Improving Mobile Fitness and Weight Loss Apps to Help Saudis Overcoming Obesity

Case Study: Akser Waznk app

A Thesis Submitted for the Degree of

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By

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CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Ryan Alturki declare that this thesis, is submitted in fulfilment of the requirements for the award of PhD, in the School of Electrical and Data Engineering /Faculty of Engineering and Information Technology at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise reference or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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In the name of Allah, the most beneficent and the most merciful.

As I am writing this section, I believe that I am at the end of my PhD journey. In this trip, many people supported me, and it is their right to be thanked.

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LIST OF PUBLICATIONS

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2. Alturki, R. & Gay, V. 2017a, 'USABILITY TESTING OF FITNESS MOBILE APPLICATION: CASE STUDY ADED SURAT APP', *International Journal of Computer Science & Information Technology (IJCSIT)*, vol. 9, no. 5, pp. 107-27.

3. Alturki, R. & Gay, V. 2019b, 'The Development of an Arabic Weight-Loss App Akser Waznk: Qualitative Results', *JMIR formative research*, vol. 3, no. 1, p. e11785.

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4. Alturki, R. & Gay, V. 2019a, 'Augmented and Virtual Reality in Mobile Fitness Applications: A Survey', *Applications of Intelligent Technologies in Healthcare*, Springer, pp. 67-75.

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CONFERENCE PAPERS PUBLISHED

6. Alturki, R. & Gay, V. 2017b, 'USABILITY TESTING OF FITNESS MOBILE APPLICATION: METHODOLOGY AND QUANTITATIVE RESULTS', paper presented to the *7th International Conference on Computer Science, Engineering & Applications (ICCSEA 2017)*, Copenhagen, Denmark.

7. Alturki, R., Gay, V. & Alshehri, M. 2019d, 'Privacy, Security and Usability within Motivation apps To Overcome Obesity', paper presented to the *IEEE 8th Global Conference on Consumer Electronics (GCCE 2019)*, Osaka, Japan. **(Accepted)**.

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GLOSSARY

3D	Three Dimensional
AI	Artificial Intelligence
ANP	Analytic Network Process
Apps	Applications
AR	Augmented Reality
ASD	Autism Spectrum Disorder
ASQ	After Scenario Questionnaire
AWC/DL	Air War College Distance Learning
BMI	Body Mass Index
CADISS	Coronary Artery Disease in Saudis
CHI	Computer-Human Interaction
CIT	Critical Incident Technique
CUE	Comparative Usability Evaluation
FA	Framework Analysis
GOMS	Goals, Operators, Methods and Selection Rules
HCI	Human Computer Interaction
HTI	Human Technology Interaction
HMD	Head-Mounted Display
HTML	Hypertext Markup Language
IBM	International Business Machines
IEC	International Electrotechnical Commission
IS	Information System

ISO	International Standards Organization
IT	Information Technology
KLM	Keystroke Level Modelling
KSA	Kingdom of Saudi Arabia
LED	Light Emitting Diodes
MIT	Massachusetts Institute of Technology
MUSiC	Metrics for Usability Standards in Computing
NASA	National Aeronautics and Space Administration
NET	Network Satisfaction Scale
PACMAD	People At the Centre of Mobile Application Development
PARC	Palo Alto Research Center
PC	Personal Computer
PEOU	Perceived Ease-Of-Use
PSSUQ	Post Study System Usability Questionnaire
PU	Perceived Usefulness
QUIM	Quality in Use Integrated Measurement
QUIS	Questionnaire for User Interaction Satisfaction
R&D	Research and Development
RMIT	Royal Melbourne Institute of Technology
SA	San Francisco
SEQ	Single Ease Question
SMEQ	Subjective Mental Effort Questionnaire
SMS	Short Message Service
SRI	Stanford Research Institute

SUMI	Software Usability Measurement Inventory
SUS	System Usability Scale
TAM	Technology Acceptance Model
TLX	Task Load Index
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
TV	Television
UGC	User-Generated Content
UI	User Interface
UME	Usability Magnitude Estimation
UPA	Usability Professionals' Association
UPT	Usability Problem Taxonomy
US	United States
UXD	User Experience Design
UxPA	User Experience Professionals Association
VR	Virtual Reality
WAP	Wireless Application Protocol
WHO	World Health Organization
WIMP	Windows, Icons, Menus, and Pointer

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ABSTRACT

Obesity and its related illnesses are a major health problem around the world. Saudi Arabia has one of the highest national obesity rates globally; however, it is not easy to intervene to prevent obesity and overweightness due to Saudi Arabia's cultural and social norms and linguistic barriers. In recent years, there has been an exponential growth in the usage of smartphones and apps in Saudi Arabia. These could be used as a cost-effective tool to facilitate the delivery of behaviour modification interventions for obese and overweight people. There are a variety of health and fitness apps that claim to offer lifestyle-modification tools. However, these do not identify the motivational features required to overcome obesity, consider the evidence-based practices for weight management, consider the social and cultural norms of Saudi society, or enhance the usability of apps by considering usability attributes. Therefore, this research aims at improving mobile fitness and weight loss apps usability guidelines and features to motivate obese users and especially Saudis to lose weight and then overcome obesity. Qualitative and quantitative studies were conducted with 26 obese Saudis who tested the level of usability of two Arabic fitness and weight-loss apps and then provided feedback and recommendations. The following usability attributes were tested: effectiveness, efficiency, satisfaction, memorability, errors, learnability and cognitive load. Qualitative studies were also conducted with seven health professionals (dietitians and physical activity professionals) to evaluate the tested apps regarding their nutrition and physical activity options. This was undertaken in collaboration with the Armed Forces hospitals Taif Region and King AbdulAziz Medical City Ministry of National Guard Health Affairs in Jeddah, Saudi Arabia. Based on the results, comprehensive usability guidelines for fitness and weight loss apps were established and an Arabic weight-loss app called Akser Waznk was developed to facilitate the adjustment of key nutritional and physical activities and behaviours of Saudi users. Akser Waznk app is an interactive, user-friendly app designed primarily for iPhones. It has several features intended to help users to monitor and track their food consumption and physical activities. The app provides personalised diet and weight loss advice. To validate the proposed app, its level of usability was tested and its nutrition and physical activity options evaluated by conducting qualitative and quantitative studies with the same 26 obese Saudi users and the same seven health professionals.

CHAPTER 1 INTRODUCTION

1.1 Background

According to the facts provided by World Health Organization (WHO), in 2016, 13% of world's adult population was considered obese and 39% of the adult population was believed to be overweight. The prevalence of obesity around the world almost tripled between 1975 and 2016 (World Health Organization 2018). Overweight and obesity are considered as major risk factors for various chronic diseases such as cancer, cardiovascular diseases and diabetes (Calle et al. 1999; Fontaine et al. 2003; Manson et al. 1995; Sjöström 1992; Stevens et al. 1998). Obesity and overweight are associated with more deaths than underweight (World Health Organization 2018).

Saudi Arabia is one country where obesity is increasing at an alarming rate. According to a report by World Health Organization (2016), in 2016, the prevalence of obesity in men was 29.5% and in women was 39.5% and the prevalence of overweight in men was 67.5% and in women was 69.2%. This is supported by another study, which states that in 2016, 35.5% of the Saudi population experienced obesity (Alturki & Gay 2019b). According to a recent statement by a Saudi health official, the percentage of obesity has increased to reach more than 40% and when the ratio of overweight cases is added to this rate, it reaches 70% (AL-KINANI 2019).

Given the health problems and diseases that result from obesity, many researchers have been encouraged to explore how the condition can be overcome or prevented (Bar-Or 2000; Hill & Peters 1998; Hill & Wyatt 2005; Saris et al. 2003; Summerbell et al. 2005). Most of the research work states that obesity can be overcome by increasing physical activity and changing eating behaviour. However, it is sometimes very difficult to motivate obese individuals to change their lifestyle and become involved in physical activity. There is ample work available, which discusses various means to motivate individuals to counter obesity (Adler & Stewart 2009; de Vries & Brug 1999; Foster, Makris & Bailer 2005; Schelling et al. 2009; Teixeira et al. 2006; Teixeira et al. 2012; Wang, Volkow & Fowler 2002). A significant quantity of research finds that the behaviour change techniques that influence behavioural determinants are linked to their

effectiveness and that the most effective behaviour change related to fitness and health occurs through behaviour interventions (Brownell 2000; Contento et al. 1995; Foster, Makris & Bailer 2005; Wadden & Stunkard 2002). Mobile technology such as mobile applications (apps) have been found to be a very useful intervention tool for increasing physical activity because their unique features motivate individuals to achieve their fitness goals (Arteaga et al. 2010; Conroy, Yang & Maher 2014; Denning et al. 2009; Yang 2009).

Mobile apps are developed specifically to be installed in handheld devices such as tablet computers or smartphones. Some mobile apps are preinstalled on smartphones and others can be downloaded from different mobile app stores such as Apple's App Store or Google Play. In many developed countries, the rate of mobile phone penetration is above 100, with some individuals using multiple mobile devices (BBC 2010). According to Reisinger (2011), more than 500,000 new Android-based devices are activated each day. Mobile phone technology is constantly evolving as mobile devices and their operating systems become more and more sophisticated. On average, a smartphone user dedicates two hours each day to their mobile device. Such extreme use of smartphones has resulted in the significant popularity of mobile apps (Miller & Monaghan 2013). Moreover, the developments in mobile phone technology has motivated the creation of various mobile apps designed for operating systems in smartphones and which are provided by mobile operating system vendors such as Apple, Microsoft and Google. For instance, in 2019, Google has 2.1 million apps and Apple has 1.8 million apps that users could download on their mobile phones (Statista 2019b). According to Statista (2019a), between July 2008 to June 2017, mobile apps from Apple store had been downloaded 180 billion times.

