

**EFFECTS OF USER EXPERIENCE (UX) ON
FITNESS BAND USAGE AND HEALTHY
LIFESTYLE**

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FITNESS BANDS USAGE AND HEALTHY
LIFESTYLE**

by

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LIST OF ABBREVIATIONS

A	Attitude
BI	Behavioural Intention
CB-SEM	Covariance-Based
CHESS	Comprehensive Health Enhancement Support
CFA	Confirmation Factor Analysis
CMB	Common Method Bias
COTS	Commercial-Off-The-Shelf
CSE	Computer Self-Efficacy
DOI	Diffusion of Innovation Theory
ECG	Electrocardiogram
EE	Effort Expectancy
EEG	Electroencephalography
EFA	Exploratory Factor Analysis
EMG	Electromyography
FBSE	Fitness Band Self-Efficacy
FC	Facilitating Condition
GDPR	General Data Protection Regulation
GSE	General Self-Efficacy
HCI	Human-Computer Interactions
HCM	Hierarchical Component Models
HLCs	Healthy Lifestyle Characteristics
HTSE	Healthcare Technology Self-Efficacy
IDC	International Data Corporation

IoT	Internet of Things
IS	Information System
IT	Information Technology
ITU	Intention to Use
JPEM	Human Research Ethics Committee of USM
LMS	Learning Management Systems
MEMS	micro-electromechanical systems
MJPHM	Malaysian Journal of Public Health Medicine
NADI	National Diabetes Institute
NCD	Non-Communicable Disease
NHMS	National Health and Morbidity Survey
OHRP	Office for Human Research Protections
PAAI	Physical Activity Assessment Inventory
PACMAD	People at the Centre of Mobile Apps Development
PEOU	Perceived Ease of Use
PLE	Personal Learning Environments
PLS-SEM	Partial Least Squares Structural Equation Modelling
PPG	Photoplethysmography
PS	Perceived Satisfaction
PU	Perceived Usefulness
QS	Quantify Self
SDG	Sustainable Development Goals
SDT	Self-Determination Theory
SI	Social Influence
SN	Social Norm

Sop	Standard Operation Procedure
T2D	Type 2 diabetes
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TTM	Transtheoretical Model
UN	United Nation
UTAUT	Unified Theory of Technology Acceptance and Used Technology
UX	User Experience
WFT	Wearable Fitness Technologies
WHO	World Health Organisation

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**KESAN PENGALAMAN PENGGUNA/*USER EXPERIENCE* (UX) KE ATAS
PENGUNAAN *FITNESS BAND* DAN GAYA HIDUP SIHAT**

ABSTRAK

Kajian ini bertujuan untuk mengkaji teori pengalaman pengguna atau *user experience* (UX) daripada Interaksi Manusia Dengan Komputer atau *human computer interaction* (HCI) dalam menjangkakan penggunaan peranti kecergasan yang merupakan teknologi boleh-pakai serta kesannya ke atas gaya hidup sihat pengguna. Kajian ini mengenalpasi faktor UX yang memacu penggunaan peranti kecergasan dan sumbangannya kepada komunikasi kesihatan, khususnya dalam menangani isu kesihatan rakyat Malaysia yang membimbangkan. Teori UX biasanya mengutamakan teknologi dan mengabaikan faktor kemanusiaan yang mempunyai potensi besar dalam memacu penggunaan teknologi baru. Kepentingan kajian ini adalah penerangan pemahaman teoritikal berkenaan penggunaan peranti kecergasan dengan memperkenalkan aplikasi keberkesanan diri dan keperluan untuk *self-tracking* sebagai faktor kemanusiaan. Kajian ini menggunakan kaedah persampelan snowballing dan bertujuan untuk merekrut 280 responden yang layak. Data yang dikumpul melalui kajiselidik berstruktur dianalisa dengan menggunakan *Partial Least Square Structural Equation Modelling* (PLS-SEM). Data kajian ini dianalisis melalui analisis model pengukuran (kesahan muka – ujian *pilot*, *convergent validity* – *Cronbach alpha*, *composite reliability*, dan *average variance extracted*, dan *discriminant validity* – *Fornell-Larcker* dan HTMT criteria) dan analisis model struktur (*coefficient of determination*, *effect size*, dan *predictive relevance*). Hasil dapatan kajian menunjukkan kebolegunaan dan utiliti mempunyai kesan positif yang signifikan ke atas penggunaan peranti kecergasan. Terapan faktor kemanusiaan

untuk memajukan model teori UX didapati tidak signifikan dalam menjangkakan penggunaannya. Secara teori, kajian ini mendapati pengguna adalah berorientasikan matlamat dan dipengaruhi oleh faktor sistem yang pragmatik untuk meningkatkan komunikasi kesihatan mereka. Sumbangan kajian ini juga bermanfaat kepada pihak berkuasa kesihatan dalam memprogramkan kursus kesihatan bagi mempromosikan gaya hidup sihat. Hasil dapatan juga bermanfaat kepada pemaju teknologi dalam perancangan rekabentuk inovasi dan pemasaran di masa hadapan yang membantu dari segi penggabungan UX dan komunikasi kesihatan untuk faedah rakyat tempatan dan global.

