

# Probing the Influence of Internet of Things (IOT) Usage on the Grassroots Innovators' Sustainability: A Malaysian Perspective

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This paper aims to investigate the basis of the influence of Internet of Things (IoT) usage on the grassroots innovators' sustainability in Malaysia. The study provides the basis for a framework for further study on the issue. The result provides that the determinants of IoT usage is important to ensure the sustainability of grassroots innovators. The IoT usage can be used elsewhere in many organisations in improving skills and services. The study is an attempt to construct a new framework using The Technology Acceptance Model (TAM) - perceived usefulness (PU) and perceived ease of use (PEOU), Unified Theory of Acceptance (UTAUT) – performance expectancy, effort expectancy, social influence, facilitating conditions) and Use of Technology and Diffusion Innovation Theory (DOI) - relative advantages, complexity, observability, compatibility. Efficacy expectation is used to measure the usage behaviour. The novelty of this study results from an operational experiment converted into academic research and it is the first study in Malaysia of this kind.

**Key words:** *Internet of Things (IoT); Multimedia Super Corridor (MSC); Grassroots Innovators, sustainability; Below 40 income level; B40.*

## Introduction

It is reported that in 1999, Internet of Things was initially a vague connection of universal computers to the technology of the internet (Ashton, 2009). It started with the ability to recognize objects with radio tags or barcodes, even though the objects were far away and unseen. In 2020, IoT will dominate the Malaysian Economy, with Gross National Income (GNI) globally at RM7.8 Billion and Malaysia at RM1.7Billion whereby IoT created 14,270 new jobs and 146 patents from the Intellectual Property sector (MIMOS Berhad, 2016). There will be 50 to 200 billion sensor equipped devices by the year 2020 (Hristov, 2017). According to Leminen, Rajahonka, Westerlund, & Wendelin, (2018) the IoT touches every single life, 24/7 around the world. IoT combines equipment with systems and integrates all aspect of knowledge, technologies and the communications field by integration of the digital and the physical to be parallel, working together (Gershenfeld and Vasseur, 2014).

Generally, sustainability is the positive result sought from the initiatives performed for social, environment and economic reasons, thus our next generations will continue enjoying the same benefits. In the case of this study, the sustainability focused on the grassroots innovators whereby the innovators are the actors within the field (Davies, 2012; Nicolosi, Medina, & Feola, 2018).

Further, to align with this study on the grassroots' innovators sustainability in Malaysia, the sustainability of certain initiative will become a central principle to be addressed whereby innovation and new technology are the medium to be used.

The issue of study is the influence of IoT usage on grassroots innovators' sustainability in Malaysia.

Few agencies in Malaysia have become key players and catalyst in Translating Innovation to Wealth, to accelerate human capital development for an advance nation for economic output, societal wellbeing and innovation and creativity. Malaysia Innovation Foundation; YIM was founded in 2008 by the Ministry of Energy, Science, Technology, Environment & Climate Change; MESTECC to promote and champion innovation. In line with MESTECC's Mega Science 4.0 study and Malaysia Foresight Initiative 2050, it is a perfect match with the country's 2050 National Transformation. Under MSC flagship, since 1990's, Malaysia Digital Economy Corporation Sdn Bhd; MDEC is known as the knowledge hub for the digital economy. MIMOS Berhad, the national internet service provider in Malaysia in their IoT Roadmap projected that domestic ICT consumption is at RM118.6billion in 2015 and higher penetration of internet users (Malaysia's National Applied Research and Development Centre; MIMOS (MIMOS Berhad, 2016). Nevertheless, not much of the economic activities has been discussed and can be directly relates to benefit Grassroots Innovators' Sustainability

and how innovation and technology should be fostered for grassroots innovators' sustainability.

