ENHANCED USABILITY FRAMEWORK WITH NEED-BASED AND PUSH-BASED FACTORS FOR MALAYSIA ELDERLY'S MOBILE HEALTH APPLICATION

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LIM KAH HAO

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LIST OF ABBREVIATIONS

ABR	Adoption of an Abort Operation
ANOVA	Analysis of Variance
CI	Facilitaning Conditions
ECM	Expectation Confirmation Model
EE	Effort Expectancy
EHR	Electronic Health Records
E-Learning	Electronic Learning
ERP	Enterprise Resource Planning
ESI	E-learning System Interactivity
FAQs	Frequence Ask Questions
IA	Instructional Assesment
ICTs	Information and Communication Technologies
iOS	iPhone Operating System
IQ	Information Quality
IS	Information System
ISO	International Organization for Standardization
LMS	Learning Management System
MCO	Movement Control Order
M-Commerce	Mobile Commerce
MOLD-US	mHealth for Older Users
MRA	Multiple regression analysis
MUG	Microsoft's Usability Guidelines
NBD	Needs-Based Design
PE	Performance Expectancy
PLS-SEM	Partial Least Squares Structural Equation Modeling
SAAS	Software As A Service
SEQ	Single Ease Question
SI	Social Influence
SL	System Learnabilitu
SN	System Navigation
SPSS	Statistical Package for Social Sciences

SUS	System Usability Scale
TAM	Technology Acceptance Model
UI	User Interface
UTAUT	Unified Theory of Acceptance and Use of Technology
VD	Visual Design

LIST OF APPENDICES

MEMPERTINGKAT RANGKA KERJA KEBOLEHGUNAAN DENGAN FAKTOR BERASASKAN KEPERLUAN DAN BERASASKAN TOLAK UNTUK APLIKASI MUDAH ALIH KESIHATAN WARGA EMAS MALAYSIA

ABSTRAK

Perkhidmatan kesihatan digital semakin mendapat permintaan tinggi di Malaysia, namun penggunaan aplikasi mudah alih kesihatan (mHealth) dalam kalangan warga emas masih rendah. Cabaran dari segi kebolehgunaan menjadi penghalang utama, namun kajian yang memfokuskan kepada reka bentuk aplikasi kesihatan khusus untuk warga emas masih terhad. Tesis ini mengkaji model-model kebolehgunaan sedia ada dan mencadangkan satu rangka kerja kebolehgunaan yang dipertingkatkan dengan tujuh faktor utama: mesra pengguna, kecekapan, kebolehbelajaran, bantuan dan dokumentasi, kemudahan mengingat, berasaskan keperluan, dan berasaskan dorongan (*push-based*). Satu prototaip aplikasi mudah alih telah dibangunkan bagi membuktikan konsep rangka kerja ini, dan satu kajian kebolehgunaan dijalankan melibatkan 151 peserta warga emas di Malaysia. Peserta berinteraksi dengan prototaip dan menjawab soal selidik untuk menilai kebolehgunaan serta tahap penerimaan mereka. Analisis statistik menunjukkan kebolehpercayaan yang tinggi terhadap faktor-faktor yang dicadangkan, dengan pekali korelasi Pearson antara 0.766 hingga 0.930 merentas tiga kategori responden. Analisis regresi berganda (MRA) menunjukkan nilai R-kuasa-dua yang tinggi (0.874–0.896), mengesahkan bahawa faktor kecekapan, berasaskan keperluan, dan berasaskan dorongan mempunyai pengaruh kuat terhadap penerimaan aplikasi mHealth oleh warga emas. Hasil kajian ini menyokong pembentukan rangka kerja reka bentuk kebolehgunaan yang dipertingkatkan untuk aplikasi kesihatan yang memfokuskan kepada warga

emas. Rangka kerja yang dicadangkan ini boleh digunakan dalam pembangunan aplikasi kesihatan masa hadapan dan wajar diuji lanjut bagi menilai kesan jangka panjang terhadap tahap penerimaan dan kepuasan pengguna.

ENHANCED USABILITY FRAMEWORK WITH NEED-BASED AND PUSH-BASED FACTORS FOR MALAYSIA ELDERLY'S MOBILE HEALTH APPLICATION

ABSTRACT

Digital health services are increasingly in demand in Malaysia, but the adoption of mobile health (mHealth) applications among the elderly remains low. Usability challenges are a key barrier, yet limited research has focused on designing health service apps specifically for elderly users. This thesis reviews existing usability models and proposes an enhanced usability framework that includes seven key factors: user-friendliness, efficiency, learnability, help and documentation, memorability, need-based, and push-based. A mobile app prototype was developed to demonstrate this framework, and a usability study was conducted with 151 elderly participants in Malaysia. Participants interacted with the prototype and completed a questionnaire to assess its usability and their acceptance. Statistical analysis showed strong reliability of the proposed factors, with Pearson correlation coefficients ranging from 0.766 to 0.930 across three respondent categories. Multiple regression analysis (MRA) produced high R-squared values (0.874–0.896), confirming that efficiency, need-based, and push-based factors have a strong influence on acceptance. These results support the development of an enhanced usability design framework for elderly-focused mHealth applications. The proposed framework can guide future health app development and should be further tested to evaluate its long-term impact on user acceptance and satisfaction.

CHAPTER 1

INTRODUCTION

1.1 Introduction to Malaysia's Digital Healthcare and Elderly Population

In recent years, the rapid advancement of technology has revolutionised various aspects of human life, including healthcare. Therefore, smartphones and mobile applications have become the common communication tools or channels for everybody. The word ‘smartphone’ was introduced on the launch of the Apple iPhone in 2007 (Tan, 2017). Nowadays, mobile retail shops highly promote and sell touchscreen-based smartphones to their customers. However, mobile retail shops seldom display keypad-enabled phones at the storefront unless their customers have special requirements. As a result, older adults are left with few choices when purchasing smartphones over keypad-enabled phones. This growing reliance on smartphones, which often feature complex interfaces, presents a unique challenge for the rapidly expanding elderly population.