EFFECTS OF USER EXPERIENCE (UX) ON FITNESS BANDS USAGE AND HEALTHY LIFESTYLE

ABSTRACT

The aim of this thesis is to deploy and develop user experience (UX) theory from human computer interaction (HCI) in predicting the usage of fitness bands as an emerging wearable technology and its impact on the users' healthy lifestyle. The study identifies which UX factors drive the fitness bands usage and how it can contribute to health communication, specifically in addressing Malaysian alarming health issues. The theory of UX mainly focuses on the technology neglecting human factors which have great potential to drive the usage of new technology. The significance of the study is that it informs the theoretical understanding of fitness band usage by introducing the application of self-efficacy along with need for self-tracking as human factors. The study adopts the snowballing and purposive sampling techniques to recruit 280 qualified respondents. Data collected through a structured questionnaire were analysed using the Partial Least Square Structural Equation Modelling (PLS-SEM). The study performs the data analysis through measurement model analysis (content validity –pilot testing, convergent validity – Cronbach alpha, composite reliability, and average variance extracted, and discriminant validity – Fornell-Larcker and HTMT criteria) and structural model analysis (coefficient of determination, effect size, and predictive relevance). The findings reveal that usability and utility have significant positive effects on fitness bands usage. The inclusion of the human factors to advance the model of UX theory was found insignificant in predicting the usage. Theoretically, the study finds that fitness bands users are goal-oriented and were driven by the pragmatic system factors to enhance

their health communication. The contribution of this study benefits health authorities in programming health courses intended to promote healthy lifestyle. The finding is also advantageous to technology developers in planning their future innovation design and marketing which helps in bridging UX and health communication for not only the good of the nation but for global as well.

CHAPTER 1

INTRODUCTION

This chapter presents the background of the study by explaining the factors driving the usage of technological innovation in the form of wearable fitness trackers or fitness bands accompanied by the outcome of such usage on lifestyle. It follows by articulating the problem statement of the study, the ensuing research questions and research objectives, the scope of the study, the significance of the study, and the conceptualisation of this research. The chapter concludes with a summary.

1.1 Research Background

Health communication studies the application of methods to enlighten and guide individual and public resolution targeting to enhance health. It was a subject of pressing concern when health disparities required effective tools (Chou, Hunt, Beckjord, Moser, & Hesse, 2009; Goldstein et al., 2015; Philbin et al., 2019). Health communication exerts a significant impact on individuals' knowledge, beliefs, attitudes, and behaviour, where communication can be presented as health warnings, communication campaigns (Cornacchione Ross, Noar, & Sutfin, 2019) or health advice from health authorities (Kristensen, Jacobsen, & Pihl-Thingvad, 2018). For health information seeking individuals, this communication is important as they believe that they can improve their health when they acquire a more in-depth understanding of behaviours that can improve lifestyle (Jaafar, Ainin, & Yeong, 2017). It also helps them make better-informed decisions in health-related matters. Although these are present in the dissemination of reliable health information, it is

inevitable for consumers to misinterpret health information (Broniatowski et al., 2018).

Hence the role of public health professionals and governments in utilising effective strategies in health communication is very important. They could leverage their expertise to endure in diverse forms of health communication such as entertainment-education, media advocacy, interpersonal communication and new technology. New technology such as wearable activity trackers are believed to be able to ideally improve health and well-being while self-tracking induces positive effects in the observed behaviour and is increasingly popular as a growing number of smart devices and applications are used to generate huge amounts of data about individuals' behaviour (Gimpel, Nißen, & Görlitz, 2013; Lomborg & Frandsen, 2016; Ryan, Edney, & Maher, 2019), making it the latest tool to be exploited in health communication.

Activity trackers, smartwatches and fitness apps are expected to support consumers in their goal of achieving a healthy lifestyle since healthy living is recognised as one of the eight megatrends through to 2030 (Stiglbauer, Weber, & Batinic, 2019). Since fitness bands are wrist-worn and recent models come with displays that show times, they can also function as watches (Kaewkannate & Kim, 2016) which could accelerate the usage to go beyond health purposes and self-tracking. This supports the theory of McLuhan that accentuates the implications of new technology as a medium outside the particular context of its use as the intended message (Euchner, 2016). This contributes to the potential of fitness bands to be extended to non-self-trackers if the usage intention could be understood and amplified. Therefore, it is crucial to study a phenomenon of new technology in order

to understand the gradual growth of the user experience with usage patterns influenced by specific system software.

This emphasises the need to investigate the experience of fitness bands usage to understand the leading factors of the usage and the users' experience with the function and features of the device. In theory, the earliest phase of the introduction of technology involves the acceptance decision made by the users which are methodically distinguishable from long-term usage decisions that vary across users due to many possible factors (Venkatesh & Morris, 2000).

This current study aims to identify elements that explain the usage through user experience (UX) factors that incorporate pragmatic and hedonic product attributes. This thesis can be considered imperative in the effort to advance the development of this exceptional literature stream by providing insights into fitness bands usage as representing wearable technology, and how it affects the health behaviour of its users, which indirectly represents their lifestyle. The outcome of the study is expected to be able to prove the connection between the UX factors of fitness bands and healthy lifestyle which can be used to encourage healthier public lifestyle, particularly in Malaysia. In contrast to prior studies, this study incorporates human factors into UX by not only focusing on the device as the medium factors to investigate the usage and the result of the usage in influencing users' healthy lifestyle.