With the total population of 32 million (DSOM, 2019) and 12 million people in B40 and grassroots, the contribution, where less than 20% benefited from the program dedicated to the B40, is indeed an alarming situation. The digital gap between urban and rural is hugely discussed by Horn & Rennie (2018); as not all Malaysian benefited and enjoyed the same equality (Tahir, Zurinah; Jalaludin, Abdul Malik; Ibrahim, 2016). The imbalance is even worse between states and narrows down to the community (Mohamed, Judi, Nor, & Yusof, 2012, Department of Statistics Malaysia, 2016). However, a study conducted by Mohamed et al., (2012) showed that technology ICT is a medium to reduce the poverty gap between urban and rural communities, defined broadly as an infrastructure consisting of all devices, networking components, applications and systems to be streamlined ,to be used by people and organization to communicate in digital manner (Margaret Rouse, 2005).

Grassroots innovators are individual using novel ideas to develop ground-breaking solution to create imaginative solutions to problems that are often overlooked by the mainstream populace. Grassroots innovation is referred to as the innovative product or services unleashed to ease the daily chores; to overcome hurdles in the common and at ordinary community or masses (Nasir & Subari, 2017).

That being said, grassroots innovator's sustainability is crucial and an important element to translate and accelerate societal wellbeing in accordance with the government's master plan (Omar, n.d.). There is also relatively little empirical research on IoT usage for the grassroots' innovator sustainability in Malaysia (Jayashankar, Nilakanta, Johnston, Gill, & Burres, 2018). Previous papers also make no attempt to relate all the possible factors of IoT usage with translating S&T policies and the policy making hierarchy for S&T Policy (Zhang & Mahadevia, 2014).

With the country to looking to position Malaysia as the Regional IoT Development Hub, IoT will be the catalyst in agriculture, healthcare, manufacturing and transportation to boost efficiency, boost the income of B40, enhancing productivity and alleviate poverty. Specifically, this research seeks to explore the connection between the impact of IoT use on the sustainability of the grassroots innovators in Malaysia.

- i) How do we ascertain the outcome of all the initiatives from the mainstream perspective?
- ii) How, in a real situation, are the grassroots innovators given a fair chance to contribute more into the socio-economic context?

- iii) How does IoT benefit grassroots innovators' sustainability, in term of economy, social and environment?
- iv) How to separate the needs and wants from the political view?
- v) What is the right medium used to foster the sustainability of grassroots innovators. How to transfer the skills and knowledge of the innovations?

In their study Joshi, Chelliah, & Ramanathan, (2015) further acknowledged that Grassroots Innovators are given less concern by higher authority as it is not an impactful profit making industry; the inventors are less concerned with monetary value but more for social obligation and community works. Still, they believe that it is indeed a good problem to start with. They believe that the ideas coming from Grassroots Innovators can be further recognized and replicated elsewhere which has yet to be done in Malaysia systematically (Joshi et al., 2015).

Hence, firstly, this study will help grassroots innovators to sustain using IoT in developing innovations (Silvestre & Țîrcă, 2019). This study will add to the current IoT literature in the context of the growth of social innovation for grassroots innovators (Edwards-Schachter, 2018).

Secondly, this study will value add by providing advantage for the future studies and innovators about grassroots innovators; allowing innovators to understand how to use informative and eventually become sustainable, with the assistance from the key agencies knowledge (Daud et al., 2013).

Thirdly, this study shows that the development in ICT is so vital in order to match the societies with knowledge, to ensure better quality life, orchestrate the countries into enterprising and community – driving nation combination of innovation, entrepreneurship and sustainability (Editor, Carayannis, & Washington, n.d.). The study will help to determine the outcome of certain initiatives that influence the grassroots' innovators sustainability in Malaysia. The joint efforts by the Innovation Malaysia Foundation YIM,(2012), a Non-Governmental Organization like Malaysian Association of Creativity and Innovation MACRI,(2019), Network of Urban Rural Innovators NURI, (2019), a research and academic arm for innovation like University Technology MARA, (2019) and Innovation Management, UPM, (2019) can be the pioneering organisations, spearheading the sustainable movement of the entire grassroots innovators and its community nationwide.

