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ADOPTION OF INTERNET OF THINGS IN INDIA: A TEST OF COMPETING MODELS USING A STRUCTURED EQUATION MODELING APPROACH

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ABSTRACT

Internet of Things based applications for smart homes, wearable health devices, and smart cities are in the evolutionary stage in India. Adoption of Internet of Things is still limited to a few application areas. In developing countries, the usefulness of IOT's adoption is recognized as a key factor for economic and social development of a country by both academicians and practitioners as well. Currently, there are still very few studies that explore the adoption of Internet of Things from a multiple theory perspective, namely, The Theory of Reasoned Action (TRA), The Theory of Planned Behaviour (TPB) and The Technology Acceptance Model (TAM). This research aims to satisfy a clear gap in the main field of research by proposing a Structured Equation Model (SEM) approach to test three competing models in the context of Internet of Things in India. With respect to previous literature, this research sets the stage for 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 etc.

KEYWORDS: Internet of Things, Healthcare, Smart cities, Smart supplychain management.

1. INTRODUCTION:

"Internet of Things" (IOT) and "smart" are the plugging of RFID, biometrics, sensors, actuators, and metering devices collecting, monitoring and controlling data of the real world into the information technology framework. 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. "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 and intelligent decision making (Nam and Pardo, 2011). The Internet of Things (IOT) is a network of smart and connected devices, uniquely addressable, 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. Also the smart "things" sensors can be simple sensors like RFID and biometrics to ultrasonic sensors with sensing capabilities for motion detection and metering for electricity, water and gas. Sarac et al. (2010), has done a literature review on RFID in supply chain management. Wojick (2016), suggest a potential for Internet of Things in libraries. According to them the new age technologies like augmented reality, 3D printing and wearable technologies can help create newer services based on evolving needs to the current age consumer. While the new age technology like Internet of Things has its advantages, but they also bring forth the challenge of security of infrastructure (Li et al., 2016). The time is ripe to understand what will motivate consumers to use Internet of Things and what will dissuade them from using smart devices.

2. LITERATURE REVIEW:

Miorandi et al. (2012), define smart objects (or "things") as 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. The concept of 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) consists of a variety of monitoring and control applications based on a network of sensing and actuating devices which can be selfconfigured and controlled remotely through the Internet (Li et al., 2011; Solima et al., 2016).

According to Gartner, the number of smart devices used in smart homes will reach N1 billion units in 2017, with more and more residential citizens investing in IOT based smarthome solutions (source: Gartner, March 2015). The future smart homes, smart community, smart city etc. will be a network of a multitude of "things", mobile terminals, smart embedded devices, sensors and use of smart computing technologies (Nam and Pardo, 2011).

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). IOT devices in tandem with cloud computing will enable improvement in patientcentered practice and reduction in overall costs due to enhanced sustainability. In recent years, for health monitoring, a lot of efforts have been made in the research and development of 'Smart Wearable Devices (SWH)' (Chan et al., 2012). It is basically due to skyrocketing healthcare costs and recent advancement in micro and nanotechnologies, the sensors that are being used in SWH have been miniaturized which is progressively changing the landscape of healthcare by providing individual management and continuous monitoring if patient's health status.

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). Several studies have considered usage/ adoption as an important variable of study (Koo et al., 2015; Saeed and Abdinnour, 2013). While Venkatesh and Brown (2001), investigated use in the office context and for usage of PC's , Bauer et al. (2005), in the context of mobile marketing, Pikkarainen (2015), and Tan and Teo (2000), in the context of Internet banking, Taylor and Todd (1995b), in the context of computer center resources, Ha and Stoel (2009), in the context of eshopping, Pinho and Soares (2011), in the context of social networks and Park and Chen (2007), in the context of smartphones.

