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Sharing knowledge via ubiquitous technology to enhance safety awareness: willingness and actual experience in Hong Kong

Rita Yi Man Li[1], Derek Asante Abankwa[2] and Tat Ho Leung[3]

[1] HKSYU Real Estate and Economics Research Lab, Hong Kong Shue Yan University, North Point, Hong Kong
[2] Department of Real Estate and Construction, The University of Hong Kong, Hong Kong
[3] HKSYU Real Estate and Economics Research Lab, Hong Kong Shue Yan University, North Point, Hong Kong
ymli@hksyu.edu

Abstract. Recently, various ubiquitous technological advancements have benefitted knowledge sharing in different sectors. As there is a close relationship between safety knowledge and awareness, this paper examines the use of Web 2.0, Internet of Things (IoT), and mobile applications in construction safety knowledge sharing for enhancing safety awareness at work. The use of such technologies can improve internal and external communication as well as collaboration. A quantitative survey was conducted to investigate the willingness and uptake of advanced technologies in the Hong Kong construction industry. Out of 23 respondents, 16 were eager to use mobile applications to share safety information. Regarding safety knowledge sharing via Web 2.0, respondents perceived a variety of barriers for not using it, such as the need to protect their company's privacy issues made them hesitant to share knowledge regarding safety issues; others were of the opinion that Web 2.0 was managed by the elite in the organisation. Only one respondent claimed to have used the technology before, however, without specifying how he made use of it. The willingness to apply IoT was relatively negative due to the perceived extra operation costs.

Keywords: IoT, Mobile Apps, Web 2.0, Knowledge Sharing, Construction Safety

1 Introduction

Gone are the times when knowledge sharing depended entirely on face-to-face encounters [1]. Recent ubiquitous technology advancement has provided new approaches for communication. Wireless communication and cloud infrastructure increase the power and reach of information to anybody, anytime and anywhere. Advancement in technology has become an inseparable part of our daily experience. Revolutionary improvements in microprocessor cost-performance ratios have forced the knowledge sharing activity forward while drastically reducing computing-device structure elements, enabling the inclusion of computers in many aspects of our

environments. In 40 years' time, change will have transformed the past large technological machines into compact devices that enable, mediate, help, and coordinate our everyday actions [2]. The development of the internet is changing the conventional expert hierarchies and shifting ways of distributing data. In construction safety knowledge management, the internet is enabling new ways of gathering, preparing and distributing knowledge. Safety information mining enables the use of better techniques of information structure and memory as well as investigation of huge datasets, leading to the discovery of previously undiscovered knowledge and relationships [3]. While the global telecommunication capacity per capita doubled every 34 months and the world's storage capacity per capita takes 40 months to double [4], researchers discovered that use of mobile apps strongly correlates with the individual's position and daily experience [5]. This paper aims to investigate the willingness and actual usage of ubiquitous technology for construction safety.

2 The application of IoT

The Internet of Things (IoT) is a form of technology conceptualised by smart and intelligent objects. IoT allows devices to interact automatically without human control, for example, personal items such as glasses, medical devices and wearables (from fitness trackers to baby socks); the smart home (digital assistants such as Google Home, smart thermostats, boilers, light bulbs, home security, fridges, televisions, etc), connected car systems (evolving into autonomous vehicles) and smart communities where electricity grids, traffic systems and street lights incorporate sensors to collect data continuously [6]. IoT is also used in several other sectors such as banking [7] and education [8] [9]. Ashton [10] opine that IoT is a smart network that can detect, control, and programme objects automatically. Due to the characteristics of the construction industry as reported by McKinsey, the huge number of people and the profusion of construction equipment, sites are becoming denser with vast amounts of data. On a construction site, the IoT would allow construction workers, materials and machinery to communicate with a common data platform that captures critical performance parameters.

One common example is the use of smart hard hats on construction sites. These hats monitor heart rates of workers against the outside temperatures to predict and prevent heatstroke in extremely high temperatures. Through this wearable device, workers can prevent injuries by predicting health concerns in real time and alerting managers instantly when they occur. E-tendering is also one of the tools of information technology in the construction industry that uses an internet connection [11]. The e-tender concept makes the distribution of information easier to bidders and the document delivery process is faster because the distance is no longer an issue in the use of this system. In terms of management, Scan Marker, a digital pen capable of scanning any printed text and transmitting it into any device such as computers, tablets and smartphones via Bluetooth connections, saves typing time, translating around 40 languages and text scans can produce sound [12].

The late supply of materials can disrupt the smooth running of a project and often occurs on-site due to delays in the delivery process. Recently, supply units have been

labelled with Radio Frequency Identification (RFID) tags for automatic counting of supplies. When the count falls below a certain level, the system provides information to the central system to place more orders [13].

Indeed, the adoption of IoT could benefit the construction industry level since it can alleviate the production costs. For example, IoT could be used to identify where materials, such as a window panel, should be placed, thereby reducing the costs arising due to wrong window placement. However, some IoT practices are still in the experimental stage, making it difficult to adequately convince the public of the benefit of IoT application. Consequently, this provides the basis for researching the real intentions of users in adopting IoT, especially in construction since the industry is currently focusing on technological advancements.