## **Literature Review**

The IoT, also called as Internet of Everything by van den Heiligenberg, Heimeriks, Hekkert, & van Oort, (2017), aims to increase the advantages of frequent internet connectivity and remote control data sharing (Gao & Bai, 2014). On the most layman terms, IoT is an enabler

for humans and objects to communicate using the internet, with greater efficiency which will effect human's behaviour (Gao & Bai, 2014). According to Lu, Papagiannidis, & Alamanos, (2018), following the nature of IoT services, the primary factor behind the adoption of the service is the acceptance of the user. Researchers identified two models have been widely used i.e, the technology acceptance model (TAM) (Bao et al., 2014; Gao and Bai, 2014), the unified theory of acceptance and use of technology (UTAUT) (Chong et al., 2015). These models have been successful in explaining users IoT adoption determinants. Considering the above two (2) well known models, this study will find the relationship between the technology usage and grassroots' innovators sustainability. Al-Momani et al., (2016) explained that, TAM says two main constructs, usefulness and ease of use, serve as the grounds for attitudes toward using a particular system, that is likely to determine the intention to use, and then generates the real conduct of usage behavior. Perceived usefulness (PU) is described as the extent to which an individual thinks his or her performance would be enhanced by using the system. Whereas, perceived ease of use (PEOU) relates to the extent to which an individual thinks it would be easy to use the system.

This study has also realised that the degree to which an individual perceives the significance of technology revolves around the opinions of others and whether others believe that the technology has been used Chong et al., (2015); is one of the most important determinants in IoT service and technology adoption (Bao et al., 2014; Gao & Bai, 2014). Social influence is considered to play a particularly important role in an early stage of technology diffusion because most users lack reliable information about the new product or service (Gao & Bai, 2014) (Gao and Bai, 2014). Nevertheless, the assistance to facilitate the diffusion of IoT services can be assisted by the existing early adopters, Gao and Bai, (2014) for the grassroots innovators' sustainability in Malaysia.

Assuming the underpinning model used was TAM to measure the user's acceptance about adoption Venkatesh, (2008) in a study done by Al-Momani, Mahmoud, & Ahmad, (2016), there is also technical issues in adoption of IoT technology address by many scholars. The study interpreted IT knowledge as an internet user's ability to use applications including the use of IoT. The study suggested that there is a significant positive effect of IT knowledge on the usage of IoT. Al-Momani et al., (2016) incorporating trust and IT knowledge as well as security and privacy into the framework. The above study is fully supported and further emphasised by another study by Kurnia, Choudrie, Mahbubur, & Alzougool, (2015). Further, as shows in the research done by (Lu et al., 2018), the common interest are on the individual's choices of product design, acceptance, intention to purchase new technologies, safety and privacy issues.

Nevertheless, Unified Theory of Acceptance and Use of Technology (UTAUT), is demonstrated to be stronger and can better explain the variability in technology adoption,

better than TAM (Venkatesh, 2012). UTAUT four key constructs are performance expectancy, effort expectancy, social influence, and facilitating conditions that influence behavioral intention to use a technology and/or technology use. Recent research has questioned the position of behavioural intent as the main prediction of technology usage and presented a fresh theoretical construction (i.e habit) as another critical predictor of technology use (Venkatesh, 2012). Chong et al., (2015) studied RFID adoption in the healthcare supply chain by adapting the UTAUT model to incorporate individuals' "Big-5" personality traits (i.e. neuroticism, conscientiousness, openness, agreeableness, and extraversion). Results show that performance expectancy is the strongest, while effort expectancy is the weakest predictor among the UTAUT variables (Chong et al., 2015).

Still, this study realises that there are weaknesses in UTAUT in three of their constructs, which are unimportant which assessing grassroots innovators' sustainability:

