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E-health and wellbeing monitoring using smart healthcare devices: An empirical investigation

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ABSTRACT

According to the United Nations Sustainable Development Goal No. 3 (SDG – Goal 3), for sustainable development it is imperative to ensure health and well-being across all ages, and is achievable only through effective and continuous healthcare monitoring. But in India and other third world countries, healthcare monitoring is poor compared to other countries in the world, in spite of it being affordable. The global healthcare smart wearable healthcare (SWH) devices market is expected to rise up at a CAGR (Compound Annual Growth Rate) of 5.6% and by 2020 it is expected to reach 25 Billion (GVR Report, 2016). The growing incidences of lifestyle diseases, sedentary lifestyle, busy work schedules, technological advancements in healthcare monitoring devices, and increased usage of remote devicesseems to be some of the important factors fuelling this growth. Some of the major players in this segment are Abbott Laboratories, Philips Healthcare, Life Watch, GE Healthcare, Omron Healthcare, Siemens Healthcare and Honeywell International Inc. etc. But in spite of the healthcare monitoring devices are being predicted to be technologically innovative and providing advanced as well as basic health care monitoring features and available in various price ranges based on the features, we wanted to empirically study the attitude towards adoption of such devices in India. India has traditionally been having a very lackadaisical attitude towards healthcare monitoring. In such a context, what would be the factors influencing the adoption of SWH devices. Remote health monitoring can enhance the nature of wellbeing administration and to lessen the aggregate expense in human services by maintaining a strategic distance from pointless hospitalizations and guaranteeing that the individuals who need critical consideration get it sooner. This empirical investigation would provide a detailed insight as to how these wearable Internet Of Things devices would bring about a revolution in the healthcare industry. It would also provide the future prospect of IOT devices in this sector and how the probability of increase in its usage can be increased with time. The paper explores intrusiveness (INTR), Comfort (C), perceived usefulness (PU) and perceived ease of use (EOU) of SWH devices. The study hypothesized the Impact of PU and EOU, INTR and C on attitude and intention to use towards adoption of SWH devices. Partial Least Square Structured Equation Modeling (PLS – SEM) methodology was applied to explore the relationships between the concepts and hypothesis. The data was collected from 273 respondents. The age group of the respondents was between 25 and 40 years. The results indicated that intrusiveness and comfort do not have a significant direct impact on Intention to use BI (Behavior Intention) BI SWH devices. At the same time Intrusiveness had a significant impact on PU of SWH devices and Comfort has a strong significant impact on PU and EOU of smart wearables. The research has strong implications in the current emerging context of smart wearables, their design and effectiveness. Also the research can have lasting implications on elderly health and well-being. There are very few empirical studies in the area of SWH devices. Most of the studies till now are conceptual studies or providing technology architectures and frameworks. The research in this area is still at a very nascent stage and very few studies have been done to explore the use and adoption of SWH devices.

Keywords: Internet of things; Smart healthcare; Smart cities; RFID; Healthcare computing; Healthcare systems; Innovation management

1. Introduction

According to the United Nations Sustainable Development Goal No. 3 (SDG – Goal 3), for sustainable development it is imperative to ensure health and well-being across all ages, and is achievable only through effective and continuous healthcare monitoring. But in India and other third world countries, healthcare monitoring is poor compared to other countries in the world, in spite of it being affordable. The global healthcare smart wearable healthcare (SWH) devices market is expected to grow at a CAGR of 5.6% and by 2020 it is expected to reach 25 Billion (GVR Report, 2016). The growing incidences of lifestyle diseases, sedentary lifestyle, busy work schedules, technological advancements in healthcare monitoring devices, and increased usage of remote devices seem to be some of the important factors fuelling this growth. Some of the major players in this segment are Abbott Laboratories, Philips Healthcare, Life Watch, GE Healthcare, Omron Healthcare, Siemens Healthcare and Honeywell International Inc. etc. But in spite of the healthcare monitoring devices are being predicted to be technologically innovative and providing advanced as well as basic health care monitoring features and available in various price ranges based on the features, we wanted to empirically study the attitude towards adoption of such devices in India. India has traditionally been having a very lackadaisical attitude towards healthcare monitoring. In such a context, what would be the factors influencing the adoption of SWH devices.

SWH devices incorporate the use of RFID, biometrics, sensors, actuators, and metering devices collecting, monitoring and controlling healthcare data of the real world into the Healthcare Information Systems. Extending the Internet and communication a technology by linking it with "smart" sensing devices and physical objects is a growing trend. Sensors are embedded on the objects or "things", which are linked through networks (wired or wireless) through the use of a similar addressing scheme as that used for the internet (Farahani et al., 2018; Mital, Chang, Choudhary, Papa, and Pani, 2017).

"Smart" is the coming together of software, hardware, cloud and sensing technologies so as to be able to capture and communicate real time sensor data of the physical world, which can be used for advanced analytics andintelligent decision making (Chang, 2017a, 2017b; Nam and Pardo, 2011). The Internet of Things (IOT) creates a network of connected smart devices, which are uniquely addressable, and which communicate in the real time through the standard IP, based communication protocols. Connected things can range from something as small as smart LED lighting and smart locks, to something as innovative as smart healthcare monitoring and smart logistics management (Chang, 2017c). Also the smart "things" sensors can be simple sensors like RFID and biometrics to ultrasonic sensors with sensing capabilities for metering for electricity, gas, water, and detecting motion.

There are still very few studies that explore the adoption of internet of things from various theoretical perspectives of The Theory of Reasoned Action (TRA), The Theory of Planned Behavior (TPB) and The Technology Acceptance Model (TAM). Also in case of wearable health devices Intrusiveness and Comfort can be important variables to study. Our research is one such attempt to explore the use and adoption of SWH devices in India. This study serves as a precursor to extensive research in a broad domain of application areas for the Internet of Things, like healthcare, elderly well-being and support, smart cities and smart supply chains (Li et al., 2011).

Following the introduction, to reach the goal this research applied a quantitative methodology. The paper is structured as follows: Section 2 proposes the theoretical backbone of the paper regarding Internet of things and healthcare industry. Section 3 provides the methodology of this study, also developing and testing hypotheses relating to the Structural Equation Modeling. Operationalization of the constructs, results and analysis are presented in the Section 4. In conclusion, the Section 5 emphasizes a substantial discussion identify three subsections for concluding remarks (Section 6.1), managerial and theoretical implications (Section 6.2) and limitations with issues for upcoming research (Section 6.3).

2. Literature review

2.1. Internet of things (IOT)

Smart objects (or “things”) are entities that have a physical embodiment, communication functionalities, can be uniquely identified, have a name and address, have some computing capabilities, sense real world physical phenomenon, and trigger actions that have an effect on physical reality (Miorandi, Sicari, De Pellegrini, and Chlamtac, 2012). Internet of Things (IOT) consists of sensing device, a routing and communicating device, and a cloud based application. The concept of Internet of Things (IOT) is a broad category of applications based on a network of sensing and actuating devices which self-configure and can be remotely controlled through the cloud (Marston, Li, Bandyopadhyay, Zhang, and Ghalsasi, 2011). Several works highlight this new disruptive technology are changing the manner in which innovation is managed inside and outside the organizations, calling for a new and inventive knowledge management system and an open approach, to foster knowledge flows. This pattern expectedly should also enhance the development of internal knowledge management capacity, as prerequisite of ecosystem innovativeness (Santoro, Vrontis, Thrassou, and Dezi, 2017; Cetindamar, Phaal, and Probert, 2009; Darroch, 2005).

Following these assumptions, we are able to state the number of smart devices deployed across smart home applications will reach>1 billion units in 2017, with more and more residential citizens investing in IOT based smart-home solutions (Gupta and Dan Sommer, 2015). The future smart homes will be a network ofbillions of “things”, which are fitted with mobile and smart embedded sensors and use smart computing technologies for control and monitoring of the real time environment (Nam and Pardo, 2011).