Due to the fact that mobile devices are becoming more sophisticated, companies around the world are trying to integrate mobile channels into their business strategies. Mobile apps are also impacting our lifestyle. There are apps available for fitness, shopping, news, social networking, gaming, weather, utilities, sports, business, navigation, finance, medical, music, travel and education. According to a report by Digital Trends, there are over 100,000 apps for purchase on the App Store and Google Play dedicated to health and fitness. The report also shows that the value of fitness mobile apps will reach $26 billion by 2017 (Boxall 2014).

Smartphones and their apps have seen an exponential growth in their usage in Saudi Arabia in recent times. In 2017, there were an estimated 18.7 million smartphone users in Saudi Arabia and this figure is estimated to increase to 21.3 million by 2023 (Statista 2019c). Moreover, researchers ranked the country third overall in terms of global smartphone usage (Raben & Snip 2014), with penetration at 73% and the largest global Twitter usage (Alturki & Gay 2019b). Smartphones can help Saudi people, especially women, to virtually interact publicly and socially when they would not normally be able to do so owing to cultural restrictions. Social media websites and apps, for example, Instagram, Facebook and Twitter, are also used by Saudi Arabians to start home-based businesses and contribute to social solidarity (AlGhamdi & Reilly 2013; Yuce et al. 2014).

The usability of mobile apps enhances user experience (UX) and can play a significant part in the success of the mobile apps (Consolvo et al. 2006; King et al. 2013; Pagoto et al. 2013; Tsai et al. 2007). There is ample research that discusses usability and how it can improve UX; however, most of this research is not related to mobile apps and many usability models and guidelines were developed before the advent of mobile apps. To the best of this researcher's knowledge, there are not any mobile app usability guidelines for building a fitness and weight loss app. There are several fitness and weight loss apps available in the Arabic language and those existing apps lack any advanced usability attributes, evidence-informed practices for weight loss management and the motivational features that would help and encourage people with obesity to be active and change their lifestyle in order to overcome obesity. They also fail to integrate any cultural context (Alturki & Gay 2017a, 2017b, 2019b).

1.2 Justification of the Research Topic

This research topic is both relevant and important because the use of mobile fitness and weight loss apps is a rapidly emerging trend and there is ample research being conducted in the field of mobile app design. According to a report undertaken by Nielsen's Mobile NetView, one-third (46 million) of smartphone owners in the United States (US) in 2014 used fitness and weight loss mobile apps (Pai 2014). In 2015, around the world, 16% of all Internet users used health and fitness mobile apps (Statista 2019d). In 2014, while the mobile app business had expanded by 15% overall, in terms of average daily usage, the number of health and fitness apps increased by 62% (Khalaf 2014).

Moreover, this research topic is important because it aims at overcoming obesity in general and in Saudi Arabia specifically. Obesity is one of the biggest problems in health sectors around the world. The medical cost of obesity is estimated to be billions of dollars per year. One report shows that between 2005 and 2008, Saudi Arabia allocated a cumulative amount of 94 billion riyal to the health sector (Colliers International 2012). In 2010 and 2011, the Saudi government provided an additional 113 billion riyal. The main reason for this increase was the emergence of lifestyle-related diseases such as hypertension, diabetes, heart disease and obesity (Colliers International 2012). Despite the widespread occurrence of obesity and overweight in Saudi Arabia, there is little treatment currently available. Gastric and bariatric surgery is the most popular way to reduce weight in Saudi Arabia as it is seen as the fastest and most effortless method; however, there are a number of risks and side effects related to the surgery (Alturki & Gay 2019b).

Weight loss apps can provide an easy, safe and cheap way to overcome obesity by ensuring a high level of usability and motivating individuals to change their lifestyle and become more active. The usability attributes and guidelines for mobile apps in each field differ and this research specifically examines fitness and weight loss apps. This research also aims to identify the features that can play an important role in motivating obese Saudi app users to be active, improve their lifestyle and lose weight. In addition to this, this research has the aim of proposing several unique features which can be implemented within a fitness and weight loss app that adhere to all of the 13 evidence-informed practices for weight-loss management.

This research topic focuses specifically on one culture or geographic location. Such research is more difficult to find because most of the research that has been conducted into fitness and weight loss apps and usability only discusses the apps in general. When researchers have undertaken field studies, they have done so outside the context of the Middle East. Therefore, the results may be more representative of western cultural norms. There is a need for more research that takes language barriers, cultural issues and paradigms into account.

1.3 Research Questions

To pursue this research idea, the following main question will be answered:

How to improve mobile fitness and weight loss apps usability guidelines and features to help Saudi users overcoming obesity?

In order to answer the above question, these sub-questions will be answered as well.

Sub-question 1:

What are the most important fitness and weight loss app features that would help and encourage obese people, in particular Saudis, to be active, change their lifestyle and keep them motivated to overcome obesity?

Sub-question 2:

How can the 13 evidence-informed practices required for weight loss management be incorporated and implemented within a weight loss app?

Sub-question 3:

What are the needs and requirements of Saudi obese users from a fitness and weight loss app?

Sub-question 4:

What usability attributes and factors should be considered to make mobile fitness and weight loss apps easier to use for Saudi users?

Sub-question 5:

How can the new developed weight loss app 'Akser Waznk' be evaluated to show it has a better usability level and motivational features to overcome obesity in comparison to the existing fitness and weigh loss apps?

1.4 Research Scope

The research addresses important points regarding fitness and weight loss apps. It investigates and identifies the motivational features within apps that help and encourage users to lose weight and overcome obesity. In addition to this, it includes an extensive literature review about mobile app usability, which explores models, attributes and

factors. Saudi Arabia was chosen as the location for this research because it has one of the highest obese population ratios in the world and because smartphones and mobile apps are becoming very popular with its citizens and this is changing many dynamics in this conservative society.

This research includes conducting usability testing for two Arabic fitness and weight loss apps: Twazon and Aded Surat. The participants of the study were referred by doctors from the Obesity Unit at the Armed Forces hospitals in the Taif Region of Saudi Arabia. All participants are Saudi citizens who experience obesity and want to lose weight and overcome obesity. Both tested apps are evaluated regarding their options concerning nutrition and physical activities by seven health professionals in total: five dietitians (three females and two males) and two male physical activity professionals. This is done in collaboration with the department of Food Services Contracts Operations at King AbdulAziz Medical City, Ministry of National Guard Health Affairs in Jeddah, Saudi Arabia, where the dieticians work.

Results from the end-users, health professionals' evaluation and literature investigation are used to develop and refine usability guidelines for weight loss app. Based on the guidelines, a new Arabic weight loss app called Akser Waznk is developed that includes advanced motivational features, implements all evidence-informed practice for weight loss management and considers the social and cultural norms of Saudi users and design elements. Then, the app's level of usability is tested with the same participants from the previous usability testing and its nutrition and physical activities options are evaluated by the same health professionals as well.

1.5 Research Aim and Objectives

This research aims at improving mobile fitness and weight loss apps' usability guidelines and features to help obese users and especially Saudis to lose weight and then overcome obesity.

In order to reach that goal, these objectives have been identified:

Objective 1: To identify fitness and weight loss app advance features that motivate obese users in general and Saudis in particular to follow a healthy lifestyle in order to overcome obesity.

Objective 2: To incorporate all the 13 evidence-informed practices for weight loss management within the devolved weight loss app.

Objective 3: To determine what obese Saudi users (males and females) require from fitness and weight loss apps in order to use them.

Objective 4: To identify what usability attributes and factors should be considered when developing fitness or weight loss apps to make them easier to use.

Objective 5: To validate and evaluate the developed weight loss app Akser Waznk.

1.6 Research Significance

The focus of this research is to propose a technological solution that aims to contribute to decreasing the obesity rate in Saudi Arabia. To achieve this, this research proposes an advanced Arabic weight loss app that is developed considering usability attributes and factors, motivational features, evidence-informed practice for weight loss management, the social and cultural norms of Saudi citizens and interactive design elements. The significance of this research can be categorised into two groups: scientific significance and social significance.

1.6.1 Scientific Significance

1. This is the first research that examine the usability of fitness and weight loss apps.
2. This is the first research that aims specifically to improve usability guidelines for fitness and weigh loss apps that target obese individuals with a focus on Saudi Arabia.
3. This is the first research that aims specifically to design a weight loss app that considers the impacts of motivational features, all evidence-informed practice for weight loss management, the requirements of both male and female Saudi citizens, iterative design elements and the social and cultural norms that affect individuals experiencing obesity in Saudi Arabia.

1.6.2 Social Significance

The social significance of this research can be discussed from two different point of views: individual users and the Saudi community.

1. From the point view of an individual user (who in this study is an obese user), the proposed weight loss app offers a variety of features and guidelines that helps them to be motivated and follow a healthy lifestyle to lose weight and overcome obesity.
2. From the point view of the Saudi community, the successful implementation and outcome of this work would play an important role in decreasing the obesity rate in the country.

1.7 Thesis Structure

This thesis is structured into eight chapters. A brief summary for each chapter is provided within this section. This introduction chapter provided a background information regarding obesity, related illness and its spread amongst Saudi citizens. It also outlined the growth in the use of smartphones and mobile (health) apps globally and in Saudi Arabia specifically. It provided the justification for this research and gave an overview of the research questions, scope, aim and objectives. Following this, it outlined the significance of this research from the scientific and social points of view.

The rest of this thesis is structured as follows.

Chapter Two: This chapter provides a comprehensive review of the existing literature. It discusses and analysis the available literature from a variety of aspects related to improving the usability guidelines for fitness and weight loss apps to help obese people and especially Saudis to be motivated to lose weight and overcome obesity. The literature review focuses on three key domains, which are fitness and weight loss apps, usability and obesity. The chapter concludes by identifying the research gaps in the existing literature and outlining the research questions. Contents from this chapter have been published in (Alturki & Gay 2016; Alturki & Gay 2017a, 2017b, 2019a, 2019b, 2019c).