By understanding the complicated and context-sensitive topic of a fitness band's UX, this study examines the influence of pragmatic attributes of fitness bands through utility and usability, and pleasurable experience representing the hedonic attributes by integrating the newly found UX construct known as perceived coolness

(Sundar, Tamul, & Wu, 2014). The human factors of fitness band usage are investigated by looking into motivation; which is represented by need for self-tracking and users' self-efficacy. Need for self-tracking is constructed based on the three basic psychological needs fulfillment; autonomous, competence and relatedness (Ryan and Deci 2000). Whereas self-efficacy is a concept borrowed from within Social Cognitive theory, that has been broadly used in social sciences and health-related research to anticipate behaviour such as exercise and usage of new technology (Lavoie et al., 2008; Lee & Lee, 2018).

Meanwhile, the usage is studied through actual use from technology acceptance studies that is used widely to describe acceptance and usage of technology in information system (IS) and human computer interaction (HCI) that also can refer to technological devices (Dumpit & Fernandez, 2017; Isaac, Abdullah, Ramayah, & Mutahar, 2017; Sabah, 2016; Scott, Plotnikoff, Karunamuni, Bize, & Rodgers, 2008). Actual use used to be defined as the intensity of using the technology and the time of use (Kim, Park, & Lee, 2007) but as technology rapidly grows outside work-setting with pleasure and other aspects as goals; usage surpasses that dimension (Walldén, Mäkinen, & Raisamo, 2016). Therefore, the study looks into usage in a richer measurement and is expected to result in an improved prediction of wearable technology acceptance. The outcome of the usage is hypothesised to be able to sustain the self-tracking practice using fitness bands that positively lead to healthy lifestyle.

In order to efficiently support improvements in healthy lifestyle, it is crucial to acquire a profound understanding of the experience of users during their usage. The literature demonstrates that wearable activity trackers are capable of working as

interventions that promote physical activities and health-focused self-tracking to adults who do not meet their recommended daily activity guidelines (Mercer, Li, Giangregorio, Burns, & Grindrod, 2016). In order to maximise the potential of wearable technology devices in health promotion, it is vital to understand the target users of the products by studying the factors that drive the acceptance from the UX perspective.

1.1.1 Malaysian Healthy Lifestyle

A recent report on obesity and diabetes in Malaysia has shown an extremely alarming sign of poor health behaviour among Malaysians. Malaysia has the highest rate of diabetes in Asia and one of the highest in the world, with the record of 2.5 million diabetic adults aged 18 and above, according to the National Diabetes Institute (NADI) executive chairman, Datuk Dr Mustaffa Embong (Bernama, 2018). The most dangerous aspect of diabetes is that it does not have any symptoms at all until the individual develops a heart attack, stroke, kidney failure, blindness or amputations, which will already be too late; particularly in the case of the type 2 diabetes (Bernama, 2018). While obesity is the leading risk factor for type 2 diabetes, a report in 2010 showed that only a third of Malaysian adults had exercised, while 14 percent exercised adequately (Poh et al., 2010). Meanwhile, the Malaysia National Health and Morbidity Survey in 2015 stated that 40 percent of Malaysians are physically inactive (Subramaniam, 2020). This lack of exercise causes the obesity rate to increase.

Although obesity and diabetes are significant independent risk factors for the development of cardiovascular diseases, sedentary lifestyle and physical inactivity of Malaysians are the main contribution to cause obesity and non-communicable

diseases (NCDs) such as diabetes, cancer and chronic respiratory diseases (Tan, 2019). Furthermore, the Malaysian Journal of Public Health Medicine (MJPHM) stated in a 2016 study that Malaysian adults spend 41 percent of the day sitting, which is not healthy (Subramaniam, 2020). The unhealthy diet of Malaysians that include a lot of processed foods and sugary drinks also cause diabetes and obesity (Yunus & Mohamed Radhi, 2019).

The shocking rate of these health issues and unhealthy lifestyles strongly suggests that Malaysians' health consciousness and literacy are deficient and in need of external effort to enlighten their knowledge and awareness on health that could aid in improving their overall health behaviour. Health behaviour has been defined as 'overt behavioural patterns, actions and habits that relate to health maintenance, to health restoration and to health improvement' (Gochman, 1997, p. 3, as cited in Conner & Norman, 2017). Moreover, health communication can be utilised as a prudent tool to encourage healthy behaviours to populations with health issues (Goldstein et al., 2015).

The frequency and intensity of physical activity are also related to the risk of obesity, and the effort to reduce the rate of obesity should encourage the practice of moderate-to-vigorous-intensity physical activity (Chan et al., 2017). Furthermore, overweight and obesity are indications of poor health. The high rate of these two health issues represents not only the need of Malaysians to improve their healthy lifestyle behaviour but also demands attention from the local health authorities to devise strategies emphasising skill-building for autonomous health management which can be aided with the usage of technology. To improve public health, utilising

health communication should be an important mission to address the distressing statistics of health issues in Malaysia.

