Efficiency Improvement in IoT Use for Elderly NCD Patients in Malaysia: Extending the Practical Implementation of Theory of Planned Behavior

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Abstract

**Background:** The rapidly aging population in Malaysia is no more a surprise especially due to the sudden increasing rate of infertility and greater life expectancy creating an impact on the overall mortality percentage. Nearly half or 40% of healthcare expenses are expected to yield from the growing number of elderly people.

**Purpose:** Theory of Planned Behavior (TPB) which analyses the behavioral intention, is incorporated into this study on the use of IoT among elderly NCD-patients. According to TPB particular “cognitive-emotional” and “attitudinal” factors determine the behavioral intention of consumer or user. It is assumed that intention is required for a particular behavior in any
context. This study also intend to explain the intention of elderly NCD-patients in Malaysia, while promoting a healthy lifestyle.

**Design/methodology/approach:** The conceptual framework developed in this study will evaluate the current attitude of elderly patients in incorporating IoT-technology, societal and environmental factors influencing them to adopt IoT-technology, along with the constraints – leading the intension/behavior among the population. This, in turn, is expected to render developing efficient communication to all the stakeholders in increasing awareness among the targeted elderly NCD patients.

**Findings:** The outcomes of this study are expected to produce meaningful insights for regulators, healthcare institutions and IT technology enterprises to collaborate in designing meaningful campaigns disseminating true benefits of IoT devices, by aiming to change the attitudes of elderly patients, improve their confidence

**Research limitations:** The study was undertaken in a single country (Malaysia), which is a constraint on generalizability. This study only applied a quantitative method.

**Originality/value:** Analyzing the relational impacts of the constructs in the framework for this study will ultimately enhance the intention of IoT technology’s use among elderly patients in Malaysia.

**Keywords**

Theory of Planned Behaviour, NCD patients, IoT in Healthcare, Malaysia.

**Introduction**

One of the major challenges for the society is ensuring active and healthy ageing of the elderly People Diana (Yacchirema 2019). NCDs claim the lives of more than 36 million people each year (63% of global mortality), comprising 14 million people dying before reaching the age of 70 (Ministry of Health Malaysia, 2016). Based on statistics year 2020, Malaysia has 10.7% of people aged 60 and older, out of its total population of 32.7 million (Department of Statistics Malaysia 2019). Non-Communicable diseases (NCDs) are the leading causes of death worldwide, including cardiovascular disorders, chronic respiratory diseases, cancer and diabetes. Furthermore, according to WHO (2018) three out of every four fatalities in Malaysia use to cause by NCDs.

By reducing lifestyle risk-factors, including limited consumption of unhealthy foods, tobacco, alcohol, increasing physical activity, and most importantly regular monitoring of health status (blood glucose, blood pressure, and cholesterol level), this phenomenon can be controlled and prevented (Kristoffersson, 2020). E-health systems may play a significant role in health trend investigation, while Internet-of-Things (IoT) allow
continuous monitoring of patients (Basanta, 2015). For monitoring elderly patients, several IoT-devices and services have been established (medical parameter monitoring; diet-activity-weight-sleep monitoring; fall-detection, abnormal activities and location detection; emergency support; suggestions) to address the needs of elderly people by compensating for deficiencies and/or mitigating the predictable consequences (Azimi 2017). The use of IoT-based healthcare may help to bridge the gap between medical practitioners and NCD-patients, allowing them to exchange real-time health data more frequently and effectively.

The conceptual framework developed in this study will evaluate current attitude of elderly NCD-patients toward incorporating IoT-Technology, as well as the societal and environmental factors and constraints that influence their willingness to adopt it. This, in turn, is expected to develop efficient communication between all the stakeholders and increase awareness among the targeted elderly NCD-patients. This research will also focus on exploring the behaviour and intentions of Malaysian elderly NCD-patients toward adopting a healthy lifestyle by using IoT-Based Healthcare to track their health status. Theory of Planned Behavior (TPB), which analyses behavioral intentions, is incorporated into this study on the use of IoT-Based Healthcare among elderly NCD-patients. In summary, the study will analyze the following:

1. Test the TPB and find the reliability of intention/action and behavior of elderly NCD-patients, while promoting a healthy lifestyle.
2. Develop and test a reliable intention-behaviour framework for the adoption and successful integration of health-monitoring IoT-technology for elderly NCD-patients.