Chapter Three: This chapter focuses on the framework and methodology that guides this research. It provides a comprehensive explanation that is supported by literature regarding the implemented research framework. It outlines the criteria and the selection of a two Arabic fitness and weight loss apps to test their level of usability. An overview of the usability testing regarding its environment, techniques and metrics is explained. In addition to this, information regarding the official ethical approval for conducting the

usability testing is provided. Contents from this chapter have been published in (Alturki & Gay 2017a, 2017b).

Chapter Four: This chapter presents an inclusive description for the analysis process that is used to conclude quantitative results from the usability testing of the two Arabic fitness and weight loss apps. The number of participants in the usability testing and their demographic information is provided. The quantitative results for each app are categorised into five themes based on the related tested usability attributes. The chapter concludes with determining the usability level for each app and a discussion of the quantitative results. Contents from this chapter have been published in (Alturki & Gay 2017a, 2017b).

Chapter Five: An extensive overview of the analysis process which is used to infer qualitative findings in regard to testing the level of usability for the Arabic fitness and weight loss apps is provided and discussed in this chapter. The qualitative analysis process is divided into four main headings and each heading includes related sub-headings. The chapter concludes by providing inclusive usability recommendations for developing a weight loss app in general and an Arabic one for Saudi users specifically. Contents from this chapter have been submitted to a conference and they are under review (Alturki & Gay 2019d).

Chapter Six: This chapter presents and explains the development process for the new Arabic weight loss app Akser Waznk that is developed based on the results from Chapter Four and Five. An overview and justification for the implemented methodology for developing the app is provided and the number of participants and their demographic information within the initial focus group that was established while developing the app is stated. A detailed explanation of the Akser Waznk app's unique motivational features, interactive design elements and contents is provided as well. Contents from this chapter have been published in (Alturki & Gay 2019b).

Chapter Seven: This chapter validates and evaluates the developed Arabic weight loss app Akser Waznk. It provides both the quantitative and qualitative results from testing its level of usability. An overview of the current usability issues that were highlighted by potential users, investigated via examining their video records and the proposed solutions are explained. Finally, the chapter concludes by determining Akser Waznk's usability level and discussing the results. Contents from this chapter have been published

in (Alturki & Gay 2019b) and contents from this chapter have been submitted to a conference and they are under review (Alturki & Gay 2019e)

Chapter Eight: This chapter concludes the thesis and outlines the contribution of this thesis. Future works related to this research topic are identified. Contents from this chapter have been published in (Alturki & Gay 2019b).

Figure 1.1 presents the overall structure of this thesis based on the eight chapters mentioned above.

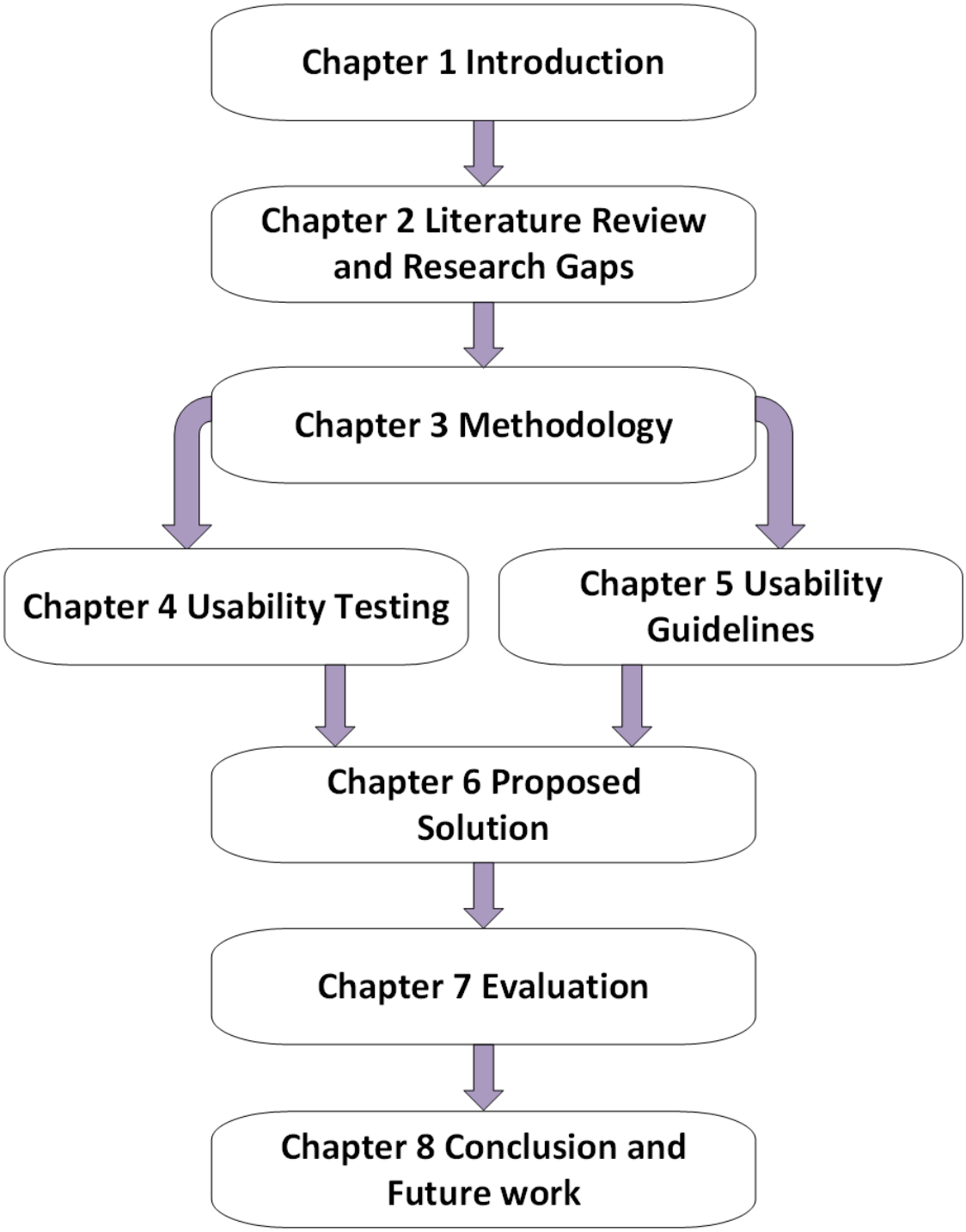

Figure 1.1 The thesis's structure

1.8 Conclusion

Obesity is a major global challenge. It increases the risk of developing health problems such as cancer, diabetes and cardiovascular disease. Saudi Arabia has one of the highest obesity and overweight rates in the world. However, due to Saudi Arabia's social and cultural norms and the language barrier, intervening to prevent the spread of overweight and obesity in the country is not easy. Over the past few years, the usage of smartphones and their apps have significantly increased in Saudi Arabia. Such technologies are cost-effective tools which can be used to easily deliver behaviour-modification interventions to overweight and obese individuals. Despite the availability of Arabic health and fitness apps, none of them offer lifestyle-modification tools or enhance the usability of apps by considering usability attributes. To address the challenges and issues that face Arabic health and fitness apps, this thesis aims to provide inclusive solutions in regard to some of the main shortcomings identified in the related existent literature.

The next chapter outlines and discusses the existent literature on how to improve mobile fitness and weight loss apps usability guidelines to help Saudi users to lose weight and overcoming obesity. It identifies research gaps in the existing literature and outlines the research questions.

CHAPTER 2
LITERATURE REVIEW AND RESEARCH GAPS

2.1 Introduction

When conducting a major research project, it is a very important to review the existing literature related to the research topic and research objectives. The main purpose of a literature review is to build the new research on existing findings while avoiding "Reinventing the wheel." In this research, the literature review is divided into several sections to include the relevant work related to the role of mobile fitness and weight loss apps and the importance of usability and features in motivating and helping obese users to overcome obesity and change their lifestyle. The literature review is structured in such a way that it builds up an understanding of the topic and leads from earlier works to some of the most contemporary ones. At the conclusion of the literature review, I identified the research gaps in the existing literature and outlined the research questions.

Figure 2.1 shows the divisions of the literature review.

