at work may drastically evolve.

A recent IoT literature review by Mishra et al. (2016) identifies five current research 'clusters': 1) Theoretical and conceptual studies; 2) studies that consider the implementation of well-established concepts and theories; 3) studies that investigate the application of IoT in logistics and supply chain; 4) design and planning of IoT studies; and 5) security and privacy aspects of IoT. To date research has tended to be largely theoretical within clusters 1 and 2, and there has been limited empirical research addressing IoT application (clusters 3, 4, and 5). Further, it is in these latter clusters where socio-organizational elements including social, cultural, cognitive and indeed ethical decision making factors come to the fore. Mishra et al. (2016, p.1345) surmise 'scholars are yet to conduct and report findings on case studies focusing on the adoption of IoT in these contexts, as well as the challenges that may come to the foreground during IoT adoption' at local, national and international scales. It is against this backdrop that we can locate the empirical contribution of the current study.

Mobile work

According to Karanasios & Allen (2014), mobile workers are workers who are always on the move. Chen & Nath (2008) describe them as employees who demonstrate a high level of mobility, using computer devices to access remote information from their home base, while in transit and at their work destination. Mobile workers are viewed as workers who perform tasks in a mobile context using mobile technology (Cousins & Robey, 2015). Often, their place of work is not fixed, however, they are required to be effective in a range of different work settings (Hislop & Axtell, 2009). Drawing from these descriptions, it can be argued that a mobile worker is a worker that isn't tethered to the traditional fixed office location, hence the reason they are described as 'nomads' and 'road warriors' (Chen & Corritore, 2008). Due to the nature of their work, mobile workers are required to work at different and diversified locations using mobile computing technologies to configure and adapt the workspaces available to them to a conducive work environment (Hislop, 2008) and to access/update corporate information systems, communicate, collaborate and share knowledge with co-workers. Based on the concept of mobility, the nature of their work predominantly requires spatial mobility, including travelling and visiting clients. The nature of contemporary mobile ICTs increasingly means that such workers may also work while undertaking such journeys (Hislop & Axtell, 2015).

There are a number of reasons to expect IoT to have an impact on mobile work and mobile workers based on the recognition of the ways technology and work is often mutually intertwined in these contexts. However, developments are not necessarily straightforward and may result in unintended consequences. The emergence of the smart homes or buildings with intelligent thermostats and security systems may impact on the work of meter reading engineers and security guards (Wortmann & Flüchter, 2015). Impacts may also occur at a micro-mobility work level, where mobility occurs within a single work location, such as a campus, hospital or warehouse. For example, Beane and Orlikowski (2015) describe how a hospital has implemented a robotic telepresence to perform night rounds in place of the usual practice of consultants visiting patients in their wards. Despite these developments, to date there is limited academic literature that has explored the organizational drivers for adopting IoT technologies and the impacts of IoT on mobile workers.

Method

As the academic literature is relatively underdeveloped in this area we wanted to develop our understanding through the experience of experts from academia and industry. For this type of exploratory research, a Delphi study is an appropriate research design. In broad terms, a Delphi study is a method to examine a complex problem by asking a panel of experts a series of questions and feeding back an anonymized consolidated summary of responses. This procedure is repeated through a number of iterations, enabling the experts to reflect and revise their opinions and judgments in the next iteration (Strasser, 2016). The Delphi study lends itself to studying new complex interdisciplinary issues often involving new or future trends (Akkermans et al., 2003). In the IS field the number of studies using the Delphi Method has increased and Delphi appears to be an established method in IS research (Strasser, 2016).

For the adoption of the Delphi method this study follows Skinner et al.'s (2015) three-stage process (exploratory, distillation, utilization) for guiding the execution of Delphi methods. First, the exploratory stage involves a pilot study, refinement of the research question(s) and identifies and validates experts to form the panel. To achieve these goals a literature review will be conducted by searching a range of relevant databases (e.g. EBSCO Business Source Complete, EBSCO Psych INFO) using appropriate search criterion. To examine the most up-to-date technological developments our focus will be on relatively recent literature searching for material from 2013 onwards. Once the initial, collection of published material has been conducted, the project team will review the results and work together to draft an outline thematic analysis of the findings. Academic and industry experts will be identified and approached for initial discussions regarding participation in the study to achieve a target panel size of 20. Twenty participants are considered the minimum sample size to overcome risks of individual biases contaminating the consolidated responses (Akkermans et al., 2003). A snowball sampling approach will be adopted until the desired expert panel is achieved.

Second, the distillation stage involves the development of a series of questions that

are posed to the expert panel. The expert responses are evaluated for consensus and assuming consensus is not reached, anonymized feedback is provided to the expert panel. The process is repeated through several iterations (Skinner et al., 2015). For this stage, the study will adopt a 'real-time' Delphi method (Gordon & Pease, 2006). The experts identified in the first stage will be invited to a one-day facilitated workshop to investigate the key drivers of IoT mobile work related technology developments and how IoT technologies impact on mobile work. Real-time Delphi is described as a 'roundless' Delphi. The experts participate by responding to questions and 'updated' responses are captured and shared in real time via a computer system. Experts are encouraged to revisit their responses and can change their inputs based on feedback (Gordon & Pease, 2006). Our approach takes inspiration from Akkermans et al. (2003) study and involves eight steps that will occur during the workshop: 1) Position and define IoT and mobile work; 2) Generate IoT mobile work drivers; 3) Group IoT mobile work drivers; 4) Generate IoT mobile work impacts; 5) Assess business impact of IoT mobile work; 6) Prioritize IoT mobile work impacts for sub-group discussion; 7) Generate IoT mobile work shortcomings; 8) Cluster IoT mobile work shortcomings.

Third, the utilization stage occurs once consensus is achieved. The findings are reported back to the participants and prepared for publication (Skinner et al., 2015). These findings will be synthesized with the literature and complied into a report for participants and for future publication. The study commenced on 1 October 2016 and will conclude by 30 March 2017. It is envisaged that the exploratory literature review and Delphi study will deliver a clear and detailed foundation that identifies key priorities for industry and academia regarding the drivers for organizational engagement with IoT technologies for mobile work and the impacts of IoT on mobile workers. This will help to inform a future research agenda for IoT and mobile workers.

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