1.1.2 Wearable Fitness Technology

As consumers of information, the public often anticipates obtaining health information by the health authorities and adapt the recommended health course or practice such as the campaigns implemented worldwide that recommend walking 10,000 steps a day for a healthy heart and body (Kristensen et al., 2018; Yunus & Mohamed Radhi, 2019). To achieve the recommended practices, fitness bands are wearable fitness trackers that count steps and track various health and activity metrics. Essentially, wearable devices have been in use for years ever since governments and health practitioners widely recommended them as being convenient and affordable in helping users to monitor their health (Gay & Leijdekkers, 2015).

Wearable device research has explored the acceptance of this technology in assisting patients with illness, such as the ring sensor as an ambulatory wearable sensor (Sokwoo Rhee, Boo-Ho Yang, Kuowei Chang, & Asada, 1998), wearable ECG monitoring device (Martin, Jovanov, & Raskovic, 2000), wearable medical computer for high-risk patients (Lukowicz et al., 2002), electronic patch for continuous wireless monitoring (Haahr, Duun, Thomsen, Hoppe, & Branbjerg, 2008), wearable medical systems for p-Health (Teng, Yuan-Ting Zhang, Poon, & Bonato, 2008), and wearable sensor-based systems for health monitoring and prognosis (Pantelopoulos & Bourbakis, 2010). These early studies on medical purposed wearable devices are very much confined to health and patient behaviour.

Since wearable devices recently extended into the general public for health management purposes, fitness bands have become prominent as a wrist-worn fitness tracker to motivate behavioural change (Asimakopoulos, Asimakopoulos, & Spillers, 2017; Attig & Franke, 2019; Schaben & Furness, 2018). This wearable device has the potential to improve or change individual lifestyles and provides significant user or patient benefits (Lee & Lee, 2018). As a trending technology widely accepted due to its experiential quality and design, it has been gaining acceptance by the public (Ryan, Edney, and Maher 2019). Health-conscious individuals who have been quantifying their body or self-tracking are among the early users of fitness bands (Gao, Li, & Luo, 2015; Piwek, Ellis, Andrews, & Joinson, 2016). These wearable activity trackers are popular tools for self-trackers and is often associated with the practice of “quantified self” (QS), which include self-tracking and quantifying their body as part of managing and improving their life (Gerhard & Hepp, 2018; Lupton, 2013).

Previous health-related technology has demonstrated fairly substantial result as an intervention tool in changing health behaviour, such as social media (Korda & Itani, 2013), mobile devices (Klasnja, Consolvo, McDonald, Landay, & Pratt, 2009; Fanning, Mullen, & Mcauley, 2012; Khokhar et al., 2014; Lyzwinski, 2014) and pedometers (Schofield, Mummery, & Schofield, 2005; Zizzi et al., 2006; Jackson & Howton, 2008). Fitness bands have the technology-related attributes that parallel those technologies but can also be worn seamlessly on the body with continuous tracking sensors, thereby making it significant to examine factors that drive the usage of fitness bands. Fitness trackers and smartwatches alike accommodate self-monitoring practices for health management and well-being (Lee & Lee, 2018; Teng et al., 2008). The advancement of technology has enabled wearable devices to be

slightly more appealing to consumers than smartphones because of its size and battery life, including its human-centred design in the aspects of being fashionable and unique (Ilhan & Fietkiewicz, 2019). Hence the connection between fitness bands usage and health behaviour offers much room for exploration as an effort to stimulate healthier behaviour.

1.1.3 User Experience (UX)

In technology, there is a significant field that specifically studies the trend of users' interaction with computing devices. User experience (UX) is used initially in reference to human-computer interactions (HCI), specifically in human-design interactions with an emphasis on tasks, work-related and usability paradigm (Hassenzahl & Tractinsky, 2006). It can be described as the phenomenon felt by users before, during and after usage that often comprises usability, usefulness, emotional impact, and meaningfulness (Hartson & Pardha, 2019).

UX used to focus on usability and task accomplishment. However, the literature of experiential marketing by Schmitt (2010) emphasised that a product should provide experiences beyond supplying a set of functional features and benefits (Hassenzahl, 2004; Lee, Ka-hyun Lee, & Choi, 2018; Schmitt, 2010). Experiential marketing is customer-focused marketing that can build a connection to customers by evoking experiences (Schmitt, 2010). The approaches appeal to all senses; perceptions, feelings, and thoughts of consumers, to resolve one of the key challenges in marketing new products which are to provide unique and memorable experiences to customers to achieve positive customer-brand relationship (Lee et al., 2018; Wiedmann, Labenz, Haase, & Hennigs, 2018). Hence, UX study has evolved,

and new factors besides usability have been recognised in product design in the principles of usability engineering (Hartson & Pardha, 2019).

On top of that, customers nowadays are given more choices due to the copious amounts of information available that grow with the increasing amount of brand products and services. As a result, it becomes important for developers and marketers to understand the customers' perception in order to win their loyalty. This goes beyond just focusing on physical and functional aspects (Wiedmann et al., 2018). Due to consumers having more choices, they seek brands that provide them with unique and memorable experiences (Wiedmann et al., 2018). Additionally, philosophy argues that the nature of experience involves emotions, which, in turn, are considered essential experiences that guide consumer decision-making and affect their behaviour.