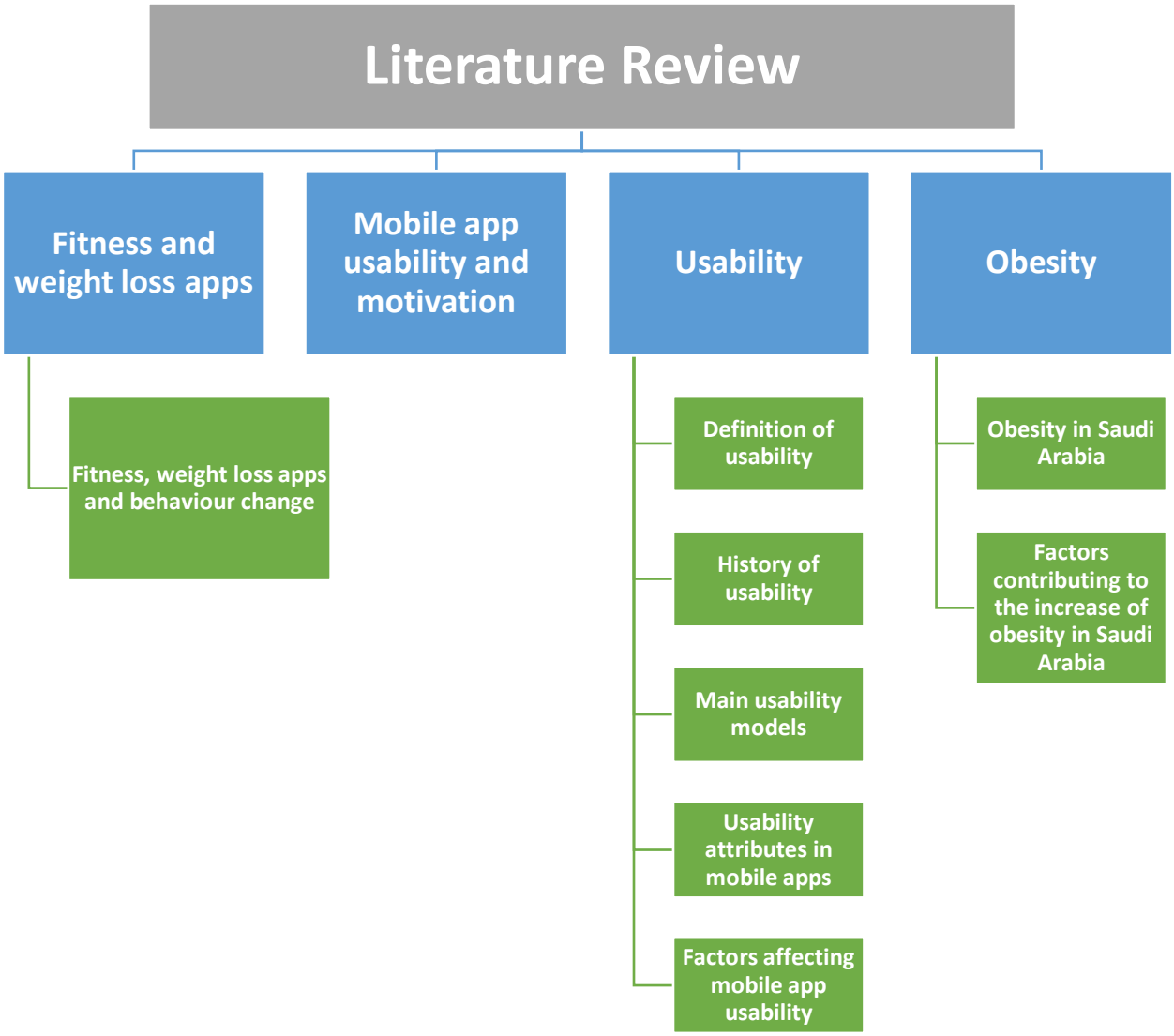

Figure 2.1 The division of the literature review

The divisions of the sections are based on the logic of the title of this research work: "Improving Mobile Fitness and Weight Loss Apps to Help Saudis Overcoming Obesity, Case Study: Akser Waznk app". The first step of this process was to conduct a comprehensive literature review regarding the relevance and roles of fitness and weight loss apps in helping people reach their goal of overcoming obesity. The work of various authors was included to show that fitness and weight loss apps can act as motivational tools in influencing human behaviour to overcome obesity. Following on from this, the literature review identifies the importance of usability and its role in motivating users to use apps.

Next, I did an extensive literature review on usability, starting with its definition then outlining its history, developments and evolution. The history and background of

usability is discussed in chronological order. Different models of usability are reviewed so as to gain a comprehensive idea of the term. Again, a chronological order is used to make apparent the improvement of one model on the next. The work of different authors on usability attributes in mobile apps is then discussed so as to find the importance of its enhancement of mobile apps, before factors that are relevant and important in improving the usability of the apps are discussed.

Next, the literature review focuses on what obesity is and how it is defined or measured. I then study why obesity is a prevalent problem in various societies. Following this, I discuss obesity in Saudi Arabia, which is where the case study is based. I explain the prevalence of obesity in Saudi Arabia and its various causes. Finally, based on the literature review, I conduct a critical discussion to determine the research gaps within the existing literature and outline the research questions.

2.2 Fitness and Weight Loss Apps

This section discusses studies found in the literature related to mobile fitness and weight loss apps and evaluates how the features used in these apps can act as motivational tools to help individuals lose weight. The literature used on fitness and weight loss apps is relatively new, so in order to find out how the features used in modern fitness technology can motivate users, I reviewed traditional literature relating some motivational theories with the features used by apps, such as how a goal-setting feature can act as a motivational tool. I explored the main features of fitness and weight loss apps and examined their impact on the motivation of the user. Doing this identifies and articulates the relationship between the literature and this research.

2.2.1 Fitness, Weight Loss Apps and Behavior Change

Mobile apps have many advantages when being used as a delivery mode. They are adjustable to the needs of the user, constantly accessible and able to provide feedback and have interactive features and large reach (Griffiths et al. 2006). Smartphones are used by many people and allow them to access data anytime and anywhere, mobile apps can act promote physical activity behaviour change (Conroy, Yang & Maher 2014). The use of mobile apps for increasing physical activity is a relatively new intervention tool and therefore little research has been published on the effectiveness of the main features used in these apps in motivating individuals to increase their physical activity. It is also

unclear how much these apps differ in their content. A lot of research done previously advocates that behaviour change techniques that influence behavioural determinants are linked to effectiveness. Research has shown that the most effective behaviour change related to fitness and health occurs through behavioural interventions (Contento et al. 1995). Behavioural interventions are extremely effective in inducing a behaviour change; however, some interventions are effective in influencing health and behaviour outcomes while others might fail to achieve the same goals (Ogilvie et al. 2007). Michie et al. (2011) developed a taxonomy to identify potentially effective behaviour change techniques used as interventions to help increase the level of physical activity. The study had the aim of improving the reliability and extending the scope of the classification system that determines the behavioural change strategies provided by Abraham and Michie (2008). Using this taxonomy, Middelweerd et al. (2014) scored the behaviour change techniques used in apps. They took a sample of the top 64 health and fitness apps available on 2012 to 2013 on iTunes and Google Play. They rated the apps using the behaviour change taxonomy as the base, then two viewers scored each app from 0 to 26 representing the main behaviour change features or techniques employed by the app based on the 26 items of the adapted taxonomy. The results were analysed using an electronic database. According to their research, the most frequently applied techniques used in health and fitness apps are to give feedback on performance, encourage the self-monitoring of behaviour, advocate specific goal-setting, and address the need for social support or social change. The following section of the chapter will discuss how the above-mentioned features can act as motivational tools in influencing human behaviour so that individuals achieve their fitness goals.

2.2.1.1 How Goal-Setting Motivates Individuals to Achieve their Fitness and Weight Loss Goals

One of the most prevalent features of fitness technology is goal-setting. Goal-setting features are widely used by many mobile apps because the app developers realise the importance of goal-setting. A good example is Nike Training Club app, which allows the user to select certain fitness goals (for example to get toned, lean, focused or strong) and select easy-to-follow plans for workout (Nike 2019). Although goal-setting research in a workplace setting has been common over the last three decades (Locke et al. 1981), in recent years it has been used by health and fitness educators to systematically study

its effect on health and fitness. Locke et al.'s study of 110 workplaces shows that setting goals, which are specific, proximal and difficult yet attainable resulted in better task performance than setting no goals (Locke et al. 1981). Adding rewards and feedback to the goal-setting process increases task performance and motivation. All of these properties together help in promoting motivation and ultimately behaviour change in individuals (Strecher et al. 1995). In contrast to other behavioural and motivational theories, goal-setting theory developed inductively as it is based on the accumulated research judgments of studies which have been conducted (Atkinson 1958). Early research focused on the hypothesis that goals motivate action. After this hypothesis gained a lot of support, research moved in various different directions. The initial findings were further investigated by exploring whether goal-setting worked in different settings and for different tasks. There was then an attempt at lateral integration that involved linking goal setting with related conceptions at the same level of construct, such as participation, incentives, feedback, satisfaction and self-efficacy. At the same time, there were attempts at vertical integration. This meant relating goal setting to broader concepts such as personality and values. There were attempts made to specify mechanisms through which performance is affected by goal-setting and attempts were made to identify moderators or boundary conditions for goal-setting. Locke et al. (1981) and Latham, Mitchell and Dossett (1978) described three motivational mechanisms that have a positive impact on performance because of goal setting: effort, persistence and concentration. Setting goals encourages individuals to strive harder and more persistently with less distraction. Goal setting has also been found to have cognitive advantages in terms of simulating strategic analysis. Strategic analysis helps to develop a series of sub-goals to achieve the main goal. For example, if an individual wants to achieve a body mass index (BMI) in the normal range, then his/her sub-goal would be to lose some weight every month until a goal weight is reached. Sub-goals are tangible and prevent the postponement or delay of the activities outlined in goal-setting. Sub-goals enhance satisfaction and self-efficacy with performance.

Goal setting has also been linked to self-regulation. According to Latham and Locke (1991), humans are natural self-regulators but they are not innately effective self-regulators. Self-regulation can be improved through goal setting because goal setting can provide self-direction. Therefore, goal-setting features in fitness and weight loss apps can improve self-regulation and help individuals to focus on their fitness.

2.2.1.2 How the Tracking, Monitoring and Feedback of Fitness Motivates Individuals

Feedback has a powerful effect on performance. Hattie and Timperley (2007) conducted a synthesis of more than 500 meta-analyses involving hundreds of thousands of effect sizes and studies. They cited over 100 factors that can affect performance and achievement. The effect size of all the factors together was 0.40 (these factors together on average improved the standard deviation of performance or achievement by 0.4%), but feedback had an effect size of 0.79, which is approximately double the average. They ranked feedback among the top influences. Similar research has been applied in various settings to find the effect of feedback on performance. Veloski et al. (2006) studied the literature on feedback effect in medical education. 74% of studies demonstrated that feedback has a positive impact on the performance of doctors. The authors also found that feedback was also effective when combined with other interventions (for example, practice guidelines and reminders). A review conducted by Kassebaum and Eaglen (1999) of feedback in the medical education context produced similar results. Archer (2010) studied this topic from the perspective of health. He examined the literature relevant to feedback effect on the health performance of an individual and he concluded that feedback could enhance the learning and training of an individual. He also highlighted the work of other researchers who suggest that feedback culture provides opportunities for learning, tracking performance and enhances performance.