All the studies have focused on adding a few new variables based on contexts. The problem is also that we have so many new variables in different contexts added to the original theory that the theory is no longer parsimonious, which is also a challenge for theory development. While Gefen et al. (2003) added trust, Pedersen (2005), analyzed based on cognitive and social factors, Porter and Donthu (2006) incorporated demographic variables, Yu et al. (2005) introduced perceived enjoyment and trust. The challenge today then is to understand to what degree the original theories explain usage, adoption and behavior and compare three theories TAM, TRA and TPB in the context of Internet of Things. The attitude construct has been introduced as an antecedent to BI, and PEOU and PU introduced as antecedents to attitude towards use by the TAM 2, TAM 3 and UTAUT models respectively (Venkatesh and Bala, 2008; Venkatesh and Davis, 2000; Venkatesh et al., 2003).

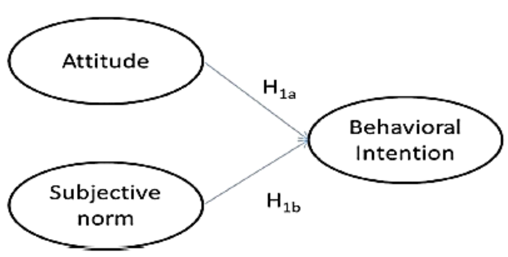

Fig. 1: Theory of Reasoned Action (TRA). H1a: Behavioral Intention to use IOT is positively affected by the attitude towards IOT usage. H1b: Subjective norm in the use of IOT positively affects intention to use IOT.

3. METHODOLOGY:

Structured Equation Modeling (SEM) has been used to test TRA, TAM and TPB (MacCallum and Austin, 2000). 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 (Hair Jr. et al., 2016). Since there is mixed information about the constructs, the chances of multicollinearity between independent or the predictor variables could be quite high. Further PLSSEM, measurement error variables are not correlated as they are not part of the model at all. The SEM technique is useful since it assumes that individual variables are changed one by one with the rest in the model and resultant model fit indices are monitored in the measurement part of the model. Since error terms are not directly dealt in the model in PLSSEM, 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 PLSSEM technique as against the SEM technique (Del Giudice and Della Peruta, 2016; MacCallum and Austin, 2000). The R2 for the dependent construct in each of the three models i.e. TRA, TPB and TAM was used to assess the explanatory power of the three models.

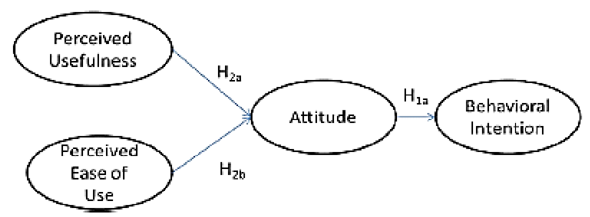

Fig. 2: Technology Acceptance Model (TAM). H2a: Intention to use IOT is positively affected by perceived usefulness of IOT. H2b: Intention to use IOT is positively affected by perceived ease of use of IOT.

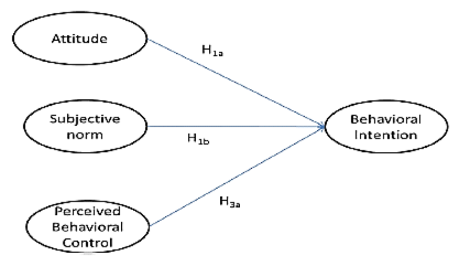

Fig. 3: Theory of Planned Behavior (TPB). H3a: Intention to use IOT is positively affected by perceived behavioral control.

Since it is an exploratory study and the adoption of IOT is still at a very nascent stage in India, the study was done on a sample of 314 respondents. PLSSEM is suited to small sample sizes. The Demographic details of the sample are as follows: Out of the total sample 84% were males and 16% were females. 46% of the respondents belonged to the age bracket of 20–30 years, 31% were in the age bracket of 31– 45 years and the remaining were in the age bracket of 46 years and above. The annual income of 54% of the respondents was between 2 and 6 lakhs, 27% earned between 7 and 15 lakhs annually, 11% were in the salary bracket of 16–30 lakhs per annum and the rest had an annual income of N31 lakhs. Almost 94% of the respondents owned smart phones and 23% of the respondents owned smart televisions.