Figure 1.1 shows that as of January 2024, around 10 million people were using digital health treatment and care in Malaysia, which has increased by around 3% compared with the year 2023. In terms of market value, as Figure 1.1 shows, there is a 10% increase compared to 2023, which is around 18 million. Figure 1.2 shows the overview of online doctor consultation in the year 2024, as the figure shows that the number of users that use online doctor consultation has increased by around 2.6%. The market value has increased by around 13.6%, around 14 million. Based on the overview of digital health treatment and care in Malaysia, it can be concluded that there is a potential market for digital health treatment and care in Malaysia, especially for the increasing ageing population in Malaysia.

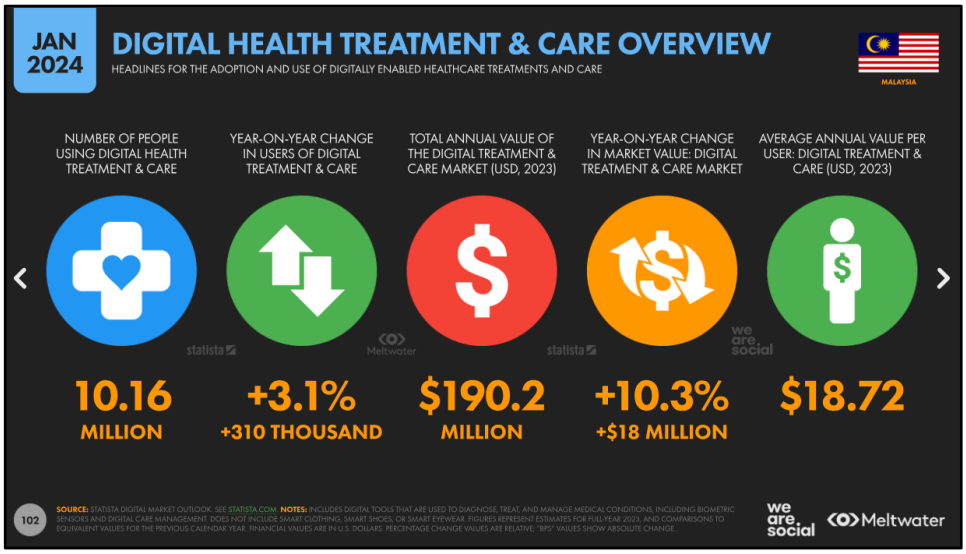

Figure 1.1 Overview of digital health treatment and care (Kemp, 2024)

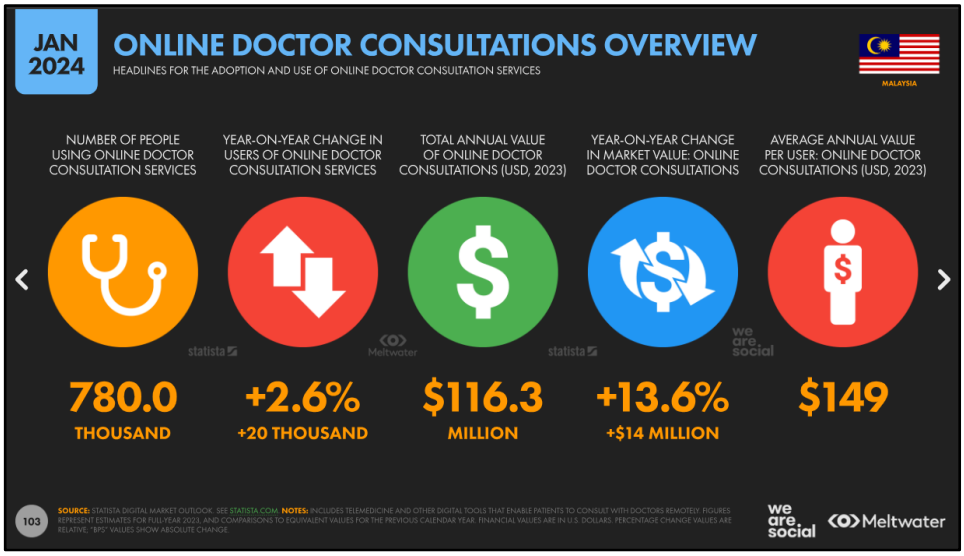

Figure 1.2 Overview of online doctor consultation (Kemp, 2024)

The emergence of digital health, defined as the integration of digital technologies into healthcare services to improve health, enhance healthcare delivery, and promote wellness (World Health Organization, 2020), has the potential to reshape

the healthcare landscape in Malaysia. This broad field encompasses a wide array of tolls and services, ranging from mobile health (mHealth) application and wearable devices to electronic health records and telemedicine. Crucially, the Malaysian population is ageing rapidly, posing significant demographic shifts and increasing demands on the healthcare system (Department of Statistics Malaysia, 2024). The government and healthcare authorities need to stem the possible burdens of disease severity and disabilities by applying efficient evidence-based knowledge to those who need it the most. As people age, integrated care from nutrition and physical activity is crucial on top of the currently available medical care in optimising and maintaining physical and mental capabilities (Seah et al., 2019). Decade for Healthy Ageing (2021-2030) highlighted that healthy ageing does not mean being free of diseases or debilitating conditions but living optimally in health and well-being (World Health Organisation, 2020). Other than nutrition and physical activity, home environment and social connectedness are also part of healthy ageing (Fang et al., 2018). To assist older adults in Malaysia in coping with ageing healthily while optimising the available resources in the country, technology adoption becomes crucial. Therefore, defining optimal platforms for older adults is critical if we are to connect older adults to healthcare services in an innovative manner (Betts et al., 2019).