Fitness and weight loss apps usually provide feedback through messages, videos and the reminders. They also monitor health indicators such as BMI, heartbeat and blood pressure. This feedback and monitoring can improve the fitness of the individuals by helping them track their progress and motivating them to achieve their fitness goals. The literature demonstrates that feedback and monitoring are vital in making goal setting effective, as there is little value in setting goals without providing any information about goal attainment. In a study of scientists and engineers, Latham, Mitchell and Dossett (1978) found out that feedback makes a substantial difference to performance when goals are set. Feedback and monitoring help people to see how they are doing and helps them measure their success or failure in achieving their goals. Research by Bandura and Jourden (1991) found out that giving the feedback that an individual was doing gradually better enhanced analytic thinking, self-efficacy, performance satisfaction, goal setting

and actual performance. For feedback to be effective, it should be communicated in an interactive manner. Clarke (1972) found that the interactive feedback has a far more outreaching effect on motivation than non-interactive feedback. Fitness and weight loss apps provide interactive feedback through graphs, progress charts and peer comparison charts, which suggests that such apps can be a very effective feedback tool.

2.2.1.3 Impact of Reminders Feature in Improving Fitness and Losing Weight

Reminders can be used as motivational interventions to improve performance. The impact of reminders on health in various settings has been discussed by many researchers. Esbensen et al. (2015) conducted a study on patients with rheumatoid arthritis and explored the impact of short message service (SMS) reminders as motivational interventions to increase exercise and reduce sitting time in patients. They recruited 150 patients who had at least five hours of sitting time each day. Using a 16-week intervention through SMS reminders, they measured the impact of this intervention on the sitting time of the patients. They discovered that using SMS reminders as motivational interventions had a significant impact on the activity level of the patients. The intervention was found to reduce the risk of type 2 diabetes and cardiovascular disease in patients with rheumatoid arthritis by reducing their average daily sitting time. Similar research was conducted by Beebe et al. (2011), where reminders were used as motivational intervention to increase exercise behaviour among persons with schizophrenic disorders.

Similarly, research by Turner-McGrievy and Tate (2011) measures the impact of reminder features in apps as weight-loss intervention among obese individuals. The study explored the efficacy of a six-month weight-loss intervention by mobile apps and the results concluded that intervention through reminders could produce modest weight loss. Mobile apps reminder features have been used successfully to give dietary guidance and help lose weight. Patrick et al. (2009) conducted research among overweight women and men in which they delivered behavioural intervention through SMS with a combination of targeted and standard reminders to the participants. The behavioural weight-loss intervention proved to be very effective and participants lost 5.17% of their weight at four months on average. Intervention group participants received messages on overcoming obstacles and reminders to be physically fit and active through email and

SMS and they also had access to a message board where they could discuss experiences with peer participants. These research findings provide ample evidence that mobile app technology for fitness can enhance the fitness of the app users through constant and effective reminders that enhance compliance with physical activity and dietary recommendations and improve BMI. The results of this study contribute to the growing health and fitness literature on reminders as a successful motivational intervention.

2.2.1.4 Impact of Reward Feature in Improving Fitness and Losing Weight

Some mobile fitness and weight loss apps offer their users very unique rewards; for example, users of the Charity Miles app are paid money every time they jog, go for a walk, or cycle. Corporate sponsors donate several cents to a charity for every mile the user completes. If a significant number of people use the app, then that small amount of money begins to increase (DUFFY 2016). Some apps, which connect peers together, reward the user by mentioning his/her performance in the groups. These all are small rewards, but they give sense of achievement and satisfaction to the user, which in turn leads to motivation and the achievement of fitness goals. Adding rewards to goal setting increases motivation and task performance. The consideration of the outcomes of future results in actions is vital in achieving valued outcomes (Bandura 1986). Anticipated rewards not only motivate an individual but also increase the creativity used to achieve the goals (Eisenberger & Shanock 2003). Novel performance is increased by rewards because individuals feel self-satisfaction when they achieve their goal. Research by Lawler III (1982) and Nealey (1963) argue that individuals value and appreciate the rewards they get for their efforts and conclude that therefore the reward process is motivational.

The gamification feature is an interactive reward feature that is rapidly gaining popularity in fitness and weight loss apps. The term “gamification” was first used in 2008. It includes a range of game-like and technology elements used in the commercial world (Deterding et al. 2011). Apps use gamification to increase the initiation and retention of desired behaviours (Ferguson 2012). In fitness and weight loss apps, gamification combines goal setting, feedback and rewards to motivate users to commit to a physical activity. It includes game-like incentives and rewards aimed at promoting desirable behaviours with the aim of increasing motivation and sustaining the habits of

individuals in the long run (King et al. 2013). The most frequently implemented gamification mechanics are leader boards, badges, points and levels, quests and challenges as well as on boarding and social engagement loops (Zichermann & Cunningham 2011). Research conducted by Miller, Cafazzo and Seto (2014) on the role of gamification on health management has found out that gamification increases physical activity levels because it engages the user and, by setting goals and sub-goals, motivates users to enhance their performance to achieve health and fitness goals.

2.3 Mobile app Usability and Motivation

The development of an app can cost millions of dollars; however, most apps fail (Deloitte LLP 2012). Of all the branded apps, 80% are downloaded less than 1,000 times and only 1% has been downloaded one million times or more. After downloading, 25% of mobile apps are never used again (Dredge 2011). Ample market research suggests that the main reason for the failure of mobile apps is a lack of usability (Deloitte LLP 2012; Husson 2010; Youens 2011). Usability is a very important feature for the success of mobile apps. Enhancing the usability of mobile apps has been found to have a positive impact on motivation and the achievement of goals. According to Marcus (2014), enhancing usability helps users to engage more often with apps. According to Alturki and Gay (2019b), health apps with creative features and high level of usability can motivate users to achieve their health and fitness goals. How well we engage with any activity determines our decision-making such as beginning an activity or maintaining a behaviour. The same concept when applied to human-computer interactions (HCI) takes on a very important dimension. If technology is engaging, it will be used frequently or even integrated with life habits; however, if it is not engaging, its frequency of use will be minimal leading to rejection or even total abandonment (Tissier & Gronier 2014). Therefore, it is essential that technology should improve UX so that it can survive in the competitive market.

Motivation is considered to be a major driving force in any human–technology interaction (HTI). Much of the literature emphasises the inclusion of motivational theories when designing technologies that involve HTI (Deci & Ryan 2000; Luczak, Kabel & Licht 2012; McLaughlin et al. 2012; Venkatesh 2000). It is very clear that any technology, including mobile apps, can exacerbate or induce boredom (Cooke et al. 2010; Cummings et al. 2013; Hancock 2013). Indeed, a lack of engagement is

considered an adaptive response by individuals to inadequately designed environments (Hancock 2013). Moreover, a user's lack of interest in the technology makes clear the importance of incorporating motivation theory in technology design. Hancock (2013) notes that in many contexts lack of motivation is a result of failure in the design and not of the person. It is therefore essential to enhance UX in order for a mobile app to be successful. I have also seen previously that a high level of usability does this effectively (Baharuddin, Singh & Razali 2013).

Various studies have discussed the importance of usability in mobile apps to increase user motivation. Toxboe (2010) argues that easy-to-use apps push users forward and encourage them to continue using the app to perform their tasks or achieve goals. One example of usability enhancing motivation is that principles of emotional design and effective computing are being widely promoted and advocated (Norman 2005; Picard 2003), such as in the Emotive Alert system. Designed by Zeynep Inanoglu and Ron Caneel at the Media Lab in the Massachusetts Institute of Technology (MIT), Emotive Alert aims to identify urgent messages by labelling them according to the voice tone of the caller (Smyslova & Voiskounsky 2009). This feature increases the usability of the product and motivates the user to achieve their goals. In the field of e-learning research, Hu (2008) shows that designing online learning portals that are more usable through better navigation and easy access to the information increases user motivation and leads to better learning. Traditionally, the Air War College distance learning (AWC/DL) had text-based tests for evaluating students (Armstrong 2015). Simulations were added in order to enhance the valuable and realistic augmentation of the curriculum learning. Simulations have an advantage in that they increase motivation and enhance learning (Armstrong 2015). Ferrer et al. (2013) concentrated on finding out about the effects of usability of educational Augmented Reality (AR) games on motivation. The scholars used two pilot studies with nine teachers and 13 high school students. This led to three development iterations along with a study involving 36 college students in order to determine the usability, motivation and learning outcomes of the use of educational AR games. The results of the study provided evidence that enhancing usability increases user motivation (Ferrer et al. 2013). Research by Darin et al. (2015) explored how usability's role in mobile apps leads to greater motivation in developing a longer-term exercise routine. The research discussed how apps should have an effective design and should possess features that enhance UX and increase the intrinsic motivation of the user

(Darin et al. 2015). Healthline held a competition to select the best weight loss apps of 2016 (Schafer 2016). The first criterion was the usability of the app. If the app was usable, then it could motivate the user to achieve its goals. Kranz et al. (2013) investigated Gymskill, a smartphone app developed to support people through monitoring their general health and their exercise behaviour. The system also provided feedback. The enhanced features along with improved UX showed that users were motivated to use it in order to boost their fitness.