The communication expanded from human-human to thing-thing interaction, bringing a new era of network and ubiquitous computing and communication, changing people's lives irrevocably (Ashton, 2009). The IOT wave will usher in an era of computing that will shift computing from the desktop environment to an all pervasive computing environment, where the objects around us would be on the network through RFID's and smart sensors (Gubbi, Buyya, Marusic, and Palaniswami, 2013).

Ashton (2009) first coined the term IOT in the year 1999. Then it was used in the context of RFID for loss prevention in supply chain and inventory management. Within a decade, the technology of IOT infiltrated surveillance, healthcare and transport sector. In present context, this technology helps in locating people and everyday objects by with the help of geological signals.

2.2. Internet of things (IOT) and the healthcare industry

IOT, a new revolution of the Internet, is rapidly gaining ground as a priority multidisciplinary research topic in healthcare industry. With the advent of multiple wearable devices and smartphones, the various IOT based devices are changing and evolving the typical old healthcare system into a smarter and more personalized one. Due to which, the healthcare system of today is also called as Personalized Healthcare System (PHS). According to Bresciani, Ferraris, and Giudice (2017), IOT solutions have affected the approach of organizations to innovation and how they create and capture value in everyday business activities. Hence, IOT devices in tandem with cloud computing will enable improvement in patient-centered practice and reduction in overall costs due to enhanced sustainability, emphasizing an ambidextrous commitment for the Healthcare Industry where the objective of exploiting new medical device ICTs solutionsis reconciled by the exploitation of added-value services for citizens, giving to the companies more opportunities to innovate through the use of the latest technologies in smart environments (Bresciani et al., 2017; Scuotto, Ferraris, and Bresciani, 2016; Vrontis, Thrassou, Santoro, and Papa, 2017).

In recent years research has focused on the development of SWH devices and health monitoring systems (Chan, Estève, Fourniols, Escriba, and Campo, 2012). The skyrocketing healthcare costs combined with the advancement in Micro/Nano sensor technologies set the stage for the use of SWH devices, and are progressively changing the landscape of healthcare by providing individual's with tools and technologies to monitor and manage their health on a continuous basis.

The rapid growth of IOT and Big Data as well as public slowly becoming miniature wearable biosensors embracers have generated new opportunities for personalized eHealth and mHealth services. These advanced services have numerous advantages ranging from personalized and tailored content and cost effective delivery system. But still a lot of challenges need to be addressed for cost efficient, flexible and consistent systems fit for medical needs. This empirical investigation would provide a detailed insight as to how these wearable IOT devices would bring about a revolution in the healthcare industry. It would also provide the future prospect of IOT devices in this sector and how the probability of increase in its usage can be increased with time. Remote health monitoring can possibly enhance the nature of wellbeing administrations and to lessen the aggregate expense in human services by maintaining a strategic distance from pointless hospitalizations and guaranteeing that the individuals who need critical consideration get it sooner.

Remote health monitoring systems and smart wearable devices together with a cloud based telemedicine platform can contribute significantly in the prevention of diseases by enabling early diagnosis and management, and consequently managing treatment and rehabilitation of the patients. The SWH research faces numerous challenges such as designing biomedical sensors, patient data security and data confidentiality, SWH devices user acceptance and awareness and business model exploitation across a multitude of applications addressing specific user needs of specific segments.

3. Research model and methodology

TRA posits that behavioral intention to use i.e. (BI), of a product or a system is dependent upon an individual's attitude towards the behavior and the subjective norms related to the behavior. BI further predicts actual behavior (Ajzen and Fishbein, 1973; Hansen, Jensen, and Solgaard, 2004; Liker and Sindi, 1997; Mykytyn Jr and Harrison, 1993; Shih and Fang, 2004; Venkatesh, Morris, Davis, and Davis, 2003). Attitude towards Adoption (ATT) is as an individual's evaluation, of a particular behaviorand is measured by behavioral beliefs about the outcomes and attributes (Madden, Ellen, and Ajzen, 1992). Subjective Norm (SN) is an extent to which behavior is influenced by the beliefs and actions of parents, spouse, friends, teachers i.e. the significant others (Madden et al., 1992). Behavioral Intention (BI) is an individual's readiness to perform an action and is an antecedent to actual behavior (Mathieson, 1991).

TAM extends TRA in the specific context of organizational Information Technology acceptance and adoption (Davis, 1989; Adams, Nelson, and Todd, 1992; Jackson, Chow, and Leitch, 1997; Gefen et al., 2003; Venkatesh et al., 2003). TAM hypothesizes an individual's BI to use Information technology is dependent upon the individual's perception of perceived usefulness (PU) and perceived ease of use (EOU) of that information technology. PU is the extent to which an individual perceives an improvement in their job performance is as a result of using a particular information technology (Davis, 1989). EOU is the extent to which an individual perceives that using a particular information technology would be effortless (Davis, 1989). The attitude construct found in TRA has been excluded in the TAM. Researchers have attempted to extend TAM Model by introducing new factors, by exploring the underlying belief factors, and by introducing antecedent, moderator and mediator variables into the TAM framework (Wixom and Todd, 2005). The attitude construct has been introduced as an antecedent to BI, and EOU and PU introduced as antecedents to attitude towards use by the TAM 2 and TAM 3 models respectively.

TPB introduces a variable perceived behavioral control (PBC) and tries to extend the TRA (Brown and Venkatesh, 2005; Chau and Hu, 2002; Hansen et al., 2004; Hsu and Chiu, 2004; Liao, Shao, Wang, and Chen, 1999; Shih and Fang, 2004). According to Hair Jr, Hult, Ringle, and Sarstedt (2013), PBC is an individual's perceived control over performing the particular action. The TPB posits that PBC, ATT, and SN act as antecedents to BI to use and actual behavior. Mathieson (1991) compares TAM and TPB and reports that although both predicted intention to use equally well, but TAM could be applied more easily compared to TPB. Also they found that TAM captures the user perceptions in a more general manner compared to TPB, which provides more specific information and as a result leads to better predictions.

Technology Acceptance Model (TAM) by Davis (1989) explains why users sometimes accept or reject information systems (IS). TAM is a valuable tool for predicting intentions to use IS. Whenever a new Information Technology is introduced, the TAM model suggests the critical factors involved in users accepting a particular technology and getting used to it. We need to understand why people accept or reject new information system applications to be able to predict, explain and increase user acceptance (Davis, 1989).

The model in this study explains that the external variables like PU and EOU develop attitude in users towards using an SWH system and that further results in BI to use that system.

Besides this, we are going to include other external variables in our study like “intrusiveness” and “privacy” which would further streamline our study. Wearable IOT devices are more sophisticated than mere watches and do much more than tell time. These devices are undoubtedly intrusive to the generation that is not used to it (Pentland and Choudhury, 2000). By “intrusiveness” of IOT devices, we mean that to wear them on a regular basis requires us to overcome quite a bit of initial resistance and undergo a (longer or shorter) period of habit formation. The same thing applies to most fitness bands, like Fitbit, that have in-built sensors to track our heart rates and in sync with mobile devices to deliver selective notifications (Lee, Kim, Ryoo, and Shin, 2016). These devices are like adding something foreign to our preferred and usual way of lifestyles. In a way we can say that IOT devices are intrusive but useful to quite an extent. As wearable devices are gaining widespread acceptance among the general population, there is urgency and need to ensure that associated privacy and security vulnerabilities are kept to a minimum (Piwek, Ellis, Andrews, and Joinson, 2016).

According to (Sixsmith and Johnson, 2004), users expressed concerns about cost, intrusiveness, reliability, and replacement wearable technology. These concerns were similar to those reported in previous studies on assistive technology (Brownsell, Bradley, Bragg, Catlin, and Carlier, 2000; Doughty, Lewis, and McIntosh, 2000; McKenna, Nait- Charif, Marquies-Faulkes, and Newel, 2003).