- i) **Performance expectancy** is referred to as the extent or level of individuals in performing certain activities, which had some advantages as a result of using a technology (Venkatesh, 2012, Owusu Kwateng, Osei Atiemo, & Appiah, 2018). Whereas, grassroots innovators perform based on the sustainability that respond to the social interest and the need to use tacit knowledge (Smith & Seyfang, 2013). This means that innovators are expected to churn naturally, not in a competitive and/or performance based sector, but in their informal setting with non-monetary element involved (Gill Seyfang, 2007).
- ii) **Effort expectancy** is the degree of ease associate with the individual's use of the technology (Venkatesh, 2012). According to Norzaidi & Salwani, (2009), there is no relationship relating to the use of technology and managerial satisfaction. Supported by Pattnaik & Dhal, (2015), in their study, non-single solutions provided by high technology can combat the entire roots of the problem. In their study they also said that Technological Appropriateness (AT) is not only a matter of introducing a new gadget in a village but also to solve in a holistic way the management of the system. Results also show that effort expectancy is the least important predictor among the UTAUT variables (Chong et al., 2015). In the case of grassroots innovators, they have their own ability to curb with hardest situations and limited resources. Thus, the effort expectancy is non-significant with the focus of this study.

- iii) **Social influence** is the extent to which individuals perceive that the technology is vital to their circles (Venkatesh, 2012). This factor agrees and is in line with the informal setting that grassroots innovators operate in (Nasir & Subari, 2017). As an example, in 2009 the pool of more than 500k project titles from 400 students represent 500 institutions (nurtured through a web portal ([www.techpedia.in](http://www.techpedia.in)) created by the Society for Research and Initiatives for Technologies and Institutions (SRISTI)) can be accessed by anyone, on a voluntary basis which carries the intention of effective shared knowledge of innovations (Anil Gupta, 2013). Thus, this study will further investigate the social influence relationship with the influence of IoT usage on the grassroots innovators' sustainability in Malaysia.
- iv) **Facilitating** refers to availability of the resources and support systems to use the technology (Venkatesh, 2012, Owusu Kwateng et al., 2018). Grassroots innovators have different belief whereby in informal setting, motivations, resource limitation and conflicting interest are essential to innovate at the grassroots level compared to formal context (Joshi et al., 2015). Thus, the facilitating conditions do not match with the study.

Based on the weaknesses found in UTAUT, the only variable relevant to this study is social influence (Al-Momani et al., 2016).

Knowing about adverse action of usage, this study also take into consideration the study conducted by Daud et al., (2013) in *Investing the Impact of Intranet Resistance and Intranet Withdrawal in Malaysia Maritime Industry* This research shows that efficacy expectation is a predictor of managers' performance. The study admitted that efficacy expectation will apprehend users in using new technology. The situation exists especially the first time the technology is introduced. The study proved that an individual can believe that they can perform better without the influence of new technology. More scholars believed that individuals are complacent and driven to use traditional methods, as in this study, the efficacy expectation will give effect to the grassroots adoption to use the appropriate technology (Pattnaik & Dhal, 2015). Thus, efficacy expectation is an important variable to be addressed relating to the grassroots innovators' sustainability. In order to further investigate the relationship between the IoT usage and the Grassroots Innovators' sustainability, this study will aid with Efficacy Expectation as one of the determinants.

In another study performed by Hubert et al., (2018), further adoption progression of technology usage and the connection in new technologies diffusion is often explained by the diffusion innovation theory (DOI) established by Rogers (2003). DOI contributes to the understanding by covering antecedents which have been neglected in TAM. Rogers, (2003)

in his book, *Diffusion of Innovations* interpreted an innovation that an individual perceived as a new idea and the perceived newness of the object is much dependent on the users' reaction towards it. He further explained that newness is not limit to the new knowledge but also to newness of adoption of an innovation. The diffusion innovation theory (DOI) will provide further understandings into the related factors in informal system which leads to more vibrant transformation in the general landscape of grassroots innovators in Malaysia and their perceived behaviour of usage towards IoT. This investigation is supported by Venkatesh, (2008); there are plenty of IT adoption studies being conducted, but there has been inadequate study related with the focus subject of grassroots innovators' sustainability (Joshi et al., 2015; Cozzens, Susan E.; Sutz, 2012). As most of the researches are focus on the players or individuals at the mainstream level of The Economic of Pyramid (Hubert et al., 2018).

Therefore, these two theoretical frameworks TAM and DOI are to be used to identify and define the importance of variables for grassroots innovators that are relevant to the roots of the problems and subsequently describe and explain their relationship. At this juncture, this study has taken into consideration to add the Social Influence from UTAUT and Efficacy Expectation as one of the construct and further investigate the relationship between the usage of the IoT with the Grassroots Innovators' sustainability.