2.4 Definition of Usability

Usability has become a very significant topic in smartphone discussions because it is very important for apps to be easy to use in order for them to succeed. Usability is one of the main factors that define the success of a smartphone and apps (Baharuddin, Singh & Razali 2013). Usability can be defined as the multidimensional characteristic of any product. International Standards Organization (ISO) standard 9241-11 describes usability as the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use"(International Organization for Standardization 1998). According to ISO/International Electrotechnical Commission (IEC) 9126-1, a software's capability to be learned, utilised, comprehended and be desirable to the user when operated under particular conditions is defined as usability (Fleming n.d.). This definition of usability was accepted widely (Folmer & Bosch 2004) but in 2011 was replaced by ISO/IEC 25010. This form includes a model of software quality that portrays usability as the degree to which a satisfied user can efficiently and effectively attain certain goals under specific conditions. The conclusions of ISO 9241-11 complement ISO 9126-1. However, ISO 9241-11 presents a set of wider usability perspectives than ISO 9126-1. Some researchers have included the learnability characteristics to prove their own models, such as (Nielsen 1993), (Abran et al. 2003a) and (Dix et al. 2004).

The definitions of usability in ISO/IEC 9126-1, ISO/IEC 25010 and ISO/IEC 9241-11 are primarily used for software products but these definitions can be easily applied to mobile devices considering these features that are specific to all mobile devices.

The term UX is used extensively in relation to usability and the two terms are often used interchangeably. However, UX has a much broader meaning than the term usability

(Saffer 2007). Usability is more concerned with how easy the product and display features are to use and the term is related to how practical and interactive the product is overall. UX includes the user and product's complete interaction as well as the thoughts, feelings and perceptions that are the results of this interaction (Albert & Tullis 2013).

2.5 History of Usability

Many of the methods applied to enhance and test the usability of a product originated in the older disciplines of ergonomics and human factors. These fields emerged at the start of the 20th century and were very influential during the Second World War. Many people believe that starting point of usability testing was around the time of the "dot com" boom era of 1998 to 2001, when usability started to be utilised for commercial purposes on a wide scale. In the past, usability discussions had been limited to corporate research and development or academic study (such as Sun, Apple, HP, Microsoft, Bell Labs and AT&T). With the Internet boom, for the first time usability figured largely in executive teams' process of decision-making (e.g. eTrade, Amazon, Dell, Google etc) (Spillers 2007).

Research into human factors emerged during the First and Second World Wars. For practical reasons, the Second World War is considered the emerging point of research based on usability. After the end of the war, the interdisciplinary study of cognitive science was created (Spillers 2007) and it is under this name that researchers study usability engineering or HCI (Cognitive Science Society 2016). One employment of usability is in the design of military weapons. Military designers consider some of the following usability metrics when designing artillery (Soegaard 2012):

- Time required for the new crew to learn how to use artillery.
- How the design improvement of a cannon will improve the ability to kill more enemies.
- The effectiveness of the cannon in killing more enemies with both experienced and inexperienced crew.
- How improving the design will decrease crew fatigue.

With the emergence of computers and artificial intelligence (AI), there was an increase in the study of how humans process information and how they interact with computers. The industrial psychologist Joh Flanagan discovered that by reducing the number of

knobs, buttons, control panels and switches in newly designed aircraft, the operator's performance could improve significantly (Cucina & Bowling 2016). Table 2.1 contains is a brief timeline of significant people, dates and literature that have great importance not only in the history of usability but also its future.

Table 1.1 The history of usability development

Historical Marker	Events
1930-1954	At the start of the Second World War, electrical and electronics systems were introduced that were controlled through a user interface by human operators. The work of John Flanagan was impressive during this time. Flanagan discovered that making the machines easy to operate increased the efficiency and effectiveness of the user (FREEMAN 1996). He developed the critical incident technique (CIT). CIT is a set of procedures that help in the collection of information related to observations of human behaviour. The development of CIT had a critical significance because the findings were achieved through criteria that were defined methodically. In 1943, the work of Alphonse Chapanis, the US Army lieutenant, became very popular. It showed how pilot error could be greatly reduced through making the layout of airplane cockpits more intuitive (Roscoe 1997).
1955-1969	During this era, there was a growth in usability research that was linked to computer interfaces because the micro-electronics boom had begun. International Business Machines (IBM) was very active in this area of research during this time. Certain academic and Research and Development (R&D) innovators such as Ivan Sutherland at Utah University, Doug Engelbart at the Stanford Research Institute (SRI) and Alan Kay produced some remarkable work. Pioneers like Sutherland developed interfaces that were not available to the public, such as virtual reality (VR) technology (Spillers 2007). One of the most important events to happen during this time was the formation of the Human Factors Society (Human Factors and Ergonomics Society 2019).
1970-1983	Xerox played a major part in the innovation of user interfaces during this period. These interfaces are known as windows, icons, menus and pulldowns (WIMP) (Sandor 2004). The current age of corporate usability research is inspired by Xerox's R&D work and the resulting user interface innovations and usability. Bennett (1979) published "*The Commercial Impact of Usability in Interactive Systems"*. It is the first scientific publication that has the word "usability" in the title. In 1981, Alphonse and his associates

	published tutorials that were designed to teach people how to use computers for the first time (Al-Awar, Chapanis & Ford 1981). In 1983, researchers at Xerox Palo Alto Research Center (PARC) and Carnegie Mellon published the book "*The Psychology of Human Computer Interaction"* (Card, Newell & Moran 1983). The book explained keystroke level modelling (KLM) and goals, operators, methods and selection rules (GOMS). In the same year, in Boston, the Computer-Human Interaction (CHI) Conference was held as a part of ACM's SIGCHI subgroup (INTERACTION DESIGN FOUNDATION 2011).
1984-1992	In 1984, during the Super Bowl, Apple introduced the Macintosh, stressing its ease of use (Sauro 2013b). The personal computer was designed and it was advertised as having a very strong emotional and sensitive connection with the user. During this era, achievements in user interface research were adopted by the public on a grand scale. Usability research in 1990s built on the research work and developments of the 1980s. Microsoft's adoption of the Windows operating system and personal computer spurred further research into usability (Gibbs 2014). Some significant academic work appeared during this time. The first book based on description and analysis of CHI, "*The Human Factor"*, was published by (Rubinstein & Hersh 1984). Moreover, *"Computer Usability Testing & Evaluation"* was published by (Spencer 1985). In 1985, an influential paper by (Gould & Lewis 1985) was published with the title "Designing for Usability: Key Principles and What Designers Think". The paper discussed empirical measurement and iterative design. The paper also mentioned the importance of placing a continual focus on users. Smith and Mosier (1986) published their work "Guidelines for Designing User Interface Software". In the same year, the System Usability Scale (SUS) was developed by (Brooke 1986) at the Digital Equipment Corporation. This went on to become the most widely accepted and utilised a questionnaire to determine system usability. Shneiderman (1987) published the first edition of "Designing the User Interface". Based on the work of Ben Shneiderman, the Questionnaire for User Interaction Satisfaction (QUIS) was published at HCI Lab, University of Maryland. In 1988, John Whiteside at Digital Equipment Corporation and John Bennett at IBM published various papers and chapters that focused on usability engineering (Sauro 2013b). Their work highlighted the importance of prototyping, iterative evaluation and early goal setting. Joe Dumas, one of the legends in the field of usability, has attributed their work and the era itself as the birth of usability as a proper profession.

	Norman (1988) published the "*Psychology of Everyday Things"*, which was later renamed the "*Design of Everyday Things"*. Davis (1989) introduced the technology acceptance model (TAM), which also included a questionnaire for measuring perceived usability and usefulness. *"Human Factors and Usability"* was published by (Shackel 1990). It argued that usability was a "function of satisfaction, effectiveness, and efficiency". This definition has been the basis of all proposed extensions to the definition of usability. In the same year, (Wharton et al. 1994) published several papers on the cognitive walkthrough. Nielsen and Molich (1990) published the paper "Heuristic Evaluation of User Interface," which described the method of influential discount usability. Three experiments were conducted by Robert Virzi at the Human Factor and Ergonomics Society Conference. He replicated the previous work of Nielsen by introducing binomial formulas for derivation of sample sizes for studies related to usability (Sauro 2013a). In 1991, CHI attendees including Ginny Redish and Janice James formed the Usability Professionals Association. Janice James and Ginny Redish later started the special interest group for usability known as the Society of Technical Communications (Sauro 2013b). Virzi (1992) published his paper "Refining the Test Phase of Usability Evaluation: How Many Subjects is Enough?" This paper determined that additional subjects have less probability of revealing new information in a usability test. Virzi discovered that 80% of problems in a usability test are found by the first four to five users (avg. p of 0.32). In the same year, the Post Study System Usability Questionnaire (PSSUQ) was published by (Lewis 1992).
1993-2003	With the advent of the Internet, there was mad rush to "easily" edit and index information with the Hypertext Markup Language (HTML), a newly developed markup language (W3schools n.d.). Furthermore, there was an emergence of e-commerce sites through which business could be carried out online and products could be sold via the Internet. 1993 was a year of some important publications on the topic of usability. Nielsen (1993) published "*Usability Engineering"*. Dumas and Redish (1993) published "*A Practical Guide to Usability Testing"*. Kirakowski and Corbett (1993) from the Cork University published the Software Usability Measurement Inventory (SUMI) questionnaire. Tharon Howard started a listserve dedicated to usability and is still a very popular discussion to this day (Sauro 2013b). The first comprehensive work on usability testing, "*The Handbook of Usability Testing"*, was published by (Rubin 1994). In the same year, Bias and Mayhew (1994) published "*Cost Justifying Usability"*, which was the first attempt by any author to justify investing in improving the usability of products. Lewis (1994) re-examined the results of Virzi's ' research in his paper "Sample Sizes for Usability Studies: Additional

