

Exploring the Significance of IoT-Enabled Health Monitoring and Assistive Systems for Elderly NCD Patients in Malaysia

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ABSTRACT

Apparently, it might show that for elderly people staying at their own house can be the main secured center for them in order to reduce health hazards. In this regard, the improvement of connected devices has had a remarkable effect upon the entire healthcare sector and has been noticeably appreciated in remote clinical monitoring, chronic disease management, preventive care, and assisted living. This study intends to explore the significance of IoT particularly wearable technology and digital healthcare for senior patients of non-communicable diseases (NCD). The study also discusses several benefits of IoT like reducing cost, raising quality for the healthcare service providers in Malaysia including a higher level of success, productivity, and precision of health monitoring and treatment systems. Based on effective knowledge management as the key strategy in this regard, the insights of this study will help the elderly community and healthcare providers to recognise the use of IoT Enabled Health Monitoring and Assistive Systems and their significant contribution to improving healthcare for the country in the long run.

Keywords: IoT, Healthcare, NCD, Elderly patients, Malaysia

I INTRODUCTION

According to an estimate of the World Health Organisation (WHO), non-communicable diseases (NCDs) were accountable for 41 million deaths. This is equivalent to 71% of global deaths in the year 2016. Moreover, the WHO report in 2018 depicted that, from every four reported deaths in Malaysia, three were due to NCDs (WHO, 2018). Hence, the Ministry of Health Malaysia has designated the prevention and control of NCDs as a high priority, which is evidenced in the country's National Strategic Plan for NCD 2016–2025 and its complementary national strategies to control risk factors associated with NCDs.

The number of people aged 60 years and above has tripled in the past 50 years worldwide. It is estimated that this number will be more than triple in the coming 50 years (Nations, 2015). Malaysia's total

population reached 28.3 million based on the Malaysian Census 2010. Among them, the proportion of people aged 60 years or above was 7.9%, compared to only 3.9% in 2000. This accession shows a large-scale “transition of Malaysia towards an ageing population worth particular attention” (Department of Statistics Malaysia, 2010). The number of elderly Malaysian patients who require unique care and support by the year 2020 and beyond has a clear discrepancy with the number of healthcare staff and physicians with suitable training to give such care presage. Therefore, “developments in public health and nutrition, along with advancements in medicine have subsidised longer life-expectancy in this country” (Poi et al, 2004).

It may be viewed that for elders to remain at their own house is the secure location for them to reduce health risks. However, as people age, it yields a couple of physiological changes. It does not only have an impact on our ‘physical outlook’ but also creates some worsening conditions for their health as well. The more people grow old the more delicate the body becomes. This leads the body to, “experience health disorders such as eyesight problems, hearing problems, body joint problems, memory losses, and so on” (Balamurugan et al., 2012, p.274). People can help the affected by alleviating the symptoms and avoid getting more worsening of the ongoing conditions. Hence the proper way is to continuously check their health condition and take rapid action if an urgent illness draws the attention.

The main idea of this study is to explore the significance to monitor the ‘elderly health condition’ through the advancement of the Internet-of-Things (IoT) applications for NCD patients. The use of IoT systems will help to create a bridge between community medical practitioners and their NCD patients in Malaysia, who can transfer their real-time health data more recurrently and effectively this way.

The term Health Information Technology (HIT) particularly in the healthcare industries is getting popular among the people and community. HIT associates with the current main information technology that facilitates health information

exchanges, thus ensuring the safety of information among the patients, healthcare staff, and healthcare service givers across the ‘computerised system’. According to a report of MarketResearch.com (2015), it is estimated that “by 2020, the amount of USD 117 billion will be contributed by the IoT enabled development in the healthcare sector” (n.p.).

II LITERATURE REVIEW

By 2030, Malaysia is estimated to appear as an ageing nation with elderly people covering more than 15% of the population (Hu, Fahmi, Yuhao, Kiong & Harun, 2018). The medical issues of elderly NCD patients are usually seen as not exciting and not reversible. Hence, this issue requires to be campaigned as exciting, challenging and curable for developing better health of the society and community. NCD comprises mainly cardiovascular disease (CVD), cancer and diabetes. In Malaysia, the largest proportion of the burden of CVD occurs between the ages of 50 and 80 years. This age group accounts for 67.4% of the CVD burden for the country (Ministry of Health Malaysia, 2018). Moreover, a remarkable proportion of the burden also from diabetes happens between the ages of 50 and 69 years, which accounts for 42.8% of the attributable costs (Table 1).