Therefore, the approach in UX research extends from the pragmatic quality of a product which looks into the utilitarian aspect (for example usefulness and usability) (Hassenzahl, 2004, 2018) to hedonic quality of a product that concentrates on the aspects of a product that amazes and excites users emotionally and psychologically (Hassenzahl, 2018; Hassenzahl & Tractinsky, 2006). With regard to that, the concept of experiential value in UX such as appealing design, enjoyable user interface, motivation and connection to others are classified as hedonic attributes (Diefenbach, Kolb, & Hassenzahl, 2014; Mare Hassenzahl, Platz, Burmester, & Lehner, 2000). By considering hedonic and pragmatic attributes, UX products can offer satisfaction and a sense of being when using the product. For example, the aesthetic appeal of the product, the brand, the culture, self-identification to keep them

using it past its functions (Hassenzahl, 2001, 2007; Hassenzahl, Schöbel, & Trautmann, 2008).

Both pragmatic and hedonic attributes are related to positive experience (Hassenzahl, 2004) which is the ultimate goal of UX besides providing designers with a better understanding on how consumer perceive and value certain products that lead to better, more satisfying and more pleasurable experience (Hassenzahl, 2018). This pleasurable experience in using fitness usage could help maintain or increase usage. With constant usage, the users may potentially adopt self-tracking behaviour and improve their healthy lifestyle.

1.2 Problem Statement

In recent years, poor lifestyle choices of Malaysians which include unhealthy choices of food, lack of physical activity and sleep are causing an alarming rise in NCDs, as reported by the recent National Health and Morbidity Survey (NHMS) 2015 (Thavarajah, 2016). The increasing numbers of heart problems and hypertension are also the signs and symptoms of unhealthy lifestyle (Bernama, 2017). It is apparent that Malaysians' health awareness of healthy lifestyles requires significant improvement. This situation calls for proactive solutions in health communication that not only to raise public awareness but also to provide practical resolution that can affect behaviour and exploit the use of new technology as a stimulating tool. However, there are limited studies discussing the issues of health-related technology application in Malaysia and its effect on healthy behaviour (Khan, Qureshi, Mustapha, Irum, & Arshad, 2020).

By seeing the huge numbers of mobile health applications (mHealth) available on major app stores which focus on wellness, fitness and meal plans (Byambasuren, Beller, & Glasziou, 2019), it demonstrates the potential of accessible health information to be in demand by technology users (Lupton, 2017). Consequently, it is expected to divert to health-related wearable devices connectable to mobile apps for self-monitoring such as Fitbit and Nike Fuel Band (Goodyear, Armour, & Wood, 2019). The long-term adherence to this wearable activity trackers has also shown to be positively affecting individuals' level of health (Attig, Karp, & Franke, 2019). However more understanding on this effect of this technology on healthy lifestyle has received less attention, albeit that more research is emerging in this area.

International Data Corporation (IDC) (2016) also projected promising market growth rate in wrist-worn wearables by the year 2019, however the growth rate for wearable devices by the fourth quarter of 2018 declined from 31.4 percent in 2017 to 27.5 percent. The fluctuations in the market growth rate of wearable devices indicate that the usage of fitness bands is unpredictable. It is possible that public are mostly uninformed of the existence of wearable devices, especially fitness bands. For instance, Lee and Lee (2018) discovered that about 40 percent of individuals sampled in their study were unaware of wearable fitness trackers, suggesting more studies need to be done particularly in identifying the usage factors of this device and its effects.

Numerous studies have been focusing on its functionality and technicalities which mainly relating to the device as medium, however examining psychological stimulations as driving factors of fitness bands usage are equally important.

Enjoyment and motivation have been recognised to be among the most significant drivers of technology usage in HCI and UX perspectives (Asimakopoulos et al., 2017; Bittner & Schipper, 2014; Carmelo, Costabile, Rosa, & Montinaro, 2007; Law, van Schaik, & Roto, 2014; Zhao, Chen, & Wang, 2016). Consequently, these aspects can be addressed through UX hedonic product attributes and human factors which emphasise individuals' psychological well-being (Bannon, 1995; Hassenzahl, 2018; Szalma, 2014).

Technology implementation previously only focus on the system, however human factors are important in which if they failed to understand a system operability, the developers and the system design team should be responsible for that (Bannon, 1995). Human factors mainly involves sensory/ perceptual, cognitive, emotion and personality (Szalma, 2014); and can also be studied through need fulfilment as discussed in previous technology acceptance studies (Bittner, Jourdan, Obermayer, & Seefried, 2016). It has the potential to influence the usage of fitness bands more strongly than pragmatic quality on certain individuals but there has been little work exploring this aspect in UX of wearable technology, particularly in developing countries such as Malaysia.

The rapid technological transition is overtaking the application of existing techniques of design process into fallacies of oversimplification that delay comprehension, innovation, and the reputation of human factors (Holman et al., 2020). Human factor is usually taken into account in the application of information to prepare for mistakes by users due to ignorance, mischief, apathy, resistance, and negligence (Sohrabi Safa, Von Solms, & Furnell, 2016). Another important cognitive and psychomotor process of human factors is self-efficacy which is an important

determinant of technology acceptance and usage (Asimakopoulos et al., 2017; Rahman, Ko, Warren, & Carpenter, 2016; Reychav et al., 2019). Although UX also covers human factors, psychological and cognitive aspects of new technology usage are rarely taken seriously in UX studies. Psychological analysis of UX is important to bridge psychological research and design solutions (Saariluoma & Jokinen, 2014).