4. DISCUSSION:

Based on data collected from 334 respondents in India, the utility of TAμ for exploring the intention to use IOT based smart devices was analyzed and the results suggested the applicability of TAμ in the current context of IOT , as indicated by the goodness of fit indices like the SRMR and GF for the model. The results supported the Technology Acceptance Model. The analysis reported that PU had a significant influence on respondent's intention to use IOT based smart devices. The effect of PEOU is found to contribute more than PU on the intention to use smart devices. The reason behind this could be that people have started using smart technology based products in their routine dayto day activities. As a result they feel that they would like to try out other newer smart devices based devices in their homes also. Also it would be help if the solution providers were able to demonstrate the ability of these devices to reduce the effort required to do their dayto day activities and the desired utilities proven. Practical demonstrations and training could result in an increased intention to use smart device based IOT devices in their daily activities. Also, based on TRA, the results suggest a significant and positive effect of attitude and subjective norm on the intention to use IOT based devices. This implies that people find the idea of using IOT based products and services as smart, beneficial and important. A positive significant effect of subjective norm implies that an individual's intention to use IOT based devices would be based on whether their friends and relatives are using such devices and find them useful. Word of mouth and snow ball marketing techniques could be a good way of propagating the benefits of such technologies. The results indicated a nonsignificant effect of perceived behavioral control in – line with the theory of planned behavior, which would imply that availability of resources to buy and access IOT based solutions and devices, is not considered a constraint. Compared with prior TPB studies, this study reported that the TPB model was unable to explain the behavioral intention to use in the context of IOT based devices and solutions. PBC was found to be not so important in the context of Internet of Things adoption.

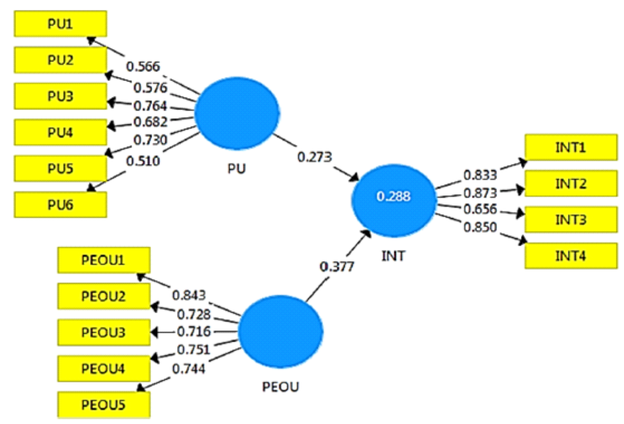

Fig. 4: PLS Path diagram for predicting intention to use IOT from the Technology Acceptance Model (TAM) perspective.

Also compared to prior TAM based studies, PU and PEOU together accounted for only 28.8% of the variance in intention to use IOT based devices, which is much less compared to Taylor and Todd (1995b), and Mathieson (1991).

5. CONCLUSION:

The study is exploratory in nature and one of the first to study adoption of smart devices in the context of Internet of Things and smart cities in India. This consideration expresses currently the unique relevant limitation of this research. The study reported that PU, PEOU as theorized by TAM, and subjective norm and attitude as theorized by TRA are significant predictors to intention to use smart devices in the future. The study reported that perceived behavioral control is not a significant predictor to intention to use IOT. The study explores the adoption of smart devices and IOT in India, within the framework of already existing theories and uses the multitheory perspective to understand the intention to adopt smart devices. The results of the study indicate that TAM, TPB and TRA explain the intention to use IOT equally well in terms of Goodness of Fit indicators i.e. SRMR and GF index but the impact perceived behavioral control was found to be non significant. So, we can say that TPB does not explain intention to adopt well as perceived behavioral control is introduced as an important variable in the TPB. The results suggest that there might be other factors which could strengthen the research model. And this is could be consider the second limit of this research, indeed.TAμ, TRA and TPB, separately, lack adequate ability to explain the intention to use IOT based devices in India. Further studies need to explore whether there are some factors specific to India, which could help explain the intention to use better. In this way, we will consider as third limit helpful for future research developments of the stream. The study will need to be tested with more control variables.

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