Telematics and Informatics 34 (2017) 528–539

Contents lists available at ScienceDirect

Telematics and Informatics

journal homepage: www.elsevier.com/locate/tele

The underlying factors of the perceived usefulness of using smart wearable devices for disaster applications

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ARTICLE INFO

Article history:
Received 4 August 2016
Received in revised form 12 September 2016
Accepted 13 September 2016
Available online 13 September 2016

Keywords:
Smart wearable devices
Perceived usefulness
Disaster preparedness
ICT for disaster management
Technology acceptance model

ABSTRACT

Smart wearable devices offer much potential to assist citizens in disasters. To the general public, however, using these devices for disaster applications is still a novel concept. In disasters, most people are reluctant to rely on unfamiliar technologies. Thus, for these devices to become truly useful in disasters, it is important to understand factors that affect their acceptance by the public. Previous studies show that perceived usefulness is a clear antecedent of people's acceptance of smart wearable devices. However, the underlying factors that affect perceived usefulness itself are not clearly known. Thus, the aim of this study is to fill this gap, and by doing so, to derive some practical implications for solution developers and governments.

This study used structural equation modelling to analyse survey data collected from 647 respondents in Japan. We found that the respondents' perceived usefulness of the current applications of smart wearable devices was a strong predictor of their perceived usefulness of using these devices for disaster applications. Although indirect factors such as the ownership of ICT gadgets and the usage of social media also had some influences, most of their effects were mediated through increasing the respondents' perceived usefulness of the current applications. In other words, through appreciating the functions of the current applications of smart wearable devices, people can visualise the usefulness of these devices in disaster situations. That being said, we found that in parallel, people also had concerns on the privacy issues of these devices. These findings shed light on the promotion and development of this fast growing technology for disaster applications.

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1. Introduction

Smart wearable devices (also referred as wearable technology and wearables) have become one of the fastest growing consumer segments of the Internet of Things (IoT). In recent years, consumer wearable devices such as smart watches (e.g., Apple Watch®) and smart wristbands (e.g., Fitbit®) have attracted a lot of market attention. For example, IDC (2017) forecasts the annual worldwide shipment of smart wearable devices will reach 214 million units in 2019 – a 250% growth from 2015. Similarly, Juniper Research (2014) predicts that the global market of wearable devices will increase from 4.5 billion USD in 2014 to 53 billion USD in 2019.

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http://dx.doi.org/10.1016/j.tele.2016.09.010
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Smart wearable devices, in essence, are wireless sensor-equipped devices that are embedded in clothing or accessories. They are designed to be worn persistently by the users to measure information such as the users' locations, environments, movements, and vital signs. Wearable sensor itself is not a new technology, what makes these devices 'smart' is their wireless communication capability, which enables them to connect to the Internet. Coupling with recent ICT (Information Communications Technology) advancements such as ubiquitous wireless Internet and cloud computing, more and more wearable devices with advanced functions are becoming available in the market at affordable prices. Despite the diffusion of these devices is still at the beginning stage, some analysts are already anticipating that smart wearable devices will become the next consumer electronic device of mass adoption after smartphones (Kelly, 2014; GSMA, 2015).

Wearable technology is now being applied in many different consumer sectors such as sports, medical, personal safety, and lifestyle computing. Examples of their applications include: fitness, activity tracking, health management, wearable camera, and smart clothing (Nagtegaal et al., 2015). On top of their wireless communication capability, these devices are usually compact and durable because they are designed to be worn by the users. The combination of these form-factors makes smart wearable devices an ideal technology for disaster and emergency situations (Lee et al., 2016). For instance, special wearable computers and sensor-equipped suits have been developed for emergency and disaster responders (Kondakci et al., 2010; Baldegger and Giger, 2003). As wearable technology is becoming increasingly common, some NGOs that are working at the frontline of disaster relief, for example, the American Red Cross, have begun to realise its potential to assist citizens in disasters (Weaver, 2015). Realising this trend, Unicef initiated a call-for-action called the 'Wearables for Good Challenge' in 2015 to motivate developers around the world to design wearable solutions for humanitarian and disaster-relief applications (Unicef, 2016).

ICT devices, in particular mobile phones, have become an indispensable tool for citizens in disaster situations. For example, during the 2011 Great East Japan Earthquake[1], many people used their Internet-enabled mobile phones as an alternative communication channel to collect and dissimilate disaster information when they could not obtain the information they needed from traditional media channels (Aizu, 2011). Indeed, based on a study of the 2005 Hurricane Katrina in the US, Shklovski et al. (2010) find that in disasters, people will make the most out of the technologies that are available to them, sometimes in innovative ways, to achieve their goals. That being said, as pointed out by Zlatanova and Fabbri (2009), we shall keep in mind that in disaster and emergency situations, people are also reluctant to rely on technologies that are unfamiliar to them.

Therefore, we contend that although smart wearable devices present much potential to help citizens in disasters, for them to become truly useful, they first need to be accepted by the public. Thus, for NGOs, solution developers, and governments who are trying to utilise wearable technology for disaster applications, it is essential to understanding factors that affect people's acceptance of using smart wearable devices. Currently, however, to the best of our knowledge, only a few studies have examined the applications of smart wearable devices in disasters for the public, and even fewer have considered their acceptance. Thus, the purpose of this study is to fill this gap by finding out the underlying factors that affect people's acceptance of using smart wearable devices for disaster applications.

The rest of this paper is arranged as follows. Section 2 reviews the literature on the key concepts. Section 3 describes the hypotheses, followed by Section 4, which lays out the methodology. Section 5 reports the data and result analysis. Section 6 discusses the key findings and implications, and Section 7 concludes the paper.

2. Literature review

2.1. Applications of smart wearable devices in disasters

In general, smart wearable devices can be applied in disasters in two ways. The first way is to utilise the vast amounts of data collected by them. As Usländer (2015) points out, as smart sensor-equipped devices are becoming increasingly sophisticated and popular, they formed a ubiquitous sensing network around us. Through this network, data such as the users' movements and locations will all become an integral part of the big data in IoT, which can be harnessed to improve disaster detections and responses. Referred by Faulkner et al. (2014) as the Community Sense and Response systems, human-generated content from smartphones and other sensor-equipped consumer ICT devices can be used to detect the occurrence of disasters (Faulkner et al., 2014; Sakaki et al., 2010) as well as people's behaviours in disasters (Abe, 2014). In disasters and emergencies, such information can assist governments and disaster responders to pinpoint the location of the disaster, assess the risks, and make more accurate decisions (Usländer, 2015).

The second way smart wearable devices can be applied in disaster situations is to provide direct aids to the wearers. As Weaver (2015) suggests, smart wearable devices can be used for disaster warning, response, and rescue. For disaster warning, the location and environment data measured by these devices can be used to provide more accurate and personalised warnings to the wearers, and thus give them more time to react. Furthermore, in the wake of a disaster, smart wearable devices with location and movement sensors can be used to guide the wearers to navigate through an evacuation. Finally,

[1] The 2011 Great East Japan Earthquake is one of the most severe natural disasters in Japan in recent history. On the 11th March, 2011, a 9-magnitude undersea earthquake occurred at the north-east coast of Japan caused massive tsunamis that devastated the north-east coastal areas. More than 15,800 lives were lost and the direct damages were more than 211 billion USD (Reconstruction Agency, 2013).

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