This study further notices that when analysing the above theories, the investigated model captures constructive (e.g. usefulness of technology, ease of use of a new technology with existing technologies, social influence) and destructive factors (e.g. perceived security risk) simultaneously (Hubert et al., (2018), (Daud et al., 2013). The formation of the grassroots innovations came from the difficulty faced by the community, at the bottom of the economic pyramid, with the focus to nurture alternative solution sin producing and consumption (Seyfang & Longhurst, 2016). While everyone is talking about the technology that matters to them for the purpose of sustainability, the grassroots/underserved group is still facing limitation to access of technology in an affordable manner (Horn & Rennie, 2018). The situational, recognised as the digital divide, is found all over the world and particularly in Malaysia in remote areas.

The next question is what is the acceptance and usage level at the grassroots level?

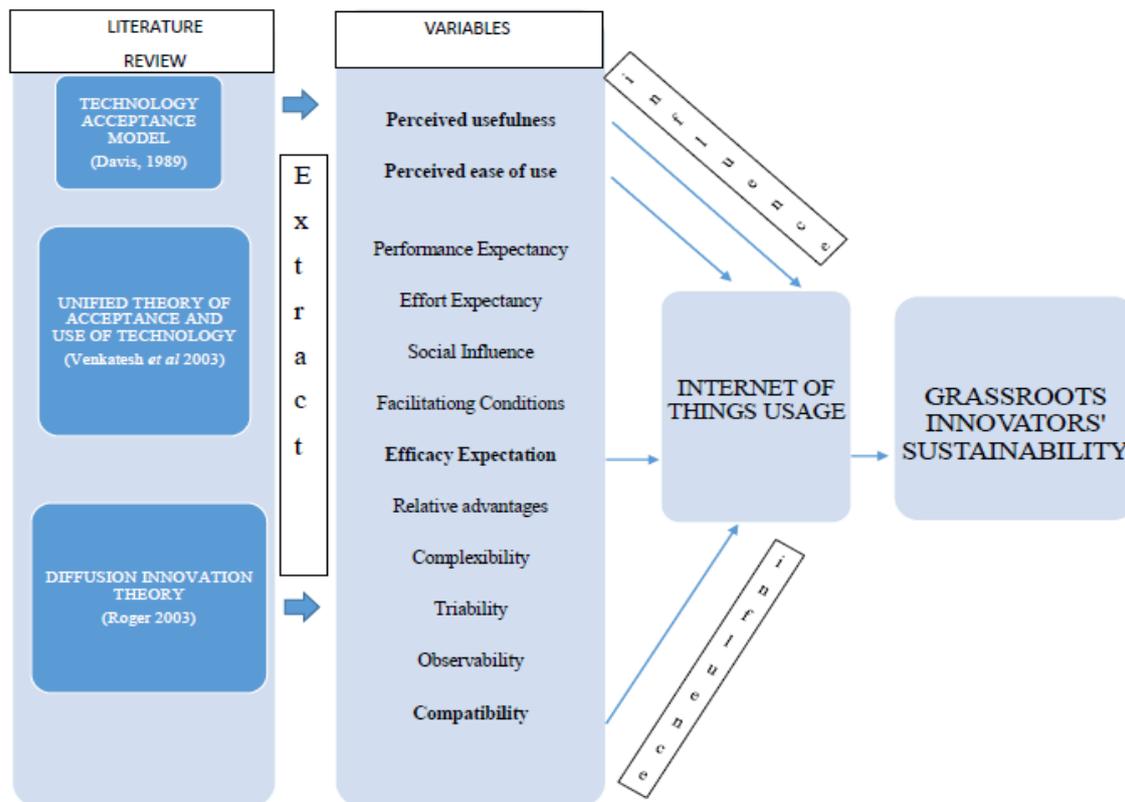
Malaysia, in recognising the importance of the advancement of ICT in giving an impact to the overall socioeconomic landscape, has established the Multimedia Super Corridor (MSC). Cyberjaya; a knowledge economy hub situated in the area of Sepang, Selangor. Cyberjaya comprises of physical and soft infrastructure to cater to domestic and foreign technology requirement. MSC aims to be a world class knowledge corridor with its own signature infrastructure for a work and family balanced lifestyle. Cyberjaya which was launched in