The ageing population is growing worldwide: in the year 2015, around 900 million people were 60 years old and above; in the year 2017, it increased to 980 million people, and it is expected that in the year 2050, the figure will more than double (Ahmad et al., 2020). As shown in Figure 1.3, the latest update from the Malaysian population statistics showed that the percentage of the population above 65 increased from 2.2 million in 2021 to 2.6 million in 2024 (Department Of Statistics Malaysia, 2024). This demographic shift underscores the urgent need for accessible and effective

digital health solutions tailored to the needs of the elderly. To the best knowledge from research findings, no previous studies have examined and explored the factors influencing elderly users' intention to continue using digital health wearables after adoption.

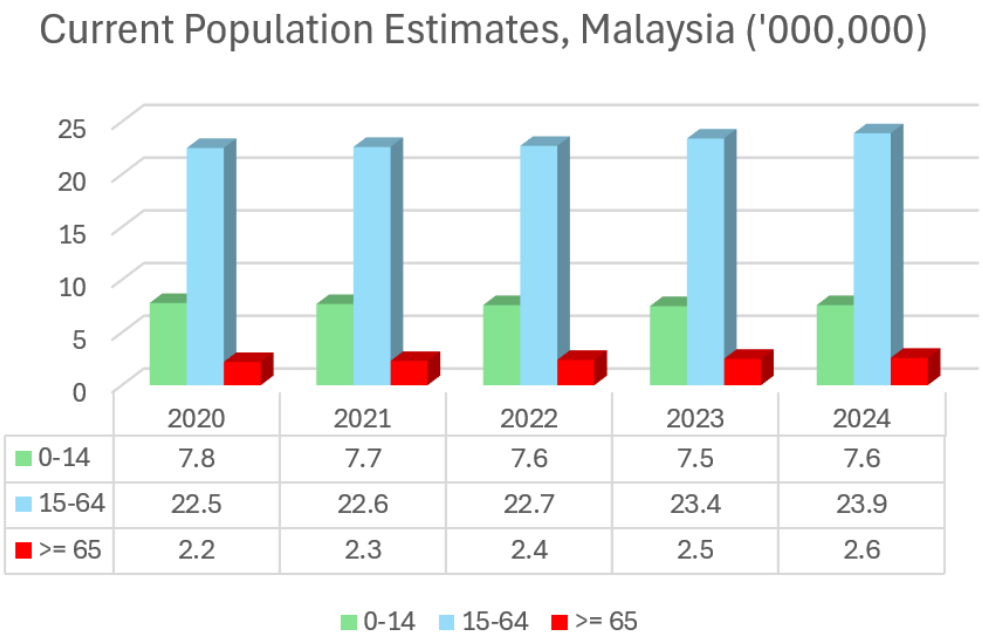

Figure 1.3 Estimation of Malaysia's population in the year 2024 (Department Of Statistics Malaysia, 2024)

To gain a deeper understanding of the digital health landscape in Malaysia, it is crucial to examine the existing digital service apps available to the citizens. These apps encompass a wide range of healthcare needs and cater to different aspects of health and wellness. Here are a few examples: DoctorOnCall, MySejahtera, GetDoc, PruBSN Navigator and Doctor2U by BP Healthcare. Specifically, online doctor consultation services as highlighted in Figure 1.2, are a prime example of telemedicine. Telemedicine refers to the remote delivery of healthcare services, including diagnosis, treatment, and consultation using telecommunications technology (Haleem et al., 2021). It is a key component of digital health that facilitates access to care, particularly

for individual who may face geographical barriers or mobility challenges, such as older adult. By studying the current digital service app landscape, the findings bring a better understanding of the extent to which digital health has penetrated the Malaysian healthcare system and the services being provided for this research. These apps represent a fraction of the digital health solutions available in Malaysia, and their presence highlights the increasing adoption of digital technologies in healthcare.

Digital service apps signify the growing trend of using technology to facilitate healthcare services, improve patient experiences, and enhance healthcare outcomes. However, it is essential to critically evaluate the benefits and limitations of these apps to ensure their effectiveness and address any potential concerns or challenges they may present. According to Tajudeen et al. (2022), senior citizens encountered various challenges when using health mobile applications, including difficulties in understanding the features and functions of the apps. This directly related to the concept of usability. Usability in the context of human-computer interaction refer to the ease with which users can learn, operate, and achieve their goals when interacting with a product or system. It encompasses factor such as learnability, efficiency, memorability, error prevention, and satisfaction. For older adults, ensuring high usability in digital health apps is paramount, as complex or unintuitive interfaces can deter adoption and continued use. The researchers mentioned that understanding and implementing senior citizens' needs as app features is another approach to increasing the adoption of mHealth apps among senior citizens.

In short, although various digital health applications are available in Malaysia, most are not user-friendly to elderly users because the mobile application does not comply with elderly usability aspects. While the potential of digital health and

telemedicine to support healthy ageing is immense, the successful implementation for older adults hinges critically on addressing specific usability challenges.

1.2 Problem Statement

As the rapidly increasing global elderly population projected to reach 2.1 billion by 2050, it presents significant challenges for healthcare system due to a rise in chronic diseases (He et al., 2025). Telemedicine and mobile health (mHealth) service offer promising solutions by transcending geographical and time limitation, enabling remote care, and potentially reducing healthcare costs (He et al., 2025). However, despite these advantages, the acceptance and widespread adoption of these digital health technologies among older adults remain critically low (He et al., 2025; Huang et al., 2025). This persistent "digital divide" highlights a fundamental misalignment between current technology design and the specific need and characteristics of the ageing demographic.