Furthermore, fitness bands are currently targeted to individuals already living an active and healthy lifestyle. Wearable developers typically highlight the potentials of their devices as a platform for improving physical performance and positive habit formation (Piwek et al., 2016). These target users that use fitness bands to attain a certain goal find pragmatic attributes; referring to functionality, as the most important and appealing. However, for users who are not goal-oriented, functionality is not as important as psychological needs and intrinsic motivation in human factors (Hamborg, Hülsmann, & Kaspar, 2014; Hassenzahl, 2018; Law et al., 2014; Szalma, 2014).

Stimulating healthy behaviour through the use of wearable devices is a complex multistep process and is only meaningful if the change is sustained (Patel, Asch, & Volpp, 2015; Quitasol, Fournier, Domenico, Michael Bagby, & Quilty, 2018). Although wearable devices may potentially facilitate healthier lifestyle behaviour, there are other factors besides these devices alone to make the change (Patel et al., 2015). Public dissemination of health information is reasonably easy, whereas changing human behaviour by restructuring attitude to healthier behaviour is becoming challenging (Lyzwinski, 2014). Previously, mobile health applications are found not to have leveraged principles from health behaviour (Patel et al., 2015). As

such, studies on wearable health technology are yet to incorporate health behaviour and strategies to predict sustainable health practices.

Improving healthy lifestyle behaviour is also a global concern. The United Nations' (UN) Sustainable Development Goals (SDGs) included health agenda as the third goal that aims to ensure healthy lives and promote well-being for all at all ages. The effort to achieve this goal that target improvements in healthcare and general well-being is challenging, especially in the developing world (United Nations General Assembly, 2015). NCD and obesity are indications of a lack of physical activity while fitness trackers promote active and fit lifestyles. Fitness bands could be a part of the solution only if these individuals could create a long-term commitment in continuing healthy habits. Evidently, the practice of "quantify self" that mainly incorporates self-tracking practice, is rising due to the positive effects in experiential behaviour of self-tracking and is catalysed by the increasing number of wearables in the market that users can use conveniently to quantify their daily activities (Shin & Biocca, 2017).

These wearables that monitor and collect health-related data for users to review personal, relevant information more effortlessly for self-evaluation, help to encourage them to become more aware of their health behaviour and autonomously improve it (Shin & Biocca, 2017). Additionally, most health-related behaviour which includes regular exercises, proper diet, and eating habit, have shown the possibility of causing significant improvements in the overall health of an individual (Lunney, Cunningham, & Eastin, 2016). This, however, is a constraint because sustaining behaviour change is a tough challenge. Therefore additional research is required to look into how healthy lifestyle behaviour can be affected by the experience of fitness

bands users from not only functional aspects of the medium as usage factors but also psychological and cognitive functioning of the users regarded as human factors.

1.3 Research Questions

This study aims to identify the usage driving factors of fitness bands by not only the medium or device, but also the human factors; by understanding the experience of the users. Additionally, this study investigates whether the usage improves their healthy lifestyle. The specific research questions are:

- i. Which UX factors are significant in driving the usage of fitness bands?
- ii. Between pragmatic and hedonic factors of UX, which is more dominant in driving the usage?
- iii. Are human factors significant in driving the fitness band usage?
- iv. Does the usage of fitness bands improve healthy lifestyle?
- v. What are the relationships between age and location with healthy lifestyle?

1.4 Research Objectives

Following the above research questions, this study investigates the fitness bands usage factors that influence health behaviour in the perspective of UX. Hence, the research objectives are as follows:

- i. To identify which UX factors are significant in driving the usage of fitness bands.
- ii. To determine which dimensions; pragmatic or hedonic as more dominant in driving the usage.

- iii. To examine the significance of human factors in driving the fitness band usage.
- iv. To determine whether fitness bands usage improve healthy lifestyle.
- v. To analyse the relationships between age and location with healthy lifestyle.

1.5 Research Significance

The improved behaviour in previous studies as a result from technology usage proposes the potential for fitness bands to open up a new possibility in health communication that can improve healthy lifestyle. The self-tracking activities correspond with the objectives of health promotion. Furthermore, past studies on health-related technology are mostly focused on the health-related workers such as physicians and nurses (see Martin, Jovanov, & Raskovic, 2000; Nasir & Yurder, 2015; Park & Chen, 2007). There are limited studies on the general consumers and public that includes healthy individuals or patients on their usage behaviour of a health-related device.

Although technology intervention in behaviour change had been studied in the past (Adapa et al. 2018; Gardner et al. 2016; Gaudet, Gallant, and Bélanger 2017; Goodyear, Armour, and Wood 2019; Lyzwinski 2014; Ryan, Edney, and Maher 2019; Shull et al. 2014), studies on the effectiveness of usage of fitness band in the perspective of UX and on healthy lifestyle are limited. Furthermore, many studies are in Western contexts with cultural and socioeconomic settings that differ from Malaysia. Therefore, it is critical to study this area by the application of instrument that involves a set of items to study the usage of fitness bands and its effect in improving healthy lifestyle in the local context. Hence the significance of this study

is explained in this section based on its conceptual, methodological and practical contribution.