1997 and throughout the development phase, has become a destination for multinational companies and universities. Cyberjaya provides an ICT driven society with high speed internet accessibility. Nevertheless, the study acknowledges that Cyberjaya, the knowledge hub, is still lacking in term of gender equality, a balance of economic advancement, sustainable environment issues and last but not least, to understand and appreciate the role of grassroots and local actors. The study also acknowledge the importance of collaboration, to link grassroots and the necessity to have good mechanism in the policy and decision making process in order to create social balance and sustainability (Yigitcanlar & Sarimin, 2015).

### ***The Basis of the Framework***

The conducted literature review pointed out an assembly of factors the influence of Internet of Things (IoT) usage on the grassroots innovators' sustainability in Malaysia. To develop the theoretical model of the influence of IoT usage, the study attempted to discover the term of IoT usage within the technology acceptance model that explains the behaviour of the innovators in the context of their usage of IoT. The study identified three prominent technology acceptance models to be investigated, ie. The Technology Acceptance Model (TAM) Davis, (1989), Unified Theory of Acceptance (UTAUT) (Viswanath Venkatesh, et. al (2003) and Use of Technology and Diffusion Innovation Theory (DOI) (Rogers, 2003). From the appended theories, the study is allowed to identify the significant variables input whereby TAM addresses two output variables - perceived usefulness (PU) and perceived ease of use (PEOU), UTAUT addresses four variables (performance expectancy, effort expectancy, social influence, facilitating conditions). While DOI recognises relative advantages, complexity, triability, observability, compatibility.

The study further concerns the area related to the grassroots innovators usage of IoT on other constructs and found that efficacy expectation is often analysed in the context of behaviour to use the technology (Norzaidi, Chong, & Salwani, 2008). Based on the above theories, the study further moves in into the factors/determinants influencing grassroots innovators to use IoT (perceived usefulness, perceived ease of use, social influence, efficacy expectation and compatibility). The study investigate further dimensions/measurable extent related to the factor/determinants that would influence the usage of IoT. These factors are PU ( IT knowledge, Trust, Security & Privacy, cost), PEOU (self-efficacy, facilitating, playfulness, anxiety, usability), Social Influence (experience, gender, age, voluntariness), Efficacy Expectation (resistance, performance, familiarisation) and Compatibility (values, skills, practices).



## Conclusion

Overall, this paper refers to the three major theories ie. The Technology Acceptance Model (TAM), Unified Theory of Acceptance (UTAUT) and Use of Technology and Diffusion Innovation Theory (DOI) that may assist the study to establish a relationship among variables towards the influence of IoT usage on the grassroots innovators' sustainability in Malaysia. The study has also capturing the efficacy expectation as an input variable to the study. The above integrated theories provides a new framework. A review of the literature showed that study in the field of grassroots innovators' sustainability in Malaysia is still in its early stages and in need of more research. The impactful Grassroots Innovators' Sustainability is still vague and has not been given a fair chance all the while. The co-joint effort by agencies in Malaysia is led by organisations such as the Innovation Malaysia Foundation YIM,(2012), a Non- Governmental Organization like Malaysian Association of Creativity and Innovation MACRI,(2019), Network of Urban Rural Innovators NURI, (2019), a research and academic arm for innovation like Institute of Research Management & Innovation (IRMI), UiTM, (2019) and Innovation Management, UPM, (2019). Nevertheless, more empirical studies in this field are suggested for future research, moreover in other developing countries, as the results may varies from each countries. Further, the research will help grassroots to deeply



understand the importance of IoT and the relationship with their innovation development sustainability. The innovation sustainability is the ability for any innovation to stay longer, upholding its values, contributing through economic, social and environment factors. The study will help to determine the outcome of certain initiative that influence the grassroots' innovators sustainability in Malaysia,

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