Firstly, a primary contributor to the limitation of adoption is insufficient of the unique needs, preferences, and capabilities of older users during the design process, which often results in suboptimal usability (Pan et al., 2021). Usability is widely acknowledged as a pivotal factor influencing the acceptance of mHealth applications for elderly individuals (Liu et al., 2021). While foundational usability principles, such as those articulated by Nielsen, provide a valuable starting point (Galavi et al., 2024), but it may not fully capture the complexities of modern design ecosystems or the specific challenges posed by "age barriers" (Wang et al., 2022).

Secondly, although the important of usability for mHealth adoption among the elderly is widely recognized, and numerous design guideline and evaluation frameworks exist, a critical gap still remain (Liu et al., 2021; Wang et al., 2022). Most existing frameworks fail to clearly consider or systematically integrate how "push-

based" and "need-based" interaction paradigms uniquely influence elderly users' acceptance and ongoing engagement (He et al., 2025; Huang et al., 2025). Existing usability studies are identifying issues related to interface design and persuasive features, do not adequately conceptualize how the initiation of information flow (whether by system push or user-initiated interaction) act as a fundamental usability factor for older users (Liu et al., 2021).

Overall, there is a pressing need to address these shortcomings in the current digital health app landscape. Digital health apps must be optimised to better serve and support the elderly population in managing their health effectively by conducting comprehensive evaluations based on usability frameworks, integrating features that meet the specific needs of elderly users, and incorporating push-based support functionalities.

1.3 Research Questions

- What factors have a positive significant relationship with the acceptance of mobile health application among Malaysia elderly?
- What factors should be included in the enhanced usability design framework for Malaysia elderly's mobile health application?

1.4 Research Objectives

- To determine the factors that have a positive significant relationship with the acceptance of mobile health application among Malaysia elderly.
- To enhance the usability design framework for Malaysia elderly's mobile health application.

1.5 Significant of Research

The findings of this research will be used to construct a usability design framework that can guide the development of digital health applications targeted at elderly users. The research aims to empower elderly individuals to manage their health effectively through digital platforms. This research is poised to contribute significantly to the overall well-being of elderly users by providing elderly individuals with a user-centric digital health experience that not only facilitates their engagement with healthcare services but also has the potential to foster proactive health management, ultimately leading to improved healthcare outcomes and a higher quality of life for the ageing population in Malaysia, making it more responsive to the unique needs of elderly users and contributing to the advancement of healthcare accessibility and quality.

The current generation of elderly individuals often faces a significant gap with technology. This research acts as a bridge to assist senior citizens in overcoming these challenges, enabling a more seamless adoption of technological advancements. By focusing on usability studies, this research aims to bridge the gap between the elderly and technology, ensuring they can overcome obstacles and embrace the benefits of modern advancements more effectively.

1.6 Scope of Study

The scope of this study is to investigate the usability factors to derive an enhanced usability design framework for Malaysia's elderly mobile health applications. This study conducts a literature review to derive a conceptual framework. From this framework, a prototype is created and used as a proof of concept. A pilot and full test are conducted with elderly participants in Malaysia using the prototype.

Evaluation is carried out through questionnaires and statistical analysis. The expected output includes usability design factors that incorporate new elements, namely need-based and push-based factors, to form an enhanced framework.

1.7 Research Contribution

This research explores and proposes an enhanced usability design framework for sustained use among Malaysia's elderly. This research proposes two new usability factors which are need-based and push-based to form an enhanced usability design framework for Malaysia elderly's mobile health application. It is envisioned that the enhanced usability design framework could guide the mobile application developers to develop more elderly user-friendly mobile health applications, enabling the elderly to accept and utilise the mobile application for their daily health needs.

1.8 Organization of the Thesis

The research is divided into five (5) chapters. Each chapter is devoted to discuss and explain specific element in the research. Chapter 1 encompasses introduction and background on digital health among elderly. Chapter 2 discusses about all the research and literature review that are related to this research. This chapter will also identify the possible usability factor that needed by elderly users. Chapter 3 explain methodology and research method that will be used for the research. It also explains justification on prototype design. Chapter 4 present the result of research analysis, finding and discussion. Chapter 5 discuss about conclusion, recommendation and discussion. Lastly, reference and appendix will be attached at the end of the thesis.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter reviews the background of digital healthcare services and the evolution of digital healthcare services. The adoption of technology among elderly users is discussed from the perspective of digital healthcare services in the marketplace. The literature review also covers the research theory, framework, and factors for the usability study adopted in past research. An overview of usability research for digital applications is covered in this chapter as well. The suggested factors, namely the push-based and need-based usability, are also studied and discussed in this chapter. Finally, the evaluation of digital health applications that exist in the marketplace is presented to have a better understanding of the current usability factors that are covered by the existing marketplace.

2.2 Background of Digital Health Care Service

The utilisation of information and communication technologies (ICTs) for delivering health care services and managing health information, commonly known as eHealth, telehealth, or digital health care services, has become increasingly prevalent. After the COVID-19 pandemic, humans have become more alert about their health status. The evolution of technologies in digital health care was able to help humans monitor their health easily in terms of efficiency and outcomes (Birkmeyer et al., 2021). Mobile health (mHealth) proved beneficial to senior citizens for various purposes, including providing information, supporting therapy, monitoring health, and offering mental health consultations (Abbaspur-Behbahani et al., 2022). The two types

of digital health devices that help monitor user health in the market are medical wearable devices and fitness. Fitness-based digital health wearables are utilized to track users' health status and activity levels, including metrics like calories burned, sleep quality, heart rate, and walking distance, as shown in Figure 2.1. In contrast, medical wearable devices track fitness-related data, including blood pressure, oxygen saturation levels, and glucose levels, as shown in Figure 2.2. Both types of devices help patients detect early warning signs of various conditions, such as diabetes or high blood pressure (Ahmad et al., 2020). Elderly people sometimes use those devices to monitor their mental and physical health and achieve a healthier life.