Theoretically, this research extends UX perspective that includes coolness factors that measures how coolness affects the success rate of a technology (Dar-Nimrod, Ganesan, & MacCann, 2018; Im, Bhat, & Lee, 2015; Kim, Shin, & Park, 2015; Park, 2019). Focusing on wearable fitness technology, the research is designed based on the context of consumers, who are fitness band users. This study also applies PU and PEOU in evaluating the aspects of utility and usability as pragmatic driving factors to usage of fitness bands. The incorporation of human factors through need for self-tracking from psychology studies on motivation (Hooke, Gilchrist, Tanner, Hart, & Withycombe, 2016; McDavid, Cox, & McDonough, 2014; Standage, Duda, & Ntoumanis, 2006; Visser & Hirsch, 2014) is also advantageous in portraying a more holistic representation of fitness band usage.

Incorporating self-efficacy as human factors of the fitness bands usage helps deepen the understanding and confirm past research that recognised the influence of self-efficacy in using new technology (Lim et al., 2011). Additionally, the depth of definition and application of selected constructs in this emerging field of wearable technology is explored. Even though some studies on the usage of existing and commonly used wearable devices such as smart glasses and smartwatches concluded that the usage was influenced by antecedents that are quite similar to the ones explored in this study, some unexplored device-specific variables may cause unique psychological effects. This depends on the different features and functions of the devices, including the user experience.

Methodologically, this study is significant in addressing the appropriateness of applying these theoretical concepts and theories in different contexts. The quantitative approach appropriates the investigation of this phenomenon by combining instruments from PU, PEOU, coolness factors, need fulfillment, technology usage, self-efficacy, and healthy lifestyle. Furthermore, the applicability of research theories and models established in developed countries to the context of a developing country is arguable due to their differences in socioeconomic and cultural settings (Talukder, Alyammahi, Quazi, Abdullah, & Johns, 2019; van de Vijver & Tanzer, 2004; Westrom, 2018). The successful use of the research instrument based on these theories contributes to providing examples of the interpretation of case studies from developing countries like Malaysia.

The process of integrating theories and concepts from multiple disciplines and the derivation of measurements adapted to suit the context of this study may accommodate future technology usage studies that share similar concerns but different contexts. The instrument is useful for public health or information technology researchers to investigate the health impact of wearable fitness technology usage and benefits the government in coordinating health-related programmes to address health issues. The application of two hierarchical component models (HCM) in the research framework that captures perceived coolness and need for self-tracking reduces the number of structural model relationships in the application of multivariate statistical analysis known as partial least squares structural equation modelling (PLS-SEM). The application covers more tangible characters of these two constructs making the PLS path model more parsimonious.

Practically, the result of this study may contribute to the benefits of wearable device development, especially from the perspective of fitness band industries on domains pertaining to health communication, technology usage, wearable technology, and UX, except for research on the detailed technicality and specification. Research on this aspect of fitness band in the context of Malaysian health behaviour is also still in its infancy. Nevertheless, this study is significant to an emergent field of interdisciplinary research by examining factors affecting the usage of wearable technology and behaviour, specifically on wearable fitness devices.

By studying the current fitness band users, this research contributes to understand the experiences of using fitness bands further by getting insights into how usage can promote healthy lifestyle comparable to existing technological systems and devices such as social media and smartphones. The framework can be used to examine the effect of UX of fitness band on the intention to use not just the device but also to adopt better health behaviour and the practices of self-tracking. As a result, the innovation of future fitness and wearable devices with improved features shall continue to satisfy user needs and help users understand how to translate their self-tracking data efficiently. Furthermore, the preventative approach can save the public resources spent on addressing healthcare. Similar to previous technologies that have historically seen immense benefits for people with low health literacy (Holmberg, Berg, Dahlgren, Lissner, & Chaplin, 2019; Mackert, Mabry-Flynn, Champlin, Donovan, & Pounders, 2016), specifically designed fitness bands health programme can also meet the needs of lower health literacy users.

By focusing on the context of Malaysian health behaviour and the ostensibly endless issues of overweight, obesity, diabetes and unhealthy lifestyle, this study helps bridge the gap between technology invention and health behaviour by understanding the potential effects fitness bands have in improving the users' health behaviour. Identifying the factors of usage, the perception of users on the device and their behaviour after the usage can help recognise areas for improvement. Besides, wearable technology is also used as a fashion statement (Chuah et al., 2016). As such, it has a share in both niche industries where fashion and technology overlap and create a mutual module to meet the expectation from target consumers by fulfilling the functional and hedonic needs of the target groups. This study helps to provide insights for holistic strategies that centralise on both hedonic and pragmatic dimensions.

Additionally, the two-dimensionality of users' perceptions can be used as a subdivision benchmark to identify user needs and demands. Even though the focus of this research is on fitness band, managerial implications are expected to be applicable to other health-related wearable technology, especially smartwatches and sports watches that have incorporated the functions of self-tracking.