3 The application of mobile applications

In terms of feasibility, mobile apps are anticipated to enhance knowledge sharing, with the possibility for further development and implementation. Lu [14] reported that many construction practitioners have smartphones and use the apps for work purposes. Indeed, there are thousands of smartphone applications advertised as 'construction apps', however, the most popular smartphone applications offered by software providers to the construction industry are in field data collection, project management, bidding, building information modelling (BIM), accounting, customer relationship management, and estimating [15]. The image and video capturing capabilities of mobile apps can be used for record keeping and documentation purposes, not just for communication.

It is estimated that there are approximately 13,000 construction related development and design apps presently on the market [16]. An empirical study conducted by [17] indicated several areas of app use in the construction industry, including site photos, health and safety reporting, timekeeping, RFI's, progress tracking, change orders, communication, and punch list. Similarly, research conducted on USA sites found that mobile solutions impacted on the quality, subcontractor management, site coordination, safety, productivity, material procurement, project duration, and budget [18]. The use of these apps can greatly improve efficiency as well as the accuracy of site inspections and reporting [19].

Nonetheless, the motivation to use such apps by construction professionals in Hong Kong is unknown. The purpose of this study was to examine the willingness of construction professionals to share safety knowledge using mobile apps and the actual usage of such apps.

4 The application of Web 2.0

Web 2.0 is a web-based platform with simple-to-use interfaces that enable users to collectively contribute and share large amounts of information. It harnesses collective intelligence by engaging users to publish, tag, link, choose and comment. Basically, Web 2.0 is a web application (technologies and websites) which makes use of the

internet in a collaborative way to provide services to users. Examples of Web 2.0 are blogs and wikis, as such, Web 2.0 relies heavily on users as a publisher model allowing content to be created by many people. These technologies are increasingly being used by companies for better staff collaboration and communication.

Web 2.0 impacts on data and information exchange, knowledge management, improved internal and external communication as well as collaboration. With the expansion of modern web services, it is easy to read email attachments on mobile phones, publish information on internal or external company pages, and send pictures from distant construction site locations directly to the concerned parties using web-based services. These are features for valuable learning, implying that individuals will be more active to participate in learning processes on Web 2.0 platforms. Despite the benefits of information technologies, the construction industry is in a relatively early phase of adopting web-based technology. Social media are considered perfect examples of Web 2.0 applications, which people use to communicate and collaborate. With the rapid development of Web 2.0 applications, knowledge, communication and sharing has moved beyond face-to-face exchanges to social media contexts such as Facebook and Twitter [20].

Compared with the application of IoT and mobile applications, Web 2.0 provides a certain and discrete benefit to knowledge sharing because the conceptual framework of Web 2.0 endeavours to improve information circulation.

5 Research method

The study employed a quantitative research approach. Questionnaires were distributed to construction practitioners in Hong Kong via LinkedIn.

6 Results and Discussion

Generally, respondents were interested in adopting Web 2.0 and mobile applications in practice, however, they were neutral in adopting IoT. There was a lack of experience of the application of these advanced technologies among respondents. The following sections present the results and discusses the willingness and actual usage (application) of the indicated advanced technologies.

From Fig.1, it is evident that most respondents were generally willing to share safety knowledge across the various mentioned technologies, particularly mobile Apps and Web 2.0 platforms as opposed to IoT. However, the general expectation that their willingness might translate to actual usage was proven to be false for construction professionals in terms of using the technologies. Fig. 2 shows that there is a huge gap between those who actually use the technologies and those who do not, as out of 23 participants, only 3 used Web 2.0 platforms. Most respondents (6 out of 23) made use of mobile apps to share safety knowledge compared to IoT and Web 2.0. Respondents were asked in an open-ended question to indicate 1) the willingness to use advanced technologies to share safety knowledge, and 2) why willingness has not resulted in actual use of these technologies to share safety knowledge.