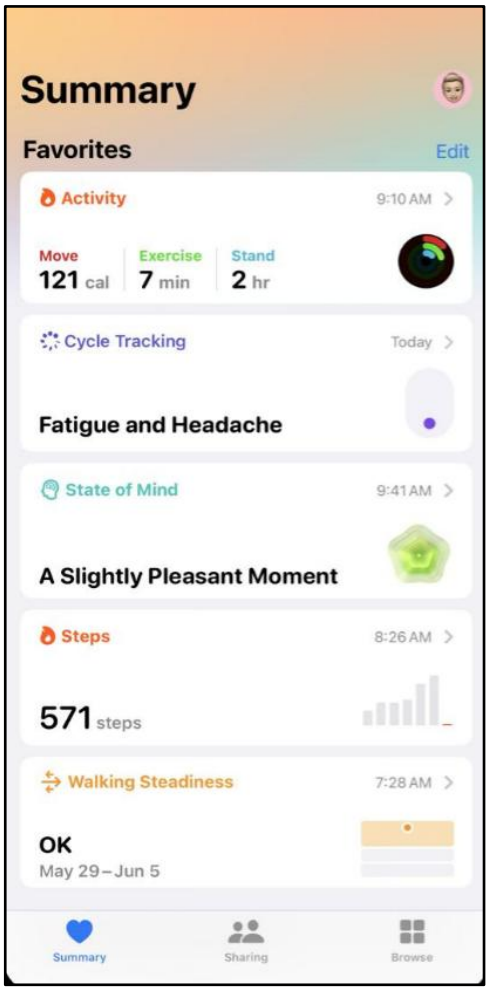

Figure 2.1 Fitness-base digital health wearable interface (Apple, 2024)

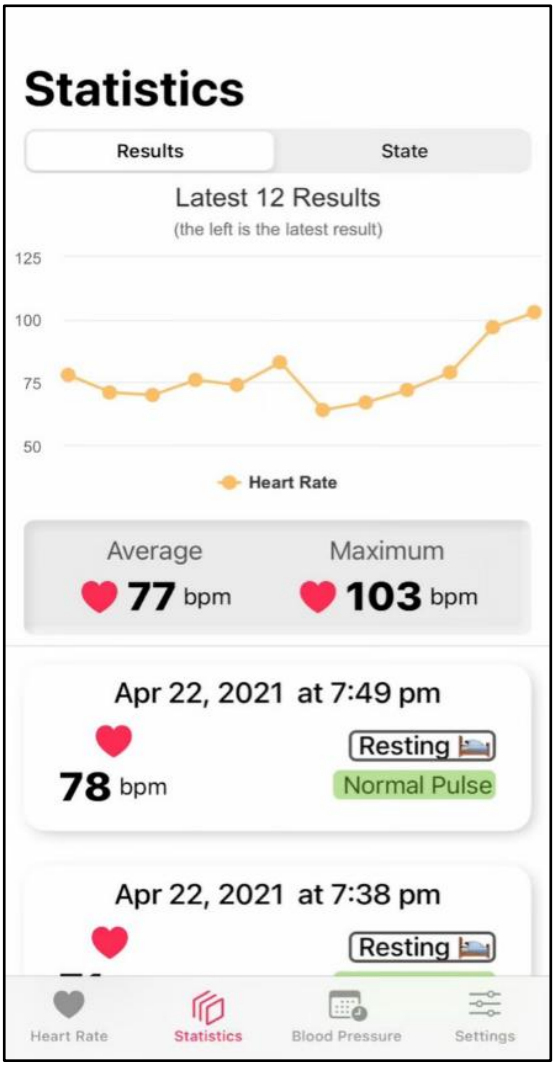

Figure 2.2 Medical wearable interface (Chung, 2021)

Electronic health records (EHR) in medical practice have significantly increased recently. The EHR system presents a valuable opportunity to increase or provide a better health life to patients. The finding by Baek et al. (2018) discovered that most clinics and hospitals use the information available or update it in the system to understand patients better and make decisions regarding their health problems. There are complementary goals of improving the health of patients and communities by primary clinical and population, but there are effective less or less partnerships

between patient and populations (Chambers et al., 2015). A flexible system is required to change healthcare goals to achieve the goals within the existing financial circumstances, which is to enhance the well-being of those individuals while keeping the cost as low as possible (Robertson et al., 2010).

Current systems for data collection and analysis frequently lack coordination and effective interconnectedness between the patient and hospital system (Peeters et al., 2016). It created challenges in analysing and interpreting patients' outcomes, especially for specific populations or communities. It leads to the issue of providing effective and preventative care management for the patient. Therefore, more sophisticated data collection methods, such as the use of mHealth applications are required to reduce the gap between the system and the actual situation of patients in low- and middle-income countries (Dornan et al., 2019).

Below are examples of digital health apps that exist and are popular in Malaysia.