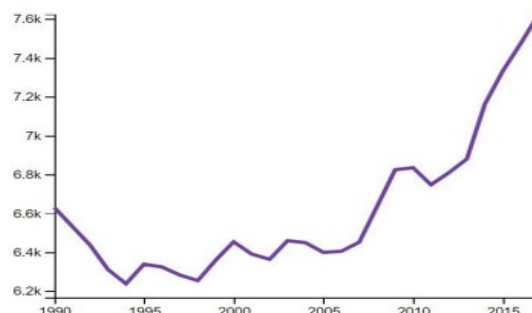
Table 1. Malaysia’s Disability Adjusted Life Year (DALY) and their Cost Burden by Age and Gender (Ministry of Health Malaysia, 2018)

Age group(years)	Males	Females	Total (%)
DALYs			
50-59	26 843	26 985	22.58
60-69	23 032	25 241	20.25
70-79	12 480	14 595	11.36
>=80	4 657	6 230	4.57
DALY cost burden (RM)			
50-59	1 149 780 038	1 155 886 323	22.58
60-69	986 536 875	1 081 174 224	20.25
70-79	534 564 233	625 159 215	11.36
>=80	199 466 436	266 863 051	4.57

*RM - Malaysian ringgit

Between 1990 and 2017, the risk of NCDs became progressively common in Malaysia (Figure 1). The chart on the right depicts the sum of years of healthy life lost while the other is the death rate for every 100,000 people.

DALYs (Disability-Adjusted Life Years), rate per 100k



Deaths, rate per 100k

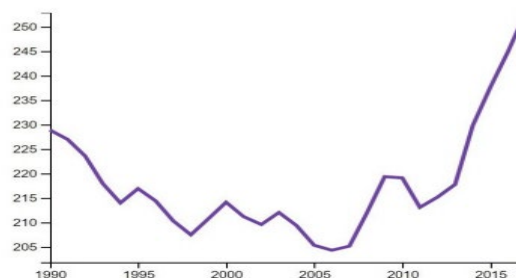


Figure 1: Malaysia Non-Communicable Diseases Risk Profile. (GHDx, 2020)

As NCD is considered under preventable conditions, it is crucial for countries to establish the risks and predictors of these types of diseases. Risks associated with NCDs can be eradicated efficiently by developing several habits. For example, reducing unhealthy diet, increasing physical activity, reducing tobacco or alcohol abuse.

If these risks are eradicated to nearly 75% of global heart disease, stroke and type 2 diabetes along with 40% of cancer could be prevented (WHO, 2019). To complement this agenda, further research on health trends of older people is advisable to evaluate different indicators of health, such as demands for care, chronic diseases and disability (Parker & Thorslund, 2007).

Technology Supports the Delivery of Integrated Care:

The improvement of ‘connected devices’ has had a remarkable effect on the whole healthcare sector. Moreover, it has been remarkably appreciated in, for instance, “remote clinical monitoring, chronic disease management, preventive care, and assisted living for elderly people” (Dimitrov, 2016). Therefore, reports show that “the total value of the IoT health care devices such as wearables like smartwatches market is expected to reach \$40 billion in 2018”.

It is also crucial to dedicate more efforts to utilise advanced technologies like IoT in elderly care. A wide range of solutions is available to fulfil the needs of the elderly and to mitigate health hazards. Figure 2 illustrates some of these current solutions and services to align with this intention in the form of small, medium, and large projects that have also been launched to effectively handle the elderly people's needs including that of NCDs.

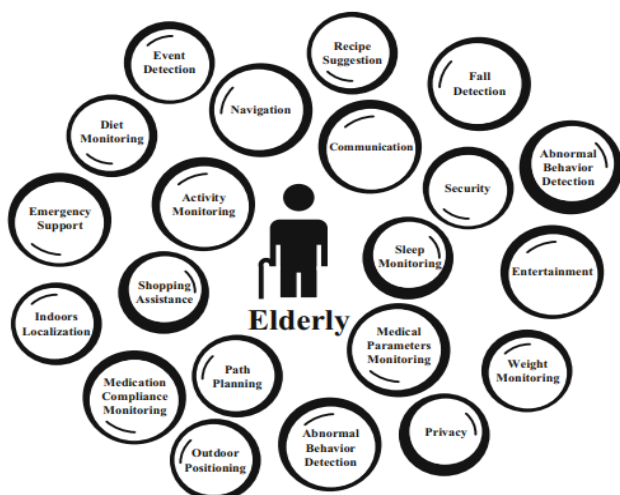


Figure 2 Various Applications and Services suggested for Remote Elderly Monitoring (Azimi, Rahmani, Liljeberg & Tenhunen, 2017).