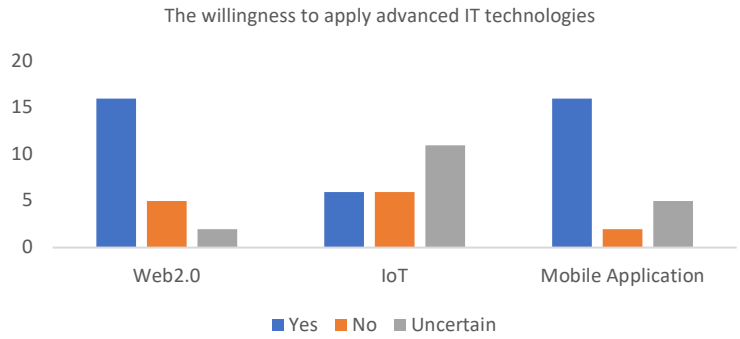

Fig. 1. Willingness to apply advanced IT technologies

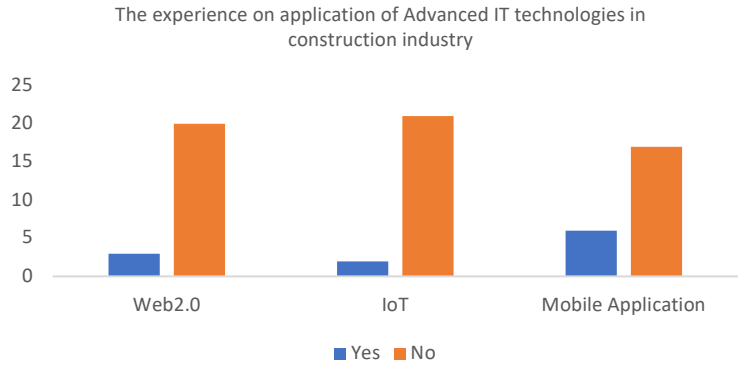

Fig. 2. Application of advanced IT technologies in the construction industry

6.1 Web 2.0

Those who used Web 2.0 to share safety knowledge in construction organisations provided positive and valuable insights into its application, believing that it can effectively reduce the number of accidents: *'I believe the usage of Web 2.0 stimulus the information sharing process, therefore, with sufficient knowledge, it can reduce the accident rate.'* However, there were various concerns regarding the implementation of Web 2.0 in practice as some respondents claim accident figures are confidential and sensitive in a competitive market such as construction.

There are foreseeable incentives in using Web 2.0 such as convenience and efficiency. Also, two of the three respondents who used Web 2.0 for knowledge sharing also used WhatsApp for intra-team communication. Respondents claimed that face-to-face and emails are the usual communication tools to share information among practitioners, these traditional methods are particularly used in the construction industry.

Regarding safety knowledge sharing through Web 2.0, respondents perceived various barriers for its application, such as the need to protect their company's privacy made them hesitant to share knowledge on safety issues. Others were of the opinion that Web 2.0 was managed by the elite within the organisation: *'I (the respondent) believe that Web 2.0 technology is only applicable in educating personnel and management level.'*

Taken together, these insights can be summarised as barriers to the use of Web 2.0 as: 1) lack of content in practice for sharing, 2) time, and 3) on-site internet connection issue.

6.2 Mobile Applications

Regarding the use of mobile applications in construction safety knowledge sharing, 2 out of 23 respondents were not agreeable to use mobile applications to share safety information. Six respondents indicated that they were already using mobile applications to share information with colleagues, while 17 had no such experience in using mobile applications to facilitate work. Although respondents had less experience in using mobile applications, 16 out of 23 respondents reported their willingness to use mobile applications to share safety information. Importantly, those respondents who refused to use mobile applications tended to anticipate the development of specific mobile applications, while it can refer to general mobile applications such as Messenger, WhatsApp, and WeChat.

In summary, of the barriers perceived by respondents, internet connectivity was the major concern. Another barrier is that workers considered reporting safety information through these mobile apps as doubling their workload. From the data analysis, the main motivation to use mobile applications was to alleviate the accident rate if the safety information could be transferred effectively and efficiently. However, some respondents were worried that the information could not be effectively transmitted to the target audience (on-site workers). In the worst-case scenario, mobile applications cannot guarantee that the workers read and understand the message, so they are not an alternative approach to face-to-face communication, even though most construction workers use a smartphone daily. Liu [17] conducted a study on the perceived benefits of Apps by construction professionals, showing that about 92% of the respondents used mobile technologies and smartphone applications were utilised by construction professionals for site photos, health and safety reporting as well as timekeeping.

6.3 IoT

With regard to the application of IoT, compared to the previous two IT tools, respondents reported that IoT would be more appropriate for presentation but not in on-site practice. While some respondents claimed they had no idea about IoT, there was relatively high negative feedback in comparison to both Web 2.0 and mobile applications. They perceived that the IoT system has the potential to be hacked, which increases the potential risk in operation. Furthermore, only one respondent reported that he had used the technology before, however, he did not specify how he made use of it.

The respondents were relatively unwilling to apply IoT as they considered it to be costly to set up, as well as the previously mentioned concerns regarding potential hacking. The respondents' motivation to apply IoT were rather ambiguous, for example, safety improvement was unclear in their view. Interestingly, there was ambivalence towards the application of IoT, some respondents were worried about increased costs, while others believed IoT could reduce the cost, albeit the cost was not well defined among respondents.

In summary, overall the respondents have no idea whether to apply IoT and they appeared confused about this technology, with only one respondent truly understanding the meaning of the application of IoT on construction sites, such that he expressed concerns regarding the hacking problem and data leakage in implementation.

7 Conclusions

This study highlighted the following critical factors which are crucial to motivate practitioners to adopt those technologies: first, practitioners are reluctant to use technologies that may violate their privacy commitment or if there is a potential risk of data leakage; second, the practitioners are willing to use applications if they consider that they will have a significant positive effect on safety management.

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