1. MySejahtera: The Malaysian government launched MySejahtera, a mobile application to assist in managing the COVID-19 pandemic. The app provides health self-assessment, contact tracing, and vaccination registration features. It has been vital in promoting public health and safety during the pandemic. The target users for this mobile application are Malaysian citizens of all ages, and it is the leading mobile application used to store personal health declaration status during movement control order (MCO) time.
2. DoctorOnCall: DoctorOnCall is a telemedicine platform that allows users to consult with qualified doctors online. This app allows users to seek medical advice, obtain prescriptions, and access healthcare services from the comfort of their homes. It provides a convenient and efficient way to address non-

emergency medical issues. This mobile application's target users are Malaysian citizens of all ages looking for online consultation with accredited doctors and e-pharmacy to purchase medication safely and deliver it conveniently.

3. PruBSN Navigator: PruBSN Navigator is a digital service app offered by Prudential BSN Takaful Bhd that helps people search for PruBSN Takaful panels. Users can use this app without registration to search for the nearest hospital or available clinic. They can filter the results by using filters such as doctor names, branches, hospitals, or clinics. The target users for this mobile application are Malaysian citizens who need to search for the nearest medication provider services.
4. Doctor2U by BP Healthcare: Doctor2U is a digital healthcare platform provided by BP Healthcare, one of Malaysia's largest private healthcare providers. The app allows users to consult with doctors, book medical services appointments, and access health information. It combines telemedicine capabilities with comprehensive healthcare services to improve accessibility and convenience. The target users for this mobile application are mainly Malaysian citizens' BP healthcare group customers looking for BP healthcare services.
5. GetDoc: GetDoc is a healthcare app enabling users to search for providers, book appointments, and access medical information. The app covers various healthcare services, including general practitioners, specialists, and clinics. It aims to simplify the process of finding and accessing healthcare services for users. This mobile application's target audience is mainly Malaysian and Singaporean citizens who need to search for the nearest doctor and clinic or hospital, which allows them to call the service provider directly.

2.3 M-Health Technology Adoption among Elderly

Rapid technological advancements have significantly impacted various aspects of modern society, including how people communicate, access information, and conduct daily activities. However, one segment of the population that has often faced challenges in adopting these new technologies is the elderly. As digitalisation continues to shape the world, it becomes crucial to understand the factors influencing technology adoption among older adults.

There are several barriers to elderly user which include:

1. Physical Limitations:

   Age-related physical challenges, such as decreased vision, hearing impairments, and reduced dexterity, can hinder elderly from effectively using technology devices (Berkowsky et al., 2017).

2. Fear of Technology:

   The unfamiliarity with technology and fear of making mistakes or breaking devices can create anxiety among the elderly, deterring them from adopting new technologies (Peek et al., 2016).

3. Cognitive Decline:

   Cognitive impairments in older adults such as executive functioning, reasoning, planning, problem solving, memory loss and deficits in attention deficit, can affect their mHealth application accessibility (Leung et al., 2025; Y.-H. Wu et al., 2015).

4. Motivational and cognitive barriers:

   Motivational and cognitive barriers significantly affect how older adults engage with mHealth applications. According to Wildenbos et al. (2019), older adults often face cognitive challenges such as memory decline, decreased

attention span, and difficulties in processing complex information, which are further complicated by individual medical conditions. These cognitive limitations, combined with low motivation to explore or trust digital platforms, can severely reduce mHealth usability. However, existing usability studies often overlook these age-related characteristics due to the lack of a dedicated framework—an issue addressed by the MOLD-US framework that maps these intricacies to usability challenges.

To counteract motivational and cognitive barriers, Cheng et al. (2022) suggested incorporating digital games into mHealth platforms. Digital games can enhance motivation by providing engaging, interactive experiences, and can also serve as cognitive aids. By simulating mHealth operations step-by-step through familiar and enjoyable gameplay, users are more likely to understand and retain operational knowledge. Furthermore, game-based learning may help reduce the cognitive load typically associated with navigating icon-based interfaces that rely on color and shape recognition.

5. Knowledge gap:

Since 2020, the percentage of Malaysia older adults ages 65 and above is growing from 6.8% in 2020 to 7.7% in 2024. Analysis from the Department of Statistics Malaysia (DOSM) reported that in the year 2023, the percentage of using smartphones in Malaysia was 97.6% and using normal phones was only 16.3%. In earlier years, internet usage in older adults has increased rapidly over from 2016 to 2021, with almost two-thirds of older adults reporting internet usage in 2016. While this group is more digitally connected than ever, older adults consistently have lower technology adoption rates than the public (Li et al., 2021).

The justification of the barriers of technology adoption and its relationship to M-health adoption needs are written in Table 2.1.

Table 2.1 Barriers of technology adoption and relationship to M-health adoption

Barriers of technology adoption	Relationship to M-health adoption
Physical Limitations	The elderly may face difficulty to read the tiny text or logo displayed in the M-health application due to default small font size design. This will hinder the elderly from using the application because of low or no readability provided, and they can't use the apps by their own attempt
Fear of Technology	The elderly usually make a call or walk in with their patient card to get a medical appointment and contact the medical centre for service. When M-health provided the self-service online booking or medical service chat, the elderly lacked know-how and fear of making mistakes to use the services.

Table 2.1 Continued

Cognitive Decline	Age-related cognitive impairments, such as memory loss or slower information processing, may hinder elderly users' ability to understand and navigate the steps required to use mHealth applications. Complex menus, unclear instructions, or excessive interactive elements can overwhelm them, leading to frustration and app abandonment.
Motivational and cognitive barriers	Elderly users may lack the internal motivation or confidence to explore and engage with new technologies. When combined with limited cognitive capacity or low digital literacy, these barriers reduce their willingness to adopt mHealth solutions, even when the services are available and potentially beneficial.
Knowledge gap	Many elderly individuals are unfamiliar with the functionalities and benefits of mHealth applications. This lack of awareness or understanding creates a gap that makes it difficult for them to initiate or sustain usage. Without proper education or guidance, they may not perceive the value or relevance of the technology in managing their health.