So we in our study hypothized that intrusiveness would have a significant impact on attitude towards adoption and intention to useSWH devices. Comfort can have a significant impact on the attitude towards adoption of wearable devices, so we also looked into this factor.

The proposed theoretical model is shown in Fig. 3.

4. Construct operationalization and hypotheses

Following are the hypotheses for our study:

H1. The PU of SWH devices is dependent on perceptions of Intrusiveness.

H2. The PU of SWH devices is dependent on perceptions of comfort of wearing SWH devices.

H3. The EOU of SWH devices is dependent on the perceptions of Intrusiveness.

H4. The EOU of SWH devices is dependent on the perceptions of comfort of wearing SWH devices.

H5. The Behavioral Intention to use SWH devices is dependent on the attitude towards adoption of SWH devices.

H6. The attitude towards adoption of SWH devices is dependent on PU.

H7. The attitude towards adoption of SWH devices is dependent on EOU.

H8. The attitude towards adoption of SWH devices is dependent on the Intrusiveness.

H9. The attitude towards adoption of SWH devices is dependent on the Comfort.

4.1. Outline model

Partial Least Square SEM (PLS – SEM) is best suited for exploratory studies where there is less of theoretical backing to the concepts and hypothesis and also where sample size is small (Table 1). Since there is mixed information about the constructs, the chances of multi-collinearity between independent or the predictor variables could be quite high. Further PLS SEM, measurement error variables are not correlated or uncovariated as they are not part of the model at all. The PLS SEM technique is useful since it assumes that individual variables are variated one by one with the rest in the model and resultant model fit indices are monitored in the Measurement part of the model. According to Gefen et al., PLS does allow all the measurement models to be created, however, it does have biased parameters for the variables. Since error terms are not directly dealt in the model in PLS SEM, unlike the CBSEM, it does utilize the proxies for latent variables for the same. In our case since the sample was small, and also since it is an exploratory study, so we chose the PLS SEM technique (Figs. 1 and 2).

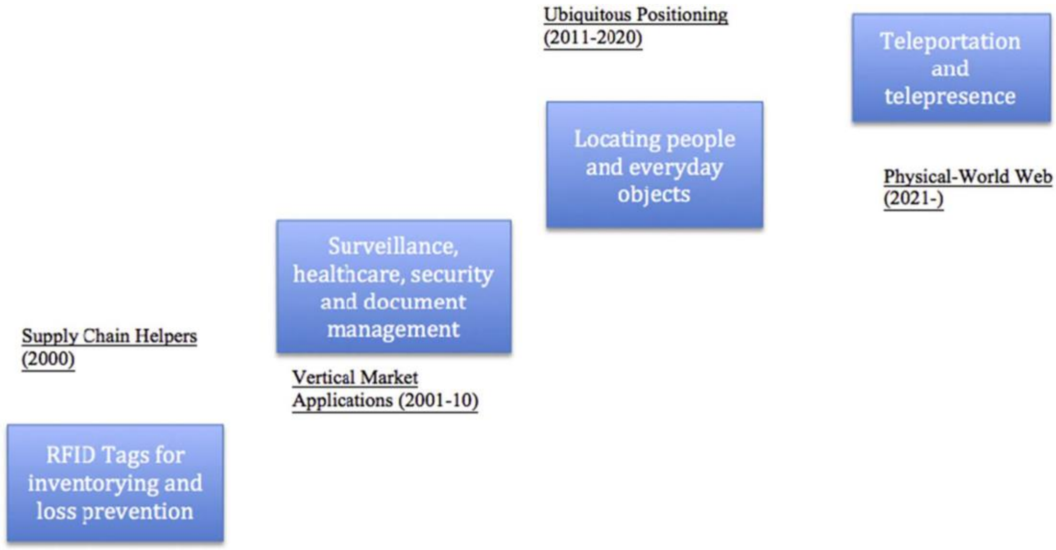

Fig. 1. Technology roadmap of IOT [4].

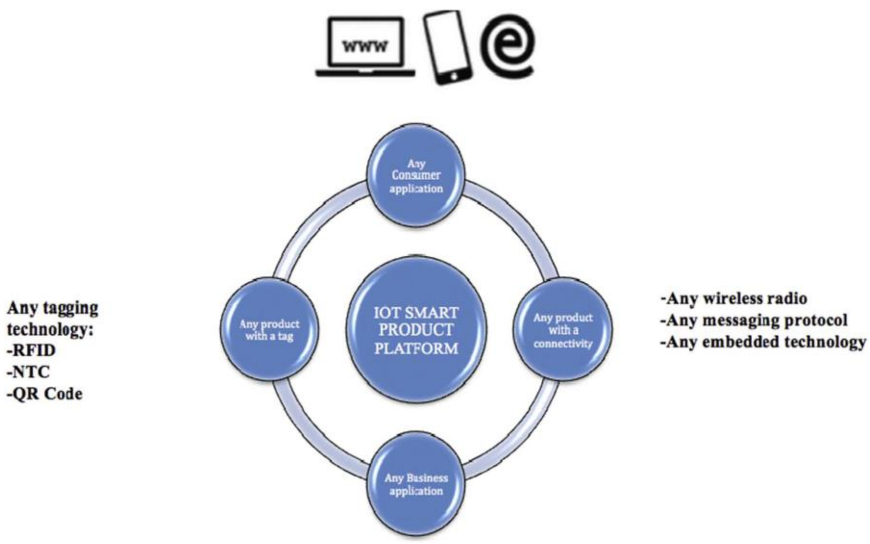

Fig. 2. The IOT ecosystem [5].

Table 1 Operationalization of the constructs

Construct	Construct operationalization (observed variables)	Question (response: 1-very low to 5-very high)
Intention to use	I1	To what extent do you intend to use Smart Wearable Systems (SWH) in the near future
	I2	To what extent do you plan to use SWH
	I3	To what extent do you expect to use SWH in the near future
Attitude towards Adoption	A1	To what extent do you feel that using SWH is a smart idea
	A2	To what extent do you feel that using SWH is beneficial
	A3	To what extent do you like using SWH
	A4	To what extent do you find SWH affordable
	A5	To what extent do you find SWH costly
Perceived usefulness	U1	SWH will help me in tracking my health performance.
	U2	SWH would improve my health performance
	U3	Wearing SWH would make it easier to track my health related activities
	U4	I find SWH useful in health monitoring
	U5	Using SWH as a health tracker would make my health monitoring better
	U6	Wearing SWH would enhance my health monitoring effectiveness
	U7	Wearing SWH would affect my tracking of daily routine activities
Perceived ease of use	E1	Learning to operate SWH would be easy for me
	E2	I find it easy to get SWH to do what I want it to do
	E3	I find the user interface of SWH clear and understandable
	E4	I find the working of SWH user friendly
	E5	It is easy for me to become skillful at using SWH
	E6	I find SWH easy to use
Intrusiveness	I1	I find wearing SWH annoying
	I2	SWH devices interfere with performing a task
	I3	SWH devices are intruding on the wearer's personal space
	I4	I find there is a loss of privacy as SWH are recording personal information
	I5	I find the data being recorded by SWH are reliable
	I6	I find SWH devices obstruct movement.
	I7	I am unable to relax wearing SWH devices.
Comfort	C1	I feel strange wearing SWH devices
	C2	I do not feel secure wearing SWH devices
	C3	The device inhibits or restricts my movement
	C4	I feel tense or on edge because I'm wearing the SWH device
	C5	I can feel the SWH device on my body

From the results we can see that the reliability of PU, EOU, C, INTR, ATT, IU constructs in the proposed hypothetical model is 0.922, 0.892, 0.906, 0.904, 0.647 and 0.803 respectively, which being>0.65 implies good construct reliability (as we can see from the Tables 2). The Discriminant validity of all the constructs used is ≥0.6. A VIF of<1.2 for all constructs shows the absence of multi-collinearity. A GoF index SRMR of 0.227 and GF of 0.66 shows that the hypothetical model explains the Intention to adopt SWH devices well.