1.6 Scope of the Study

Even though there are constraints in research beyond a researcher's control, however, some of them may remain within the capacity of the researcher to resolve (Simon & Goes, 2013). Hence, there is delimitation of the scope in this research that is set to ensure that the research focuses on the questions and research objectives only. The delimitations refer to characteristics that limit the scope and define the

boundaries of this study, and questions or issues beyond the scope of this study will not be discussed nor addressed in this study.

This research applied PU and PEOU to characterise utility and usability respectively in UX's pragmatic product attributes. Hence other aspects of technology acceptance factors in term of functionality are not investigated. Meanwhile, for the second dimension, which comprises hedonic product attributes, it is limited to perceived coolness as factors that affect the usage intention of fitness bands psychologically. Other possible psychological factors are not discussed. Human factors generally include sensory or perceptual, cognitive, psychomotor processes, anatomy, physics and biomechanics, however this study only investigate motivation and self-efficacy in addressing human factors which basically focusing of psychology of humans.

This is not intervention research on behaviour change, which refers to a study that causes an intervention on its participants for researchers to evaluate the effects of the interventions on biomedical or health-related outcomes (Prochaska & Velicer, 1997). This research focuses on the outcome of the usage on participant health behaviour by referring to the action, practice, routine or change taken to improve one's health, predominantly self-tracking practice that comes along with the function and feature of fitness bands. It focuses on the consequence of the usage of fitness bands that already took place and the factors that drive the usage. Hence the study does not include a long process of repeated observation of pre and post-usage, otherwise known as a longitudinal study.

The study also investigates the assumption of sociodemographic-related differences in adopting healthy lifestyle as it is also deemed necessary to obtain better understanding of the racial, social, and location factors that influence these basic lifestyle behaviours (Hayman & Worel, 2014). However, this study only chooses to study the controlling effects of age and location of Malaysian fitness bands users on their healthy lifestyle since the collected data on gender is not distinctive while the collected data on race is also homogenous.

The selection of the sample for this current study is restricted to Malaysians since the study is conducted in Malaysia due to having one of the most problematic populations in diabetes and overweight/obesity in ASEAN. The respondents are required not only to be of Malaysian citizens but also fitness bands users, which require them to own and use fitness bands. Having certain duration of usage or a certain level of fitness are not requirements. The sampling does not limit to a specific demographic in order to understand the usage factors in all walks of life but does requires them to be 18 years and above.

The study initially intended to look into fitness bands only; denoting that respondents must be users of only fitness bands as a basic fitness tracker worn on the wrist, excluding any other type of wrist-worn smart wearables such as smartwatches or sports GPS watch which is from a different niche market. However, given the swift advancements in the functions and features of wearables that begin to share similar basic functions in which they resemble fitness bands, and given that most respondents recognise their smart wearables as fitness bands because they use it for self-tracking and fitness, the study includes all types of wrist-worn wearables as fitness bands provided that the wearables has self-tracking functions which includes

step counting, sleep monitoring, distance counting, and heart rate monitoring. Therefore, although the study specifically selected fitness bands as the topic, the concept of self-tracking can be extended to wrist-worn self-tracking wearables that include smartwatches and sports GPS watches.

To support behaviour change, it is vital to understand the philosophical impressions and perceptions of fitness band users and their experience during the usage that affects their behaviour. This scope of this study, however, does not measure behaviour change phase by phase as a clinical study because this study starts and ends with the existing experience of fitness band usage and users' current health. Hence this study only deploys the theory of acceptance factors and UX of fitness bands and their effect on the health behaviour of the users.

1.7 Chapter Summary

Although fitness bands offer many health-related benefits, the market of this technology is still in its infancy (Lee & Lee, 2018). In order to accelerate the usage of fitness bands as an effort to influence the health behaviour of Malaysians in fighting the terrifying rate of health issues, understanding the factors that drive the usage of fitness bands is necessary. Relevant studies on this topic are growing but not specifically focusing on the Malaysian context. This study explores the field of health communication by studying wearable technology usage factors of fitness bands from the UX perspective.

1.8 Organisation of the Thesis

This study is organised in five chapters. Chapter one presents the background of the research that involves Malaysian health issues and the wearable fitness technology that is emerging. It also presents UX and self-efficacy in health behaviour as the background of the research. Following the background are the problem statements, research questions, research objectives and research significance. Lastly, the scope of study and conceptualisation of variables are presented.

Chapter two presents the literature review that consists of studies in regards to Internet of Things (IoT) where wearable technology is a part of, technology acceptance and usage and discusses UX and the concept it borrows from IS studies which are PU, PEOU and technology usage in order to study usage factors from the perspective of users, health communication and lastly presents this current research framework.

The next chapter explains the methodology used in this study that starts with research design, population and sample, research instruments, scaling technique, measurement and operationalisation, descriptive and data analysis, pilot study, ethical procedures and final survey.

Chapter four presents the research finding which includes response rate, confirmatory factor analysis, and descriptive analysis, assessment of both measurement and structural model, and summary of the hypotheses.

Lastly, chapter five discusses the conclusion based on the analysis of the research objectives, implications of the study, contributions of the study, limitations of the study and recommendations for future research.