	Considerations". Virzi showed that frequency and problem severity act freely of each other. Lewis' findings were similar to Virzi's findings and he confirmed that the addition of users has less probability in terms of revealing new information. In 1995, Jakob Nielsen published the first bi-weekly column on useit.com about usability. At the time of writing this thesis, the column still continues (Nielsen 2019). In the same year in Portland, Maine, the first annual meeting of the Usability Professionals' Association took place (Sauro 2013a). In 1996, John Brooke published SUS after having used it in industry for 10 years (Usability.gov 2016). In the same year, WebEx was founded in California and later developed conferencing and screen sharing software that was later used in moderated remote usability testing (WebEx 2016). In 1998, usability became a guideline that was embodied in ISO 9241-11. Books including the phrase "user experience" started appearing. "*Web Navigation: Designing the User Experience"* was published by (Fleming & Koman 1998). That year, the first comparative study on usability, Comparative Usability Evaluation (CUE), was published by Rolf Molich; the first study on the evaluator effect also appeared that year (Sauro 2013a). "*The Evaluator Effect in Usability Tests: Problem Detection and Severity Judgements"* was published by (Jacobsen, Hertzum & John 1998). Krug and Black (2000) published the book "*Don't Make Me Think"*. It used the think aloud method introduced by Simon and Ericson in 1996 to bring usability testing to the public. Tullis et al. (2002) published "An Empirical Comparison of Lab and Remote Usability Testing of Web Sites." This publication was one of the first to discuss remote usability testing. *"Observing the User Experience"* was published by (Kuniavsky 2003). The aim of the book was to bridge the gap and understand from the user's perspective what their wants and needs are from a product and whether users would like the product being designed.
2004-Current	New players, innovative thinking and different energy were beginning to dominate how things were being done on the Internet, for example Google. Usability was recognised as a strategic win for marketing one's electronic products and gadgets and to promote one's website (whether business, social or academic). In the last decade, mobile phone technology has made great leaps in its innovation. Smartphones have allowed users to connect and socialise with their friends. They have changed the way business is done. Users can now swipe their fingers on their tablets or smartphones to do many useful things such as banking, gamification and socialising. Around 2005, research on methods to automate usability testing were introduced and published. The purpose of this research was to avoid

	time-consuming and expensive usability testing studies and start using crowdsourcing and software to conduct this research. In 2006, time-consuming and expensive studies started appearing. They used crowdsourcing and software to find or evaluate methods of automating usability testing (Sauro 2013b). Tullis and Albert (2008) published "*Measuring the User Experience"*. It was the first book that was entirely dedicated to usability measurement. Over the last decade, it has turned increasing qualitative. The latest trend is towards conducting large-scale UX studies. The first and most famous work on this is "*Beyond the Usability Lab"* by (Albert, Tedesco & Tullis 2010). In 2012, Usability Professionals Association (UPA) changed its name to User Experience Professionals Association (UxPA) (Sauro 2013a). In 2012, the first book, which was aimed at the statistical analysis of usability data was published by (Sauro & Lewis 2012) with the title "*Quantifying the User Experience: Practical Statistics for User Research"*. Nowadays, many wearables can be connected with smartphones and this increases the usability experience of the customer. Ralph Lauren introduced a truly wearable smart shirt that has become known as the polo tech shirt. The material used has built-in sensors that assist in providing biometric data in real time from the body to the mobile device (Designboom 2019). Moreover, there are many fitness wearables such as Fitbits, Apple Watches and Samsung Gear bands that are becoming extremely popular. The academic research on usability is now more common than ever before and more usability testing tools are becoming available. There are numerous accessible mobile testing usability tools that not only store a mobile session but also record the tester's face and voice as well as their interaction with the mobile screen.

2.6 Main Usability Models

The usefulness of portable devices has significantly improved over time and operators are now capable of executing numerous tasks using their smartphones. Customers have the option to choose from a range of mobile phones and there are many apps available for them. This has made it necessary for developers to design mobile devices that enhance the usability experience. The definition of usability has evolved over time and the advent of mobile devices has changed the meaning of the term. The traditional models of usability have been challenged and altered by various researchers. In the

following sub-sections, I discuss some usability models and show how the perception of usability has changed over time.

2.6.1 Eason's Model

One of the very first traditional models of usability was proposed by Ken Eason in 1984. According to Eason, usability is an interaction between three variables – task, system and user –, which feed into the user's response to each task episode. Over the course of a number of task episodes, a pattern of response develops, which indicates more or less usability. As shown in Figure 2.2, the main independent variable is the system. The system is defined in terms of the functions it can perform. The user characteristics show how well the user can use the system. Task characteristics show how easily and regularly it can be performed by the user. Then these three variables decide the usability depending on the reaction of the user. A positive outcome will mean continued user learning (Eason 1984).

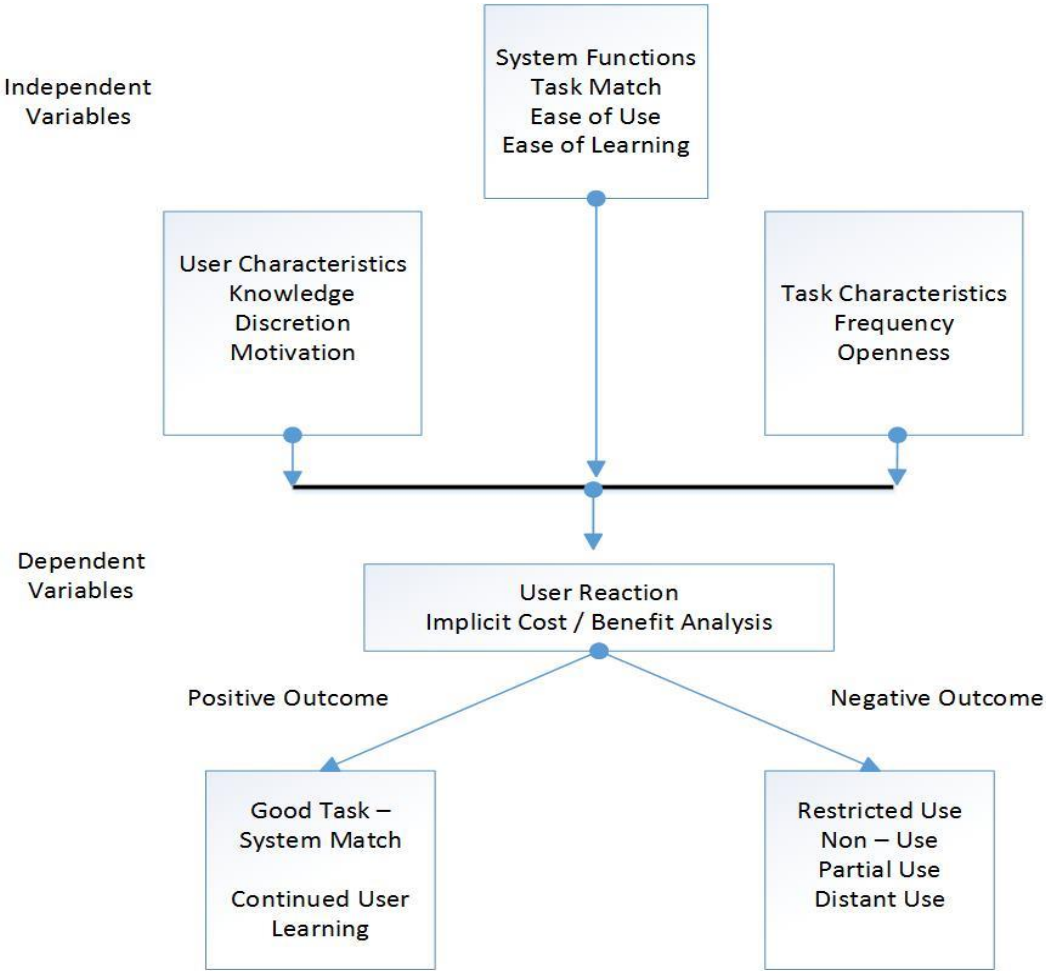

Figure 2.2 Eason's model

2.6.2 Dix's Model

Dix et al. (1993) introduced a usability model, which is very similar to Nielsen's (1994) model of usability. The findings of Dix et al. (1993) includes the same attributes as those of Nielsen but their model placed more factors under each attribute. A comparison between the Nielsen and Dix model was conducted by (Abran et al. 2003b) and is summarised below:

Table 2.2 Comparison between Nielsen's and Dix's models

Attribute	Nielsen	Dix
Effectiveness	Percentage of tasks accomplished	Percentage of tasks accomplished
		Ratio on failure of handling
		Percentage of tasks achieved per unit of time
Efficiency	Time to complete one task	Time to complete one task
	Time spent on errors	Time spent on errors
	Error percentage	Error percentage
	Documentation or use frequency of help section	Documentation or use frequency of help section
	Number of failed repeated commands	Number of failed repeated commands
		Number of available commands not called upon
Satisfaction	Number of times that user expresses his frustration	Number of times that user expresses his frustration
	Rating scale for users' satisfaction with functions	Rating scale for users' satisfaction with functions
		Percentage of users' favourable and unfavourable comments
Learnability	Time to learn	Time to learn

Dix et al. (1993) expanded upon the factors in some of the attributes that can affect the usability of the product. However, it can be argued that some of the factors are inherently included in each attribute's definition.

Figure 2.3 Dix's model

2.6.3 ISO Model

The ISO defines usability as the "extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Organization for Standardization 1998). The ISO further outlines those usability factors that needed to be considered. These are user (the person interacting); goal (or main objective); and the background of use (including users, tasks, tool used and environment). Each one of these factors affects overall how the software will be designed. Specifically, it affects user interaction with the system. In order to grasp the degree to which it is usable (the usability), the ISO mentions three usability attributes: effectiveness (demonstrating the level of accuracy and completeness of goal achievement); efficiency (how well resources were used for the sake of effectiveness); and satisfaction (relief and positive user interaction whilst operating the software).