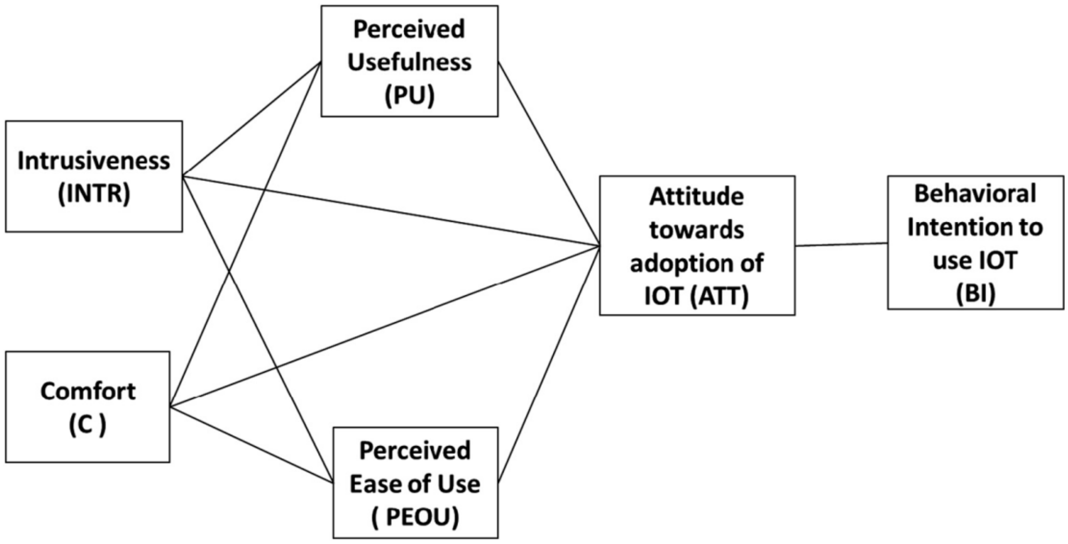

Fig. 3. The proposed hypothetical model.

PU, EOU, C and INTR together explain 77.7% of the observed variance in attitude towards adoption of SWH devices (Fig. 4). PU had a higher impact than EOU. The path analysis for TAM showed that the data supported the hypothesized model as proposed in by TAM. Both, PU and EOU were found to have a direct positive and significant impact on the respondent's Attitude to use SWH devices. The standardized path coefficient's for PU and EOU were found to be 0.459 (t-statistic- 4.896, and p-value - 0.000) and 0.315 (t-statistic- 1.914, and p-value - 0.056), respectively. These values imply that for a unit increase in PU an individual's (positive) ATT towards adoption of SWH devices would increase by 0.459 unit and for a unit increase in EOU an individual's (positive) ATT towards adoption of SWH devices would increase by 0.315 unit. Also these effects were also found to be strongly significant as shown in Table 2. C and INTR were not found to have a significant direct impact on Attitude towards adoption of SWH, but C was found to have a significant but negative impact on ease of use, with a standardized path coefficient of −0.554 (t-statistic- 4.507, and p-value - 0.00).

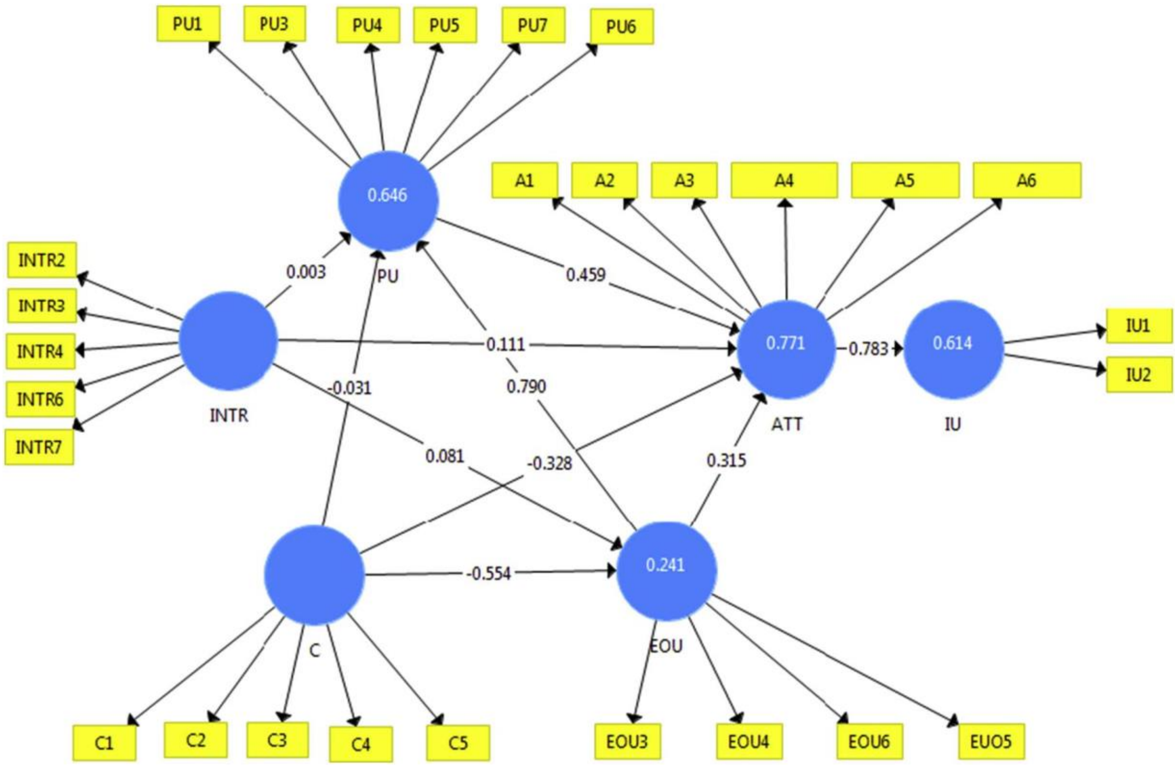

Fig. 4. Path diagram of the proposed hypothetical model.

This implies that for a unit decrease in wearing comfort of the SWH device an individual's (positive) ease of use would decrease by 0.554 unit.

Table 2 Path coefficients and quality criteria PLS path diagram.

Path	Path coefficients						
	Original samplemean	Sample mean	Standard deviation	Tstatistics	P-value	Significance (two-tailed)	Null hypothesis
ATT > IU	0.829	0.826	0.051	16.381	0.000	Significant	Rejected
C > ATT	−0.044	−0.043	0.106	0.419	0.676	Not Significant	Not rejected
C > EOU	−0.544	−0.542	0.123	4.507	0.00	Significant	Rejected
C > PU	−0.029	−0.023	0.079	0.363	0.717	Not Significant	Not rejected
EOU > ATT	0.235	0.256	0.123	1.914	0.056	Significant	Rejected
EOU > PU	0.789	0.785	0.066	11.955	0.000	Significant	Rejected
INTR > ATT	−0.022	−0.031	0.087	0.254	0.800	Not Significant	Not rejected
INTR > EOU	0.081	0.058	0.103	0.793	0.428	Not Significant	Not rejected
INTR > PU	−0.001	−0.013	0.073	0.012	0.991	Not Significant	Not rejected
PU > ATT	0.669	0.638	0.137	4.896	0.000	Significant	Rejected

* Significance at 95% confidence level
** Significance at 99.5% confidence level

Variables	Average variance extracted (AVE)	Cronbach's Alpha	Discriminant validity					
			ATT	C	EOU	INTR	IU	PU
ATT	0.665	0.647	**0.732**					
C	0.730	0.906	−0.454	**0.855**				
EOU	0.756	0.892	0.802	−0.487	**0.870**			
INTR	0.718	0.904	−0.357	0.816	0.371	**0.845**		
IU	0.835	0.803	0.829	−0.463	0.680	−0.378	**0.914**	
PU	0.720	0.922	0.883	−0.414	0.803	−0.317	0.371	**0.849**

SRMR -0.227GoF- 0.66.