**Literature Review**

Based on the Global Action Plan for Preventing and Controlling NCDs 2016-2025 (Ministry of Health Malaysia, 2016). Two important objectives among many others are (a) “monitor the trends and determinants of NCDs and evaluate progress in prevention and control” (b) “reduce modifiable risk factors for NCDs and underlying social determinants through creation of health promoting environments”. Prevalence of selected NCD risk factors in Malaysia for adults age 18 years and above, 2006 to 2015 Diabetes Mellitus-17.5%, Hypertension-30.3%, Hypercholesterolemia-47.7% (MOH 2016). Based on Malaysia’s latest burden of disease study, high Blood Pressure alone is estimated to contribute to 42.2% of deaths and 21.6% of disability adjusted life year (MOHM 2017). Healthy lifestyle practices can effectively eliminate about 75% of worldwide heart
disease, stroke, and type 2 diabetes, and 40% of cancer risks associated with NCDs (WHO 2019). Through remote monitoring, IoT-Healthcare systems are assisting elderly individuals' physical, psychological, and social challenges and requirements (Khan et al 2019). Moreover, wearable technology has facilitated on-body real-time sensing and computation of human physiological data (Pataranutaporn 2019) and Body Sensors Network (BSN) of IoT measures and analyses various human functionalities including blood pressure, oxygen levels in blood, cardiac-rate, and body temperature (Khan et al 2019). As a result, IoT can assist particularly elderly NCD-patients who can get benefit from affordable high-quality healthcare, monitoring, and treatment (Islam 215). The increasing demand for healthcare services due to aging population is encouraging the use of digital-healthcare systems for taking care of elderly citizens (Pataranutaporn 2019). A barrier for elderlies is that they did not grow-up in digital-age, so they must work a bit hard to cope with new technologies to adapt IoT (Gkouskos 2017). Moreover, several researchers identified IoT as a fresh technology for which users confront numerous challenges in adopting (Nagy, 2018). Hence, potential users are doubtful of the value and may still be unwilling to pay high prices for IoT-Healthcare systems considering high costs as a barrier (Ben Arfi 2020).

Theoretical Background

The broadly adopted theory in contemplating the attitude-behavior relation is the theory of planned behavior (TPB) by Ajzan (1991). TPB includes five major factors: perceived behavioral control, attitudes towards behavior, subjective norms, intention and behavior. Many researches have been performed using the Technology Acceptance Model (TAM) to examine users' general experiences in using IoT (Al-Tall R.M. 2020, Mital, 2017, Sheshadri Chatterjee 2020). Since this study attempts to measure the attitude and behavior towards using IoT-Based Healthcare among elderly NCD-patients, TPB is the best supported theory to analyze the actual intention.

Intention towards IoT-based Healthcare

There are still very few studies that explore the adoption of IoT from theoretical perspectives of TPB (Alraja, 2019), (Prayoga 2016). Several other studies investigated variables that could predict potential user’s intention to utilize IoT-based healthcare (Alraja, 2019), (Prayoga 2016), (Alraja, 2019). Findings from previous studies and information on selected indicators are presented below.
Attitude towards IoT

The attitude represents individual’s general attitude and is identified as an evaluative response reflecting one’s beliefs about the behavior. Attitude is constituent of two major factors: (a)-beliefs about consequences (b)-corresponding judgments about potential consequences (Ajzen, I 1991). Mital (2017) reported a positive effect of attitude of using IoT towards its Behavioral Intention. Accordingly, first hypothesis projected as:

H-1: Attitude towards IoT has a positive effect on the elderly NDC Patients intention towards using IoT-based healthcare.

Study focused on factors influencing intention to use Techno-Healthcare devices revealed positive effects of knowledge and technological Factors (Lee, S.M 2020) and value orientation as perceived value (El-Haddadeh R 2019) on actual attitude/behavior. Based on these findings, the current study intends to examine the effect of knowledge and value orientation on attitude towards using IoT; therefore hypothesis made the following predictions:

H1a: Knowledge has a positive effect on attitude towards using IoT-based healthcare elderly NCD-patients.

H1b: Value orientation has a positive effect on attitude towards using IoT-based Healthcare among elderly NCD-patients.

Subjective Norms

Subjective norms are associated with the formation of individual behavior which displays a large impact on societal expectations and people consider to inherit behaviors that are considered socially acceptable-(24). Studies which looked into subjective norms have reported positive effects on intention towards consumption of IoT-solutions (Al-Tall, R.M, 2020 Mital 2017, Lee 2020). Based on that, second hypothesis predicted as:

H2: Subjective norms have a positive effect on elderly NCD-patients’ intention towards using IoT-based healthcare.

TPB illustrated that beliefs is predictor of subjective norms, which indirectly determines intentions and behavior. The two constructs of subjective norms are (a)-normative beliefs, and (b)-motivation to fulfill (Ajzen, 1991). A recent study performed on 467 IoT users illustrated that social influence can significantly impact the intention to use
IoT (Almugari, 2020). Another study result shows the implication from social-media motivation and Word-of-Mouth almost equally influence Indians intention to use IoT (Sheshadri Chatterjee 2020). Based on the above of results from multiple studies, below hypothesis illustrated:

H2a: Normative beliefs have a positive effect on subjective norms among elderly NCD-patients towards using IoT-based healthcare.

H2b: Motivation has a positive effect on subjective norms among elderly NCD-patients towards using IoT-based healthcare.