Among the identified facilitators of the elderly's technology adoption are:

1. Social Support:

   Support from family members, friends, or caregivers who are already tech-savvy can positively influence the elderly's technology adoption (Mitzner et al., 2010).

2. User-Friendly Design:

   Intuitive and user-friendly technology devices and applications can help elderly individuals overcome the barriers of physical limitations and cognitive decline (Chen & Chan, 2014). User-friendliness and accessibility are crucial factors when interacting with technology, particularly for individuals with limited or no prior experience (Schmeier & Reithinger, 2014). Due to limited exposure, elderly individuals are less likely to become familiar with technology compared to other groups. It is believed that current software and hardware designs often overlook the specific needs and experiences of older adults (Zhang et al., 2016). To improve the user-friendly design among older adults' navigation, presentation, layout, content and operation a strategy is proposed with avoiding complex and lengthy text, presenting information in the form of texts, picture and videos, and using age-appropriate and common languages are recommended (Leung et al., 2025).

3. Purposeful Applications:

   Technologies that address the specific needs of older adults, such as health monitoring apps or communication platforms, can motivate them to adopt and use technology (Zhou & Salvendy, 2016).

This research focuses on the technology adoption of cognitive decline, motivational and cognitive barriers, and user-friendly design to design the mobile application for elderly users.

2.4 Research Theory and Framework for Usability Study

2.4.1 Theoretical Framework

a) Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), proposed by (Davis, 1989b), has become a foundational framework for understanding user acceptance of technology, and it is a widely used theoretical framework in the field of information systems and technology research, which aims to determine the acceptance, adoption, and utilisation of information technology. It does not measure success but investigates and predicts users' intention to use technology. The model is based on the idea that perceived usefulness and perceived ease of use are the key determinants influencing users' attitudes and intentions toward using a particular technology.

Figure 2.3 illustrates the core components of the TAM model, including perceived usefulness (PU), which is the extent to which a person believes that using a specific system would enhance their job performance or productivity, and perceived ease of use (PEOU), which is the extent to which a person believes that using a particular system would be free of effort.

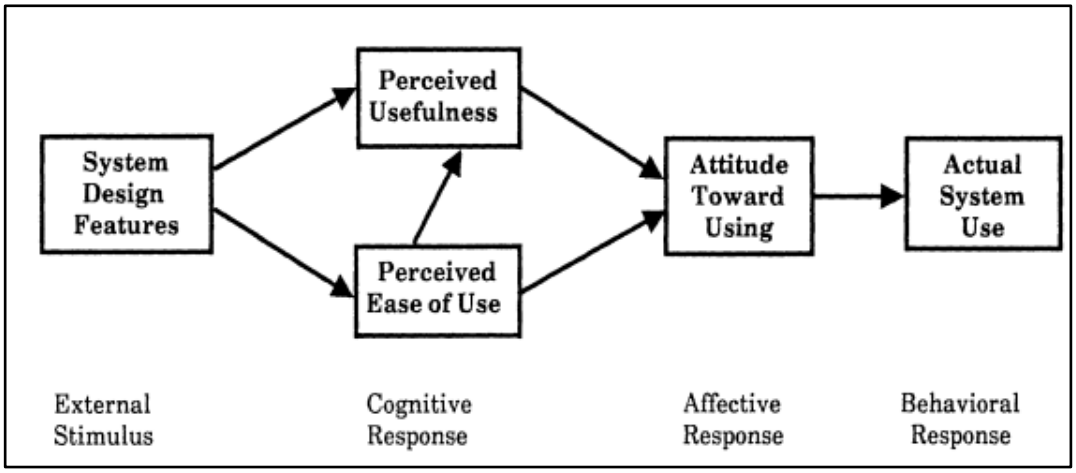

Figure 2.3 Technology acceptance model (TAM) (Davis, 1987)

According to TAM, the two factors of PU and PEOU directly influence an individual's attitude toward using a technology, which, in turn, influences their intention to use it. Additionally, some external variables, such as social influence and facilitating conditions, may also impact technology acceptance. One of the current studies that adopted the TAM model is Hidayah et al. (2020), which studied AIS mobile user acceptance by using the Technology Acceptance Model (TAM) and DeLone & McLean Information System (D&M IS). Suhartanto et al. (2019) studied mobile banking adoption in Islamic banks using the technology adoption model (TAM) and the Religiosity-Behavioral Intention Model. To (2021) study the behavioural intention to use mobile wallets (e-wallets) in Vietnam by using the TAM model to extend two other factors (trust and perceived enjoyment) as a theoretical foundation in the studies.

b) Unified Theory of Acceptance and Use of Technology (UTAUT) Model

The Unified Theory of Acceptance and Use of Technology (UTAUT) builds upon and consolidates various technology acceptance models. Developed by Venkatesh et al. (2003), UTAUT seeks to provide a comprehensive understanding of

the factors influencing the acceptance and usage of information technology. The model incorporates elements from the Technology Acceptance Model (TAM), Theory of Reasoned Action (TRA), and other related models. As shown in Figure 2.4, the key constructs in the UTAUT model are 1) performance expectancy (PE), which an individual believes that using a particular system will help them perform their tasks more efficiently; 2) effort expectancy (EE), which perceived ease associated with the use of technology; 3) social influence (SI) as the impact of social factors and the influence of others on an individual's decision to use technology, and 4) facilitating conditions (CI) the perceived support and resources available for using technology. UTAUT also includes moderating factors such as gender, age, experience, and voluntariness of use, which can influence the relationships between the core constructs and technology acceptance.