GoF=SQRT ((average AVE) * (average R2)); GoF small=0.1, GoF medium=0.25, and GoF large=0.36. These may serve as baseline values for validating the PLS model globally (Tenenhaus et al., 2004).

SRMR value of ≥0.08 (in a more conservative version view see Henseler et al., 2014; Hu and Bentler, 1998) are considered a good fit.

5. Discussion of findings and insights in the research context

Analysing the results and asserting that in an ageing world, maintaining goodand safety health as well as independence for as long as possible is essential for maintaining the state of wellness for civil societies, especially for those countries with a high population growth rate like India, it is possible to argue that the evolution the assistance and self-assistance generated by the IoT pressures with smart devices represent a promising and cost-effective way of improving home care for the elderly and the disabled in a non-obtrusive way, allowing greater independence, maintaining good health and preventing social isolation (Chan, Campo, Estève, and Fourniols, 2009).

This innovation not only creates value for patients (i.e. the customers of this innovation) but also for the entire social and economic ecosystem because it affects the decision-making processes concerning strategically and politically decisions for health's maintenance by making them quick and more efficient (Burns, 2012).

Currently, in India, we are able to state we are still in an experimental phase as probably worldwide but it appears it is opening up a new scenario for E-health and some aspects of the developments related to offering innovative services according the principle of Industry 4.0.

In this perspective, the embeddedness of IoT the new generating technologies allows the company to improve the systems and procedures, it could have a reduction in transaction times, procedural innovativeness and access to information for codification into knowledge (Van Beveren, 2003). By improving these systems, the company allows employees to take advantage of their skills, allowing the human capital to reach the fullest potential, and creating a competitive advantage for the company (Murray, Papa, Cuozzo, and Russo, 2016; Nahapiet and Ghoshal, 1998).

Based on the results of an empirical study done on 273 respondents in India, the researchers tried to extend the Technology Acceptance theory in the specific context of SWH devices. Healthcare monitoring in India is poor compared to other countries in the world, in spite of it being affordable. The global healthcare smart wearable healthcare (SWH) devices market is expected to grow at a CAGR of 5.6% and by 2020 it is expected to reach 25 Billion. The growing incidences of lifestyle diseases, sedentary lifestyle, busy work schedules, technological advancements in healthcare monitoring devices, and increased usage of remote devicesseems to be some of the important factors fuelling this growth. Some of the major players in this segment are Abbott Laboratories, Philips Healthcare, Life Watch, GE Healthcare, Omron Healthcare, Siemens Healthcare and Honeywell International Inc. etc. The healthcare monitoring devices are being predicted to be technologically innovative and providing advanced as well as basic health care monitoring features and available in various price ranges based on the features. We wanted to empirically study the attitude towards adoption of such devices in India. India has traditionally been having a very lackadaisical attitude towards healthcare monitoring. In such a context, what would be the factors influencing the adoption of SWH devices. We studied it within the technology acceptance framework and found that besides PU and EOU, comfort in wearing the SWH devices was perceived to be a very important factor impacting the EOU of the devices. For the SWH device adoption to happen in India, the companies should keep in mind the comfort in wearing. We also predicted that since the SWH devices would be saving and communicating private healthcare data, Indians would be sensitive to feelings of intrusiveness. But the results of our study indicated otherwise. Intrusiveness was found to have no significant impact on PU and EOU. While Comfort was found to have no significant direct impact on attitude towards adoption, but it was found that comfort had a strong significant negative impact on ease of use and accounted for explaining 22% of the variance in ease of use. Thus we can safely say that comfort in wearing is a strong indicator of successful adoption of SWH devices. So in addition to PU and EOU, comfort also needs to be taken care of. The study also found that the respondents perceived the SWH devices to be useful and the attitude towards adoption and intention to use was found to be high.

This implies that in a country like India where the attitude towards healthcare monitoring is careless, the SWH devices had a positive impact. It could also imply that the people of India were becoming more health conscious or could imply that the ease of use of SWH devices was much higher compared to going to the hospital for healthcare monitoring. However, the future is well-known for healthcare and medical applications in general: if emergency equipment, such as therapies followed or special medical conditions are stored in the devices, a potential first aid operator might scan the chip and get it instantly. With this in mind, the relationship between ICT and healthcare sector assumes characters of symbioticity, especially is particularly important for cost reduction by firms and the increase of service efficiency by society.

Since defining and consolidating the new concept of E-Health, the development of synergy between techniques, models, interactions contributes to reducing costs, increasing the quality of life and collecting large amounts of data research and a global evolution of society in general (Dezi, Pisano, Pironti, and Papa, 2017). However, despite this, technological and informatics innovation is continuously in progress and continues to introduce novelties and, in more fortunate cases, open new ways for future developments (Von Hippel, 2001).

This means that the ICT and IOT market is increasingly heading towards user-centric services and technologies, i.e. functionalities that revolve around functionalities and needs of the user. As a consequence, the user become fundamental since the design phases of smart device, by creating custom and "tailor-made" user functionality. This open the way for new and further "technological discoveries" in the health sector.

6. Conclusion, implications and future perspectives

6.1. Final remarks

This research examined the relationship between ICT and the healthcare sector, hypothesizing and validating a mediating role of IoT.

According to out theoretical model, all hypotheses are confirmed by the empirical assessment. In fact, the results show there is a strong correlation of IoT application on Healthcare industry and the relationship has been emphasized through with four main user key-drivers which explore intrusiveness (INTR), comfort (C), perceived usefulness (PU) and perceived ease of use (EOU) of SWH devices. The study hypothesized the Impact of PU and EOU, INTR and C on attitude and intention to use towards adoption of SWH devices.

On this regard, the result provides aspects of originality compared with the main stream on literature. It represents an upgrade of previous empirical studies by according a user-driven approach (Zhou, Fu, and Yang, 2016).

A first possible explanation is that the previous studies analyse the application of IoT device from different perspective and in different contexts i.e. the SmartCity or biotechnology and employ different qualitative and quantitative methods (e.g. especially multiple case studies) Rather, our results seem to conjoint the statistical reliability of SEM methodology with the a pool of insights based on prior conceptualizations and practical intuitions explored in academia (Axisa et al., 2005; Jirotka et al., 2005).

Developing innovation as well as transforming knowledge into economic value is the key to economic growth and competitive success in each country. From this point of view, a country's development speed may be closely related to its R&D investments, in technology production and innovation upgrades (Del Giudice and Maggioni, 2014).

Obviously, the development for a Country is strictly related to the social wellness of its citizenship, hence the public Healthcare industry could be considered as one of the first sectors that requires the highest rates of technological development, adaptation and exploitation.

In this regard, our findings do outline the key role played by IoT devices in supporting customer – firms relationship in order to adequate the using of the technology to human needs. This generate a dual positive effect in the ecosystem: from one side, the interaction human to machine provide a huge amount of data that can positively be handled by the firms for strengthen efficiency and firm performance, accordingly the principles of open innovation studies and external source of knowledge (Ahn et al., 2016; Chesbrough, 2003; Laursen and Salter, 2006; Van de Vrande, De Jong, Vanhaverbeke, and De Rochemont, 2009; Brynjolfsson and McAfee, 2014; Vrontis et al., 2017).

Hereby, the external knowledge sourcing – the role of lead users – is found not only to be an important driver for the innovation performance of the firms but also to be an important driver that lead the growth for a technology-driven intelligent environment.