**Perceived Behavioral Control**

Perceived behavioral control refers to an individual’s perception towards their own capabilities and sense of control over the given circumstances (Ajzen, 1991). The performance of the behaviors, to an extent, depend on available factors such as resources and opportunities. (Ajzen, 1991), which represents a person’s real control over a specified behavior. In the study performed by Raad, data collected from 370 Jordanian consumers of IoT, revealed strong influences of perceived usefulness of IoT, perceived ease of use of such solutions, social influence factors, and perceived behavioral control targeting the acceptance of IoT. Based on previous studies, following hypothesis derived:

H3: Perceived behavioral control has a positive effect on elderly NCD patients’ intension of using IoT-based healthcare.

As TPB illustrated that resources and opportunities must be available in order for an individual to follow a behavior Ajzen (Ajzen, 1991) mentioned two factors (a)-control beliefs, as individual’s evaluation of the availability of resources (b)-perceived power as evaluation or opportunities. As beliefs concerning opportunities and resources are considered as determinants caused by perceived behavioral control, the hypothesis made the following predictions:

H3a: Resources have a positive effect on perceived behavioral control among elderly NCD-patients intention towards using IoT-based healthcare.

H3b: Opportunities display a positive effect on the perceived behavioral control among elderly NCD-patients’ intention towards using IoT-based health.
Healthy Lifestyle

IOT provides promising opportunities for engaging elderly users in designing solutions for healthcare through which some meaningful ways can be found to empower their health and aid them to maintain, control and improve quality of life (Gkouskos D 2017). Other study on IoT-Based Healthcare examined that participants using IoT-Devices for increasing physical activity and decreased food calorie intake felt encouraged towards a healthier life style (Zois, D.S, 2016). Accordingly, the fourth hypothesis can be predicted as:

H4: Intention towards using IoT-Based Healthcare has a positive effect on adopting healthy lifestyle among elderly NCD-patients.

The discussions above and from the findings of earlier studies indicate the effects of attitude, subjective norms, perceived behavioral control are associated with the adopting of healthy lifestyle, through intention towards using IoT-based healthcare. Here the fifth hypothesis says:

H5: Intention towards using IoT-based healthcare positively mediates the relations of attitude towards IoT, subjective norms, perceived behavioral control, and adoption of healthy life style among elderly NCD-patients.

Relative Advantage

Based on the concept of relative advantages illustrated under the premises of diffusion of innovation (DOI) theory by Rogers (Rogers, E, 2003), this study argues that individuals capacity to measure the Relative Advantage may influence the relationship between intention and adoption of healthy life style. Gao and Bai (Gao, L 2013) identified lack of clear concept of IoT advantages among potential users which slowed acceptance of IoT. Based on DOI theory and the implications of relative advantages in earlier studies, the sixth hypothesis predicted as:

H6: Relative Advantages positively moderate the effect of intention and the adoption of healthy lifestyle among NCD-patients.
Methodology

The study will be conducted in four Malaysian states, namely Perak, Pahang, Johor, and Terengganu, representing regions with higher prevalence of NCD-(MOHM 2016). Multistage Random Sampling will be used for the selection of areas at state, district and sub district level. A set of questionnaires will be used for collecting data including details about head of household, family profile, social and economic background, perception of socio-economic status.

Secondary data will be collected from Ministry of Health, Malaysia, World Health Organization (WHO), Department of Statistics and Malaysian Health data Warehouse (MyHDW). A stratified random sampling technique will be used to select a sample-size meeting at least one of the following criteria: lower income, the presence of elderly people, single mothers, and/or disabled people. Following data cleaning, exploratory data analysis, 500 samples will be retained, as recommended by Wolf et al. (2013)—sample-range required for structural equation model is 30 to 460.

All statistical analyses will be carried out either using SPSS or Smart PLS. Specifically, SPSS will be used for analyzing descriptive statistics, testing of assumptions for normality, reliability and PLS for structural modelling. The findings will be reported as recommended by Hair et al., (30) for PLS modeling, including (a)-indicator reliability (b)-internal consistency reliability (c)-convergent validity (d)-discriminant validity (e)-r2 (f)-effect size or f2 (g)-path coefficient estimates (h)-predictive relevance Q2.
Conclusion

NCDs are often compared to an epidemic in Malaysia, which raises the healthcare load, impedes resource allocation, and results in losses in productivity due to impairment, premature deaths, and disabilities (MOHM 2010). Integrating positive behavioral changes in attitude and intention toward a healthy lifestyle via using IoT-Based healthcare may have a significant impact on the reduction of NCD's health risk. Analyzing the relational consequences of the constructs in the framework adopted in this study will ultimately provide a complete picture of the actual intention to use IoT-Technology among elderly NDC-patients in Malaysia for their health monitoring and, in turn, adopt a healthy lifestyle. The findings of this study are expected to provide useful information to regulators, policy makers, healthcare institutions, and IT organizations to collaborate on creating meaningful campaigns broadcasting the actual benefits of IoT-Based healthcare, with the goal of changing elderly patients' attitudes and intentions to use by increasing their confidence. This study will assist the elderly population and healthcare practitioners in recognizing the importance of IoT-Based healthcare in enhancing the overall health-service status for the country in the long run.

Data

Secondary data from MOH, WHO, MyHDW, Primary data from the NCD patients in selected states of Malaysia.

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