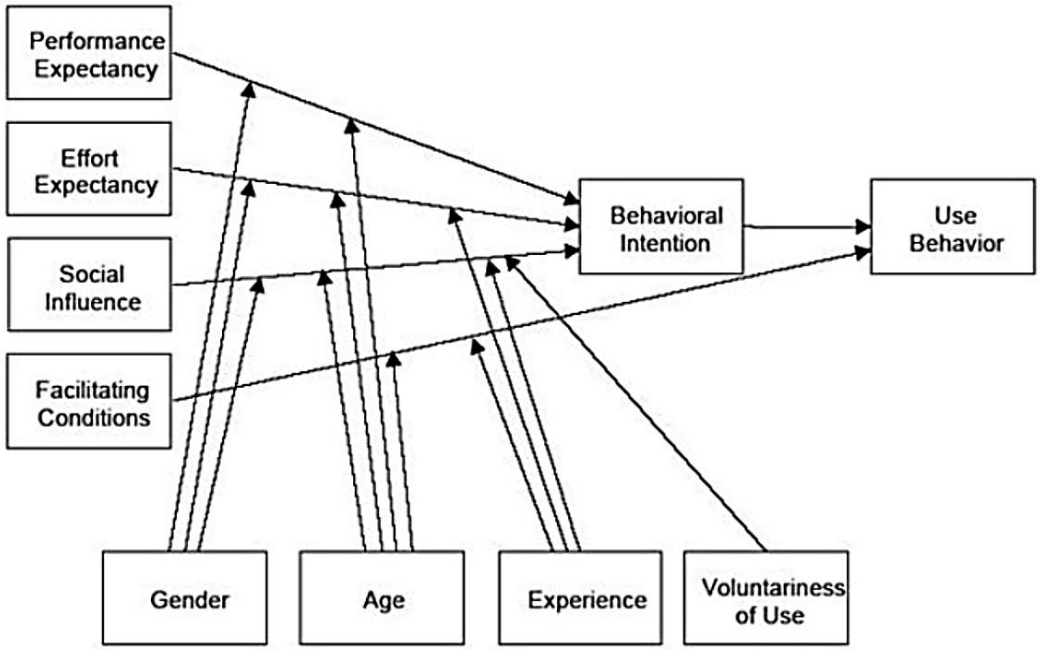

Figure 2.4 UTAUT model (Suki & Suki, 2018)

As described in Venkatesh et al. (2003), performance expectancy revolves around an individual's belief that utilising a system will improve their job performance when undertaking various tasks. Numerous studies have consistently highlighted the significance of performance expectancy as a crucial determinant of Behavioural Intention (BI) to use a learning management system (LMS) (Alshehri et al. (2019a); Bellaaj et al. (2015); Bouznif (2017); Salloum & Shaalan (2019); Echeng et al. (2013)). The underlying presumption is that as learners perceive the LMS as promisingly helpful, the likelihood of their continued or future use of the system increases (Halawi & McCarthy, 2008). A system or app may not be utilised without a positive performance expectancy, even if the system is satisfying, user-friendly, and easy to learn. Correspondingly, within the context of Saudi higher education, studies by (Alshehri et al., 2019a) and (Bellaaj et al., 2015) found that performance expectancy has a significant positive impact on students' intentions to use a Learning Management System (LMS). Consequently, these findings indicate that students' perceived usefulness predominantly drives their acceptance of the e-learning system.

Effort expectancy (EE) is characterised by the level of ease associated with the utilisation of the system, and the acceptance of an application by users is influenced by their perception of the ease of use (Venkatesh et al., 2003). Meta-analyses, exemplified by the work of Khechine et al. (2016), studies have shown that effort expectancy has a significant impact on the behavioural intention to use a Learning Management System (LMS). While numerous sources, including studies by Alrawashdeh (2012), Bellaaj et al. (2015), and Echeng et al. (2013) have reported a substantial correlation between effort expectancy and the behavioural intention to use learning technologies, this assertion is not consistent across all studies. However, the findings from (Alshehri et al., 2019a), (Attuquayefio & Addo, 2014), (Jong & Wang,

2009) , (Park, 2009), (Salloum & Shaalan, 2019) and (Šumak et al., 2010) did not find the same level of association. To comprehensively evaluate the relationship and validate its applicability in the Saudi e-learning context, Alshehri et al. (2020) proposed that effort expectancy contributes to enhanced performance and a greater willingness to use. Specifically, Alshehri et al. (2020) posit that effort expectancy has a positive effect on both performance expectancy and the behavioural intention to use a Learning Management System (LMS). This assertion finds support in various empirical investigations, as demonstrated by studies such as (Ameen et al., 2019) and (Moreno et al., 2017). When students perceive the Learning Management System (LMS) as requiring minimal effort, they believe in its utility, which motivates them to utilise the system.

Social influence (SI) pertains to how significant individuals, such as friends, colleagues, and family members, impact an individual's intention to use the system (Venkatesh & Davis, 2000). According to Alshehri et al. (2020), the influences of university lecturers, officials, and peers played a key role in motivating students to use the Learning Management System (LMS). Students tend to conform to the opinion of others and adopt the system when students in the educational environment think they should adopt the system (Eckhardt et al., 2009). This construct has been acknowledged as pivotal in technology adoption, given that the influence of peers, change agents, organisational pressure, and societal norms is unavoidable (Venkatesh et al., 2003). In the realm of e-learning technologies, a noteworthy positive correlation has been identified between Social Influence (SI) and the behavioural intention to engage in a specific behaviour using Learning Management System (LMS) (Chu & Chen (2016); Khechine et al. (2014); North-Samardzic & Jiang (2015); Salloum & Shaalan (2019); Šumak et al. (2010); Williams et al. (2015)). Recent studies from (Alshehri et al.,