Achieving universal health coverage (UHC) is now increasingly being recognized as a major development agenda in India. UHC involves coverage with good quality health services—from health promotion to prevention, treatment, rehabilitation and palliation—as well as coverage with a form of financial risk protection. SWH devices could be one means of ensuring health promotion and prevention. With the advent of SWH devices the healthcare monitoring in India was expected to improve and also people would become more conscious of their sedentary lifestyles. Based on the results of the study we would expect SWH devices to be a disruptive influence on healthcare monitoring services. The study has important implications for practice. The results of the study indicate that SWH devices are a strong and effective substitute to hospitals for continuous health monitoring. The design of the SWH devices should be such that they provide healthcare monitoring but at the same time are comfortable to wear. Based on the results of the empirical study we extend the technology acceptance framework in the specific context of SWH devices.

To the best of our knowledge, nowadays only few studies have analysed the IoT adaption on Healthcare industry from a different points of view, i.e. demonstrating how the company built a powerful new business capability (García-Muiña and Navas-López, 2007) and investigating management development (Del Giudice and Della Peruta, 2016).

This contribute aims at offer a new contribution for the management of big data and a new perspective to analyse the growth of the section switching from a technology to an customer efficiency and increase the safety and security, offering a new opportunities to reconsider decision-making process and policies.

A country such as India that is characterized by high levels of population growth will have to make a greater effort than other countries to achieve competitive targets that will adapt to the standards of Healthcare and wellness of the most advanced but low growing countries. Under the same macroeconomic conditions, it is clear India is one of the first countries having the strong technological contents of investment in innovation. This could ensure acceleration in the exploitation of IoT technologies able to ensure a durable competitive advantage as a country system.

6.2. Managerial and theoretical contributions

From a managerial viewpoint, It is not exactly intended as a best practice model for smart healthcare, but rather aims at emphasizing the integrated nature of different perspectives and the possibility to combine an entrepreneurial approach with the responsibility for public health in order to better developing innovative smart devices (Chang, 2017c). The opportunities for this research based on IoT fieldwork reveal the importance for the Healthcare sector for trust and diligence for the various forms of device with which clinicians are seen to routinely engage in safe life.

As emerged from our analysis, specifically by testing our hypotheses, the prospect of boosting IoT technologies within this industry reflects firstly the necessity of planning strategically the screening and exploitation the effective use of clinical skills and more generally understanding how to afford trust and comfort for related ethical concerns related to the handling of user-sensitive data.

In general, new challenges for practitioners and policy makers for e- Science emerge from the following gaps:

1) the perceptions of strategic value in the public and private sectors innovation and research as a driving force for economic growth;
2) the attention of decision makers for strategic policy issues in research and development;
3) the difficulties in governing and controlling strategy to capture data for smart and embedded patient engagement channels and modes as well as simplify technical barriers within organizations by ensuring a comprehensive vision to capture and distribute knowledge and opportunities from all partner.

Despite various interpretations, generally speaking, Life Science is an industry that worldwide is consider one of the keys to future economic growth. Therefore, even for India can be an indispensable goal and in this direction you have to position it in order to intercept the opportunity.

The purpose of this document is to discuss and present some analysis that aim at evaluate the contribution of smart innovation in an industry which the engagement and the respectfulness of the patients being represent not only an economic matter but also enabling the emergence of new solutions by developing technologies that support ethics issues as well. The R&D Investments in this industry are therefore essential to improving human health, but also strategic for securing the economic well-being of a country. Moreover, the Healthcare industry has grown considerably over the last years and the technological contribution of Internet-based applications could be a real breakthrough in competitiveness (Zhou, Yim, and Tse, 2005).

With this in mind, a lead-user orientation facilitates innovations that use smart technologies by providing greater benefits to mainstream customers from one side and facilitating entrepreneurial intensity from the other side.

This implication impacts significantly on firm strategies and on innovation climate within the environment because the firm are able to share risks and responsibilities for the development and implementation of a new technology or service projects with public regulators and research institutions.

Our study offers in this regard highlights that smart programs require a longer time frame for implementation but it appears an impetus for increasing the attention on quality improvement and smart approaches in the local and national healthcare industry.

Thus, the degree of smartness depends from one hand on the ability of the regulators in developing internally policies and tools to coordinate and integrate strategically knowledge-driven partnerships at all levels within the industry (Westerman et al., 2012; Papa, Dezi, Gregori, Mueller, and Miglietta, 2018). To the other hand, it emerged the fundamental role played by users (humans) in transferring and propagating tactically data and tacit knowledge in extant health services research, yet they may have a key role in healthcare innovation implementation (Alavi and Leidner, 2001; Bogers, Foss, and Lyngsie, 2017; Gilbert and Cordey-Hayes, 1996).

In particular, the gap between empirical evidences of effective care and implementation of new research project may be attributed in part to poor healthcare innovation engagement of the users, nexus of day-today activities and effectiveness for the smart healthcare solutions.

From a theoretical side, the existing literature does not satisfactorily investigate the contingent factors emerging from the application of smart technologies to the public healthcare sector. In particular most of the aspects related to the organizational and management side have been neglected probably in favour of the clinical and medical aspects as well.

However, accordingly a new era of open innovation in healthcare is now under way. In this regard, we have already experienced several works in literature thoroughly in order to obtain greater leaps unpacking the boundaries of smart innovation, by addressing several points of analysis for the industry as well as for the firms competitiveness in general (Scuotto et al., 2017).

Following the assumptions of the Quadruple and Quintuple Helix Innovation Model by Carayannis and Rakhmatullin (2014), the first implication is related to knowledge management and big data issue. In particular, the application of smart technologies within the e-Healthcare industry promote knowledge flows among stakeholders that have access to promising new threads of knowledge, transforming the basis of technological innovation and corporate competition. This knowledge circulate as a form of "data" which are "big" not only for its sheer volume but for its complexity, diversity, and timeliness and consent to obtain insights (Del Giudice and Straub, 2011; McAfee, Brynjolfsson, Davenport, Patil, and Barton, 2012).

Although this process is on its early stages of growth, the acquisition, circulation and storage of information and knowledge could collectively help the industry to address problems related to variability in healthcare quality and escalating healthcare spend, by identifying novel patterns or new conditions that can help the patients' care and, consequently, the costs for maintenance in safety.

As a matter of fact, the sustainability of medium-long term strategies of growth for the countries is based on the ability to push smartness within the ecosystem, by enabling policies and practices of innovation strategies and innovation mechanisms and investments for enterprises (Carayannis and Rakhmatullin, 2014).

A second implication comes from the human engagement for smart initiatives that describes new "pathways for health" that could shift profit pools and reduce overall cost in the near future by supporting the discovery of unpredictable events then looking for most carefully best alternatives (Dezi et al., 2017; O'Connor and McDermott, 2004).

Inside the firms, the application of smart solutions represents a complement of disruptive strategies, which at its core are about competitive responses to innovation by helps, and predicts the behaviour of citizens themselves which pose the greatest threats of failure.

Last but not the least, outside the firms, the new perspective for the industry could change the rules of the competition also in privatepublic alliance by allowing partners to differentiate its offering competitively in ways of successful performance that can help stakeholders focusing on strategies required to sustain and build on field key priorities for users (Nishtar, 2004; Sandulli, Ferraris, and Bresciani, 2017). On the other hand IoT technologies could reduce the information and communication by designing data and governance architecture useful to manage and share data, knowledge, processes and goals useful to improve social wellness and safety assistance (Elwyn et al., 2007).

6.3. Limitations and future promising of research

Bearing this in mind, our study nonetheless presents some limitations due to the novelty of the research. The main limitation is certainly due to the context of this inquiry. The India represents probably one of the most important developing country which is still lagging behind in the standards of well-being of the most developed countries. Therefore, specificity conditions make findings and considerations more difficult to replicate in contexts already developed.