Figure 2.4 ISO's model

2.6.4 Norman's Model

Norman's (2002) model of usability aimed at suggesting design principles that can make a product less complex and easy to use, thus improving its usability. He identified the following attributes:

- **Visibility**: The visibility attribute should help the user understand the device and give the user alternatives of action.
- **A good conceptual model**: Designers should design a product that is intuitive and conceptual; the product should be capable of presenting operations consistently.
- **Good mapping**: Good mapping is an important feature for improving usability because it helps the customer form relationships between actions and results. Good mapping makes it easy to determine control and its effects and makes it easy to determine the relationship between system state and what is visible.
- **Feedback**: A good design can enhance the usability by providing the user with continuous feedback regarding results of their actions.

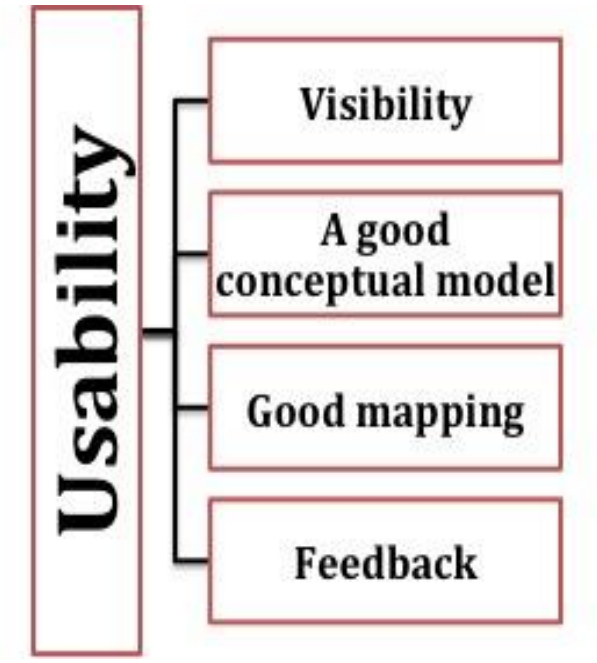

Figure 2.5 Norman's model

2.6.5 Ben and Plaisant's Model

Ben and Plaisant's model of usability is influenced by Nielsen and the ISO and, to a great extent, combines and complements these two previous studies (Ben & Plaisant 2005).

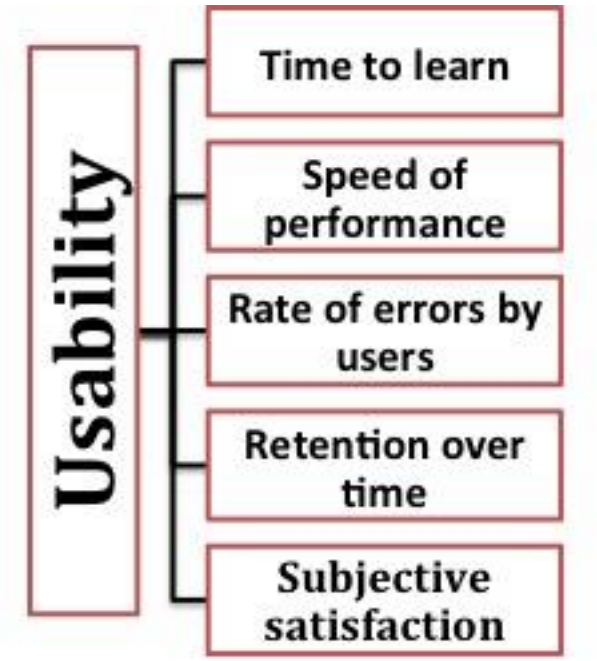

Figure 2.6 Ben's and Plaisant's model

The time taken to learn and the speed of performance can be considered part of efficiency in the ISO definition. Learnability in the Nielsen model can be compared to retention over time. The rate of errors is similar to number and severity of errors. The rate of errors impacts upon the attribute of efficiency in Nielsen and ISO. Subjective satisfaction is similar to the attribute of satisfaction in Nielsen and the ISO.

2.6.6 Yeh's Model

Yeh (2010) believed in creating a design so that it provides ease, efficiency and enjoyment to enhance the usability of the product. In turn, this makes the product more interactive to use. This is referred to as "3e indicators.". Yeh identified the following attributes:

- **Easy**: This is the ability of the system to reduce four particular elements, which are physical work, memory work, unnecessary work, and visual work.
- **Enjoyable**: This is the ability of the system to bring physiological, ideological, sociological or psychological enjoyment.
- **Effective**: The system should help the user in successfully achieving goals and completing tasks.

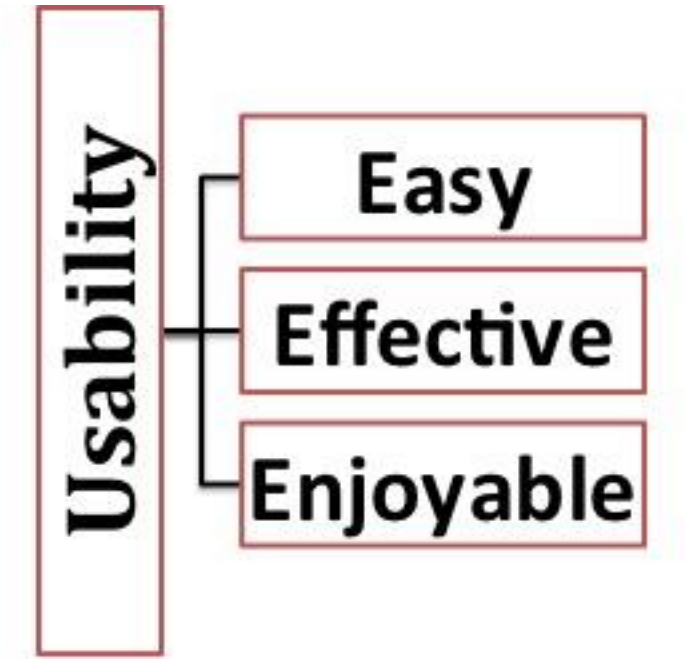

Figure 2.7 Yeh's model

2.6.7 Nielsen's Model

Nielsen was one of the first to identify the attributes of usability. Nielsen's earlier model had only four attributes: effectiveness, efficiency, satisfaction and learnability (Nielsen 1994). However, he later removed effectiveness and included both memorability and errors in his new model. He identified the following attributes (NIELSEN 2012b):

- **Efficiency**: Resources used in completing a task accurately to achieve user goals.
- **Learnability**: The ease with which the system can be learnt so that the user can start to use it to perform tasks in the minimum amount of time.
- **Satisfaction**: The product should provide comfort and also give the user a positive attitude towards using it.
- **Errors**: The error rate of the system should be minimal so that the user makes the least number of errors when using the system. If some errors are made, they should be recovered from easily. Finally, catastrophic errors should be avoided.
- **Memorability**: One should be able to easily memorise the system to the extent that when even a casual user begins using it after a substantial period of time, they do not have to put effort into learning everything from the beginning.

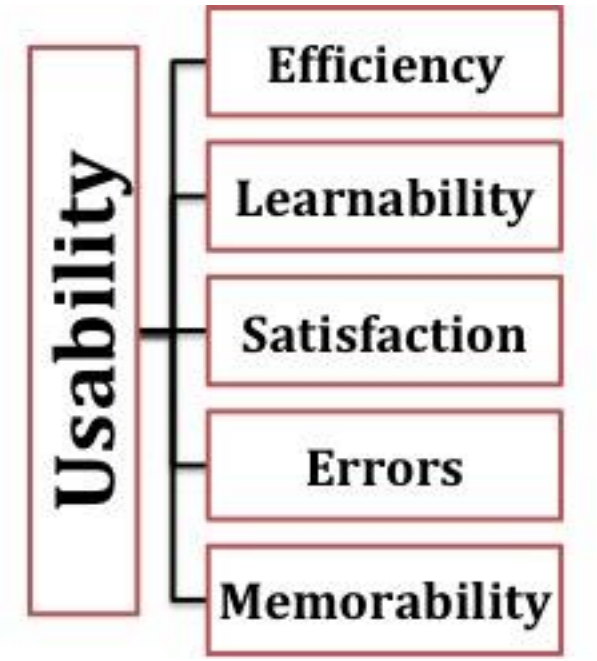

Figure 2.8 Nielsen's model

Nielsen's research defines the term utility as how effectively the system can meet user needs. This is not part of usability but rather is an entirely separate system attribute. The product that has no utility for the user lacks the functions and features required. Such a product therefore has a superfluous utility and will not help the user achieve their goals (Harrison, Flood & Duce 2013).

2.6.8 PACMAD Model

This is one of the latest and most frequently used models in recent research on usability. The people at the centre of mobile application development (PACMAD) model of usability was introduced by Harrison, Flood and Duce (2013) to overcome issues that emerged because of the advent of mobile apps. The model aims to include other attributes that were ignored by other models. The limitations of previous usability models are addressed by PACMAD when they are applied to mobile devices. They included cognitive load in their model because it is likely to have the most significant influence on either the success or failure of an app. The PACMAD model includes attributes for both the ISO and Nielsen models but also incorporates the attributes of both Nielsen's model and the ISO standard. The model states that the overall usability of a mobile app is affected by three factors: task, user, and context of use. These are recognised by both the ISO and Nielsen. Each of the three factors includes seven attributes. Six are discussed and included in the Nielsen and ISO models. Cognitive load

is therefore the new entry and so its inclusion is considered to be PACMAD's main achievement and contribution. Cognitive load is defined as the cognitive processing level that the user requires to use the app. In traditional models, it is assumed that the user is involved in or is performing one task at a time; however, in the context of a mobile device, a user can perform multiple actions whilst using mobile apps. For example, a user might be cooking food whilst he is listening to music.