Smart Continuous Glucose Monitors (CGMs) like EVERSENSE (Figure 3) and FREESTYLE LIBRE send data on blood glucose levels to a corresponding app on Android devices or iPhone and Apple watches, and allow for remote monitoring by caregivers such as the relatives of elderly patients.



Figure 3: Eversense Diabetes (Econsultancy, 2020)

A similar example can be in the smart insulin pen that helps diabetes patients by interacting with a smartphone app, storing long-term data, and calculating their insulin dose. The variety of the sensors can be associated with the nature of the stimuli that they respond to. For example, there are few big physiological symptoms like a heartbeat,

blood pressure, or body movements that are associated with elderly healthcare as well. Moreover, this sensor can be also placed on the body, for instance, as “clothing, subcutaneous implant, wearable devices such as smartwatch and glasses” (Deloitte, 2018a).

Knowledge Management in IoT Enabled Healthcare:

It is obvious that IoT is a connected system that depends on an autonomous communication of multiple and diverse physical objects, “representing an Internet-based information architecture and facilitating the exchange of knowledge, services and goods” (Dijkman, Sprenkels, Peeters & Janssen, 2015). It necessitates a clear understanding of the significance of knowledge management for the healthcare providers in Malaysia as well.

Knowledge management (KM) is generally defined as, “the process of capturing, developing, sharing, and effectively using knowledge. Knowledge management efforts typically focus on strategic objectives such as improved performance, competitive advantage, innovation, the sharing of lessons learned, integration, and continuous improvement.” (Girard & Girard, 2015). The growing emphasis on the significance of knowledge as a competitive advantage has led to the adoption of KM in healthcare organisations (Omotayo, 2015) for treating the elderly NCD patients as well. KM has been considered as an innovative management tool to facilitate healthcare organisations to efficiently handle their internal and external knowledge (Omotayo, 2015) which is essential to fruitfully utilise the IoT for elderly NCD patients care. KM helps healthcare organisations to transform large amounts of medical data (Dwivedi, Bali, James & Naguib, 2001) extracted from IoT devices related to elderly NCD patients and to promote sharing of knowledge among healthcare professionals. The concept of KM permits healthcare experts in hospitals to use global methodologies that include intellectual capital and IT software to meet medical needs (Itsquiz, 2016).

Usually, well-organised knowledge helps to make more informed decisions and alleviate the flow of data extracted based on IoT devices that doctors have every day regarding the elderly NCD patients. The implications of IoT and KM efforts simultaneously can enhance the real-time medical data that ultimately promote collaboration between different healthcare institutions and facilitate better decision making to treat elderly NCD patients with high-quality record management. Nowadays, “electronic medical record systems help to improve the

knowledge by codifying and delivering medical practices and experience into healthcare decision support systems” and making strategic decisions through data mining techniques (Itsquiz, 2016).

Nevertheless, healthcare providers are heavily dependent on access to knowledge in order to solve problems along with making optimal decisions regarding elderly NCD patients as well. It is becoming crucial for healthcare providers in the current rising complex environment to efficiently handle knowledge for giving the best possible innovative healthcare services (Haughom, 2014). An effective strategy for knowledge management in healthcare can help to maximise the benefits of the implementation of IoT to mitigate the risks associated with elderly NCD patients in a timely manner. In today’s world, “the healthcare industry is poised to be driven by the high innovative connected health technologies which consist of IoT, applications, services and solutions” (PR Newswire (2016).

The main purpose of digital health is to mainly lessen the expenditures and remarkably develop the medical services, and eventually to make the ‘IoT enabled healthcare applications’ more “realistic and viable” (Wood, 2016). The IoT empowered care related to health is being delineated with the help of mainly two improvements: firstly, the ‘wearable technology’ and secondly, ‘digital healthcare’. Wood (2016) highlighted that, “by leveraging the wearable devices in IoT, it delivers a range of health products and services from telemedicine to self-diagnosis and monitoring which results in reducing cost and becomes a major influence of driving the insurance company for IoT adoption”. Ma et al (2015) emphasized that, “the IoT enabled healthcare should deliver the core values that not only to benefit patients but also drive the entire healthcare industry to form an organism of health services”.

Figure 4 shows the conceptual IoT enabled healthcare. Based on this figure, the connected objects (“Things”) apply logic to sense the information, then gather the health data (“Data”) of elderly NCD patients (“People”), and afterwards, transmit it to private/public cloud. Lastly, the data gathered are synthesised (“Process”) to generate meaningful health information (“Data”). Meaningful information related to the health is then presented (“Process”) to medical staff (“People”) in either report format or checking GUI.