A second limitation is associated to the freshness of the research gap while on the one hand represents a strong point for the research; on the other one it makes the research theoretically vulnerable, not having a clear stream of scholarship standing about the management considerations.

Thus, starting from the findings, further investigation could validating the presented insights by investigating other countries with longitudinal analysis or by exploring new field between a well-developed country as well. This could boost the reliability of the findings and conclusion. Moreover, it would be interesting to investigate empirically other industry related to the Life Science industry within a specific context in order to propose new and valuable empirical evidence in both the scholar and managerial context on the relationship and variables that affects smart innovation. Finally, we can propose for the future to change the theoretical framework, by analysing the use of IoT technologies from a stakeholder's perspective. Naturally, the relevance of the research's topic also demands to accord further investigation and multiple perspectives of research towards to provide a complete validation. In doing so, this article serves as first stage of a much wider and deep research gap.

References

Adams, D.A., Nelson, R.R., Todd, P.A., 1992. Perceived usefulness, ease of use, and usage of information technology: a replication. MIS Q. 227–247.

Ahn, J.M., Ju, Y., Moon, T.H., Minshall, T., Probert, D., Sohn, S.Y., Mortara, L., 2016. Beyond absorptive capacity in open innovation process: the relationships between openness, capacities and firm performance. Tech. Anal. Strat. Manag. 28 (9), 1009–1028.

Ajzen, I., Fishbein, M., 1973. Attitudinal and normative variables as predictors of specific behavior. J. Pers. Soc. Psychol. 27 (1), 41.

Alavi, M., Leidner, D.E., 2001. Review: knowledge management and knowledge management systems: conceptual foundations and research issues. MIS Q. 107–136.

Ashton, K., 2009. That ‘internet of things’ thing. RFiD Journal 22 (7), 97–114.

Axisa, F., Schmitt, P.M., Gehin, C., Delhomme, G., McAdams, E., Dittmar, A., 2005. Flexible technologies and smart clothing for citizen medicine, home healthcare, and disease prevention. IEEE Trans. Inf. Technol. Biomed. 9 (3), 325–336.

Bogers, M., Foss, N.J., Lyngsie, J., 2017. The “Human Side” of Open Innovation: The Role of Employee Diversity in Firm-Level Openness. Research Policy (Forthcoming).

Bresciani, S., Ferraris, A., & Del Giudice, M. (2017). The Management of Organizational Ambidexterity through Alliances in a New Context of Analysis: Internet of Things (IoT) Smart City Projects. Technological Forecasting and Social Change. Forthcoming.

Brown, S.A., Venkatesh, V., 2005. Model of adoption of technology in households: a baseline model test and extension incorporating household life cycle. MIS Q. 399–426.

Brownsell, S., Bradley, D.A., Bragg, R., Catlin, P., Carlier, J., 2000. Do community alarm users want telecare? J. Telemed. Telecare 6 (4), 199–204.

Brynjolfsson, E., McAfee, A., 2014. The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. WW Norton & Company.

Burns, L.R. (Ed.), 2012. The Business of Healthcare Innovation. Cambridge University Press.

Carayannis, E.G., Rakhmatullin, R., 2014. The quadruple/quintuple innovation helixes and smart specialisation strategies for sustainable and inclusive growth in Europe and beyond. J. Knowl. Econ. 5 (2), 212–239.

Cetindamar, D., Phaal, R., Probert, D., 2009. Understanding technology management as a dynamic capability: a framework for technology management activities. Technovation 29 (4), 237–246.

Chan, M., Campo, E., Estève, D., Fourniols, J.Y., 2009. Smart homes—current features and future perspectives. Maturitas 64 (2), 90–97.

Chan, M., Estève, D., Fourniols, J.-Y., Escriba, C., Campo, E., 2012. Smart wearable systems: current status and future challenges. Artif. Intell. Med. 56 (3), 137–156.

Chang, V., 2017a. An overview, examples, and impacts offered by emerging services and analytics in cloud computing virtual reality. Neural Comput. & Applic. 1–14.

Chang, V., 2017b. Towards data analysis for weather cloud computing. In: Knowledge- Based Systems, pp. 29–45. 127(Supplement C). https://doi.org/10.1016/j.knosys.2017.03.003.

Chang, V., 2017c. A Proposed Social Network Analysis Platform for Big Data Analytics. (Technological Forecasting and Social Change).

Chau, P.Y., Hu, P.J.-H., 2002. Investigating healthcare professionals' decisions to accept telemedicine technology: an empirical test of competing theories. Information & Management 39 (4), 297–311.

Chesbrough, H., 2003. Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business School Press, Boston.

Darroch, J., 2005. Knowledge management, innovation and firm performance. J. Knowl. Manag. 9 (3), 101–115.

Davis, F.D., 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Q. 319–340.

Del Giudice, M., Della Peruta, M.R., 2016. The impact of IT-based knowledge management systems on internal venturing and innovation: a structural equation modeling approach to corporate performance. J. Knowl. Manag. 20 (3), 484–498.

Del Giudice, M., Maggioni, V., 2014. Managerial practices and operative directions of knowledge management within inter-firm networks: a global view. J. Knowl. Manag. 18 (5), 841–846.

Del Giudice, M., Straub, D., 2011. Editor's comments: IT and entrepreneurism: an onagain, off-again love affair or a marriage? MIS Quarterly 35 (4), iii–viii.

Dezi, L., Pisano, P., Pironti, M., Papa, A., 2017. "Unpacking Open Innovation Neighbourhoods: Le Milieu of the Lean SmartCity", Management Decision. (forthcoming).

Doughty, K., Lewis, R., McIntosh, A., 2000. The design of a practical and reliable fall detector for community and institutional telecare. J. Telemed. Telecare 6 (Suppl. 1), 150–154.

Elwyn, G., Taubert, M., Kowalczuk, J., 2007. Sticky knowledge: a possible model for investigating implementation in healthcare contexts. Implement. Sci. 2 (1), 44.

Farahani, B., Firouzi, F., Chang, V., Badaroglu, M., Constant, N., Mankodiya, K., 2018. Towards fog-driven IoT eHealth: promises and challenges of IoT in medicine and healthcare. Futur. Gener. Comput. Syst. 78, 659–676. (Part 2). https://doi.org/10.1016/j.future.2017.04.036.

García-Muiña, F.E., Navas-López, J.E., 2007. Explaining and measuring success in new business: the effect of technological capabilities on firm results. Technovation 27 (1–2), 30–46.

Gefen, D., Karahanna, E., Straub, D.W., 2003. Trust and TAM in online shopping: an integrated model. MIS Q. 27 (1), 51–90.

Gilbert, M., Cordey-Hayes, M., 1996. Understanding the process of knowledge transfer to achieve successful technological innovation. Technovation 16 (6), 301–312.

Gubbi, J., Buyya, R., Marusic, S., Palaniswami, M., 2013. Internet of things (IoT): a vision, architectural elements, and future directions. Futur. Gener. Comput. Syst. 29 (7), 1645–1660.

Gupta, A., Dan, Sommer, 2015. Market Trends: Applying Analytics in Healthcare. Gartner Inc., New York (The report is available on Gartner's website at). http://www.gartner.com/document/2974424.

Hair Jr., J.F., Hult, G.T.M., Ringle, C., Sarstedt, M., 2013. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM): Sage Publications.

Hansen, T., Jensen, J.M., Solgaard, H.S., 2004. Predicting online grocery buying intention: a comparison of the theory of reasoned action and the theory of planned behavior. Int. J. Inf. Manag. 24 (6), 539–550.

Henseler, J., Dijkstra, T.K., Sarstedt, M., Ringle, C.M., Diamantopoulos, A., Straub, D.W., ... Calantone, R.J., 2014. Common beliefs and reality about PLS: comments on Rönkkö and Evermann (2013). Organ. Res. Methods 17 (2), 182–209.

Hu, L.T., Bentler, P.M., 1998. Fit indices in covariance structure modeling: sensitivity to underparameterized model misspecification. Psychol. Methods 3 (4), 424.

Hsu, M.-H., Chiu, C.-M., 2004. Internet self-efficacy and electronic service acceptance. Decis. Support. Syst. 38 (3), 369–381.

Jackson, C.M., Chow, S., Leitch, R.A., 1997. Toward an understanding of the behavioral intention to use an information system. Decis. Sci. 28 (2), 357–389.

Jirotka, M., Procter, R., Hartswood, M., Slack, R., Simpson, A., Coopmans, C., Voss, A., 2005. Collaboration and trust in healthcare innovation: the eDiaMoND case study. Comput. Supported Coop. Work 14 (4), 369–398.

Laursen, K., Salter, A., 2006. Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. Strateg. Manag. J. 27 (2), 131–150.

Lee, J., Kim, D., Ryoo, H.-Y., Shin, B.-S., 2016. Sustainable wearables: wearable technology for enhancing the quality of human life. Sustainability 8 (5), 466.

Li, X., Lu, R., Liang, X., Shen, X., Chen, J., Lin, X., 2011. Smart community: an internet of things application. IEEE Commun. Mag. 49 (November), 68–75. http://dx.doi.org/10.1109/MCOM.2011.6069711.

Liao, S., Shao, Y.P., Wang, H., Chen, A., 1999. The adoption of virtual banking: an empirical study. Int. J. Inf. Manag. 19 (1), 63–74.

Liker, J.K., Sindi, A.A., 1997. User acceptance of expert systems: a test of the theory of reasoned action. J. Eng. Technol. Manag. 14 (2), 147–173.

Madden, T.J., Ellen, P.S., Ajzen, I., 1992. A comparison of the theory of planned behavior and the theory of reasoned action. Personal. Soc. Psychol. Bull. 18 (1), 3–9.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., Ghalsasi, A., 2011. Cloud computing—the business perspective. Decis. Support. Syst. 51 (1), 176–189.

Mathieson, K., 1991. Predicting user intentions: comparing the technology acceptance model with the theory of planned behavior. Inf. Syst. Res. 2 (3), 173–191.

McAfee, A., Brynjolfsson, E., Davenport, T.H., Patil, D.J., Barton, D., 2012. Big data: the management revolution. Harv. Bus. Rev. 90 (10), 60–68.

McKenna, S.J., Nait-Charif, H., Marquies-Faulkes, F., Newel, A., 2003. Activity Monitoring for Independent Living Using Ceiling-Mounted Visual Sensors.

Miorandi, D., Sicari, S., De Pellegrini, F., Chlamtac, I., 2012. Internet of things: vision, applications and research challenges. Ad Hoc Netw. 10 (7), 1497–1516. http://dx.doi.org/10.1016/j.adhoc.2012.02.016.

Mital, M., Chang, V., Choudhary, P., Papa, A., Pani, A.K., 2017. Adoption of internet of things in India: a test of competing models using a structured equation modeling approach. Technol. Forecast. Soc. Chang. http://dx.doi.org/10.1016/j.techfore.2017.03.001. (in press).

Murray, A., Papa, A., Cuozzo, B., Russo, G., 2016. Evaluating the innovation of the internet of things: empirical evidence from the intellectual capital assessment. Bus. Process. Manag. J. 22 (2), 341–356.

Mykytyn Jr., P.P., Harrison, D.A., 1993. The application of the theory of reasoned action to senior management and strategic information systems. Inf. Resour. Manag. J. 6 (2), 15.

Nahapiet, J., Ghoshal, S., 1998. Social capital, intellectual capital, and the organizational advantage. Acad. Manag. Rev. 23 (2), 242–266.

Nam, T., Pardo, T. a, 2011. Conceptualizing smart city with dimensions of technology, people, and institutions. In: Proceedings of the 12th Annual International Digital Government Research Conference on Digital Government Innovation in Challenging Times - dg.o '11, pp. 282. http://dx.doi.org/10.1145/2037556.2037602.

Nishtar, S., 2004. Public–private'partnerships' in health–a global call to action. Health Research Policy and Systems 2 (1), 5.

O'Connor, G.C., McDermott, C.M., 2004. The human side of radical innovation. J. Eng. Technol. Manag. 21 (1), 11–30.

Papa, A., Dezi, L., Gregori, G.L., Mueller, J., Miglietta, N., 2018. Improving innovation performance through knowledge acquisition: the moderating role of employee retention and human resource management practices. J. Knowl. Manag. http://dx.doi.org/10.1108/JKM-09-2017-0391.

Pentland, A., Choudhury, T., 2000. Face recognition for smart environments. Computer 33 (2), 50–55.

Piwek, L., Ellis, D.A., Andrews, S., Joinson, A., 2016. The rise of consumer health wearables: promises and barriers. PLoS Med. 13 (2), e1001953.

Report Grand View (GVR), 2016. Wearable Medical Device Market Analysis and Segment Forecasts to 2022, Market Research Report, ID: 978-1–68038-724-7.

Sandulli, F.D., Ferraris, A., Bresciani, S., 2017. How to select the right public partner in smart city projects. R&D Manag. 47 (4), 607–619.

Santoro, G., Vrontis, D., Thrassou, A., & Dezi, L. (2017). The Internet of Things: Building a Knowledge Management System for Open Innovation and Knowledge Management Capacity. Technol. Forecast. Soc. Chang., (forthcoming).

Scuotto, V., Ferraris, A., Bresciani, S., 2016. Internet of things: applications and challenges in smart cities: a case study of IBM smart city projects. Bus. Process. Manag. J. 22 (2), 357–367.

Scuotto, V., Santoro, G., Papa, A., Carayannis, E.G., 2017. Triggering Open Service Innovation through Social Media Networks. Mercati & Competitività.

Shih, Y.-Y., Fang, K., 2004. The use of a decomposed theory of planned behavior to study internet banking in Taiwan. Internet Research 14 (3), 213–223.

Sixsmith, A., Johnson, N., 2004. A smart sensor to detect the falls of the elderly. IEEE Pervasive Computing 3 (2), 42–47.

Tenenhaus, M., Amato, S., Esposito Vinzi, V., 2004. A global goodness-of-fit index for PLS structural equation modelling. In: Proceedings of the XLII SIS scientific meeting. vol. 1. pp. 739–742 (June).

Van Beveren, J., 2003. Does health care for knowledge management? J. Knowl. Manag. 7 (1), 90–95.

Van de Vrande, V., De Jong, J.P., Vanhaverbeke, W., De Rochemont, M., 2009. Open innovation in SMEs: trends, motives and management challenges. Technovation 29 (6–7), 423–437.

Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D., 2003. User acceptance of information technology: toward a unified view. MIS Q. 425–478.

Von Hippel, E., 2001. Innovation by user communities: learning from open-source software. MIT Sloan Manag. Rev. 42 (4), 82.

Vrontis, D., Thrassou, A., Santoro, G., Papa, A., 2017. Ambidexterity, external knowledge and performance in knowledge-intensive firms. J. Technol. Transf. 42 (2), 374–388.

Westerman, D., Spence, P.R., Van Der Heide, B., 2012. A social network as information: the effect of system generated reports of connectedness on credibility on Twitter. Comput. Hum. Behav. 28 (1), 199–206.

Wixom, B.H., Todd, P.A., 2005. A theoretical integration of user satisfaction and technology acceptance. Inf. Syst. Res. 16 (1), 85–102.

Zhou, K.Z., Yim, C.K., Tse, D.K., 2005. The effects of strategic orientations on technologyand market-based breakthrough innovations. J. Mark. 69 (2), 42–60.

Zhou, K., Fu, C., Yang, S., 2016. Big data driven smart energy management: From big data to big insights. Renew. Sust. Energ. Rev. 56, 215–225.

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