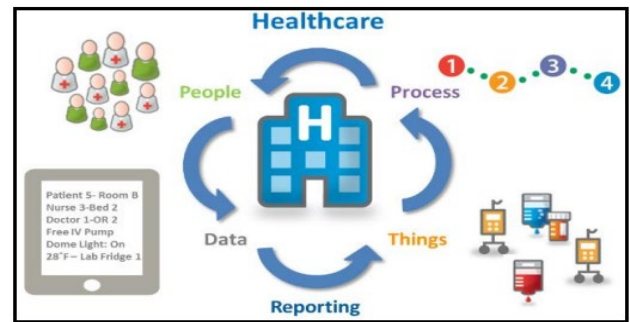


Figure 4: The Idea related to IoT Enabled Healthcare (Hossain & Muhammad, 2016)

III SIGNIFICANCE OF IOT IMPLICATIONS FOR ELDERLY HEALTHCARE

Healthcare/Medical sector make use of evolving IoT. As these have the prospect for getting close to most people especially to the elderly NCD patients group. The crucial effect is on health checking when the symptoms are mainly silent. In such circumstances, quick diagnosis may help prevention procedures and also reduce the chances of chronic illnesses or mortality. In short, bigger IoT integration seems “desirable, particularly because the global health system is clearly moving toward health care at home” (Islam et al., 2014). Table 2 depicts the significance of various use of IoT particularly for various groups associated with healthcare.

Table 2. IoT for various Users (Extracted from Karjagi & Jindal, 2020)

Stakeholders	IoT Devices	Healthcare Benefits of IoT
IoT for elderly NCD Patients	Fitness bands and other connected wireless devices like BP and heart rate monitoring cuffs, glucometer, etc.	- Personalised attention. - Constant tracking of health conditions. - Alert mechanism sends signals to family members and concerned health providers.
IoT for Physicians	Wearables and other home monitoring equipment embedded with IoT	- Keeping track of patients’ health, plan treatment, to facilitate medical attention. - The IoT data help to identify the best treatment process for elderly NCD patients.
IoT for Hospitals	IoT-enabled sensors, hygiene	- Tracking real-time location of medical

	monitoring devices	equipment like nebulisers, oxygen pumps, etc. -Deployment of the medical staff at different locations. -Preventing patients from getting infected.
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Dimitrov (2016) reports that by 2020, “20% of the IoT market will be on the Internet of medical things (IoMT) and that another 20% will be directly or indirectly related to health, well-being, and Ambient Assisted Living (AAL). Thus, the health sector would have 40% of the market”. The new IoMT sector is growing at a rapid pace and is estimated to reach US\$158 billion by 2022 from US\$41 billion in 2017 (Deloitte, 2018b). The recent COVID-19 crisis will further intensify the process of a hyper growth of this sector.

The progress of IoT enabled medical devices and equipment, and treatments in the medical sector will ultimately help to reduce cost and bring large profits for health service providers. Moreover, “IoT will also help to develop effectiveness, efficiency, and accuracy of health monitoring and treatment systems” (Islam et al., 2014). Hence, IoT can benefit the patients particularly “the elderly NCD patients to experience the affordable high quality of health care, monitoring and treatment services” (Islam et al., 2015).

IoT has created a prospect for generating fully ‘computerised systems’ that are likely to lessen human intervention into the physical world and practical life. This is especially required to drastically develop the quality, productivity, precision and cost in the industries and ultimately create merits to people particularly the elderly NCD patient community.

IV CONCLUSION

No matter it is health, manufacture, or business, a well-organised knowledge system can help to make well-thought-out and more informed decisions in all sectors and alleviate the transmission of data for regular needs. Undoubtedly, the application of IoT along with KM efforts possess immense prospects for treating elderly NCD patients and Malaysia is also no exception to this. The insights of this study will help the elderly community and healthcare providers to recognise the significance of IoT Enabled Health

Monitoring and Assistive Systems due to their significant contribution to improving healthcare for the country in the long run.

Like any other country, Malaysia too encounters a growing number of elderly NCD people. Hence, there is a necessity to understand the benefits and applications of IoT based healthcare system while recognising sociocultural and other factors that will navigate future health management and social care in NCD cases like the high occurrence of hypertension and diabetes and decreasing birth rates. Data-driven healthcare by integrating the use of IoT and advanced knowledge management system to access just-in-time solutions for elderly NCD patients is considered a timely endeavour. It can help healthcare professionals with an inter-departmental exchange of clinical information and suggestions to figure out diagnosis on time and set appropriate treatment for the elderly patients in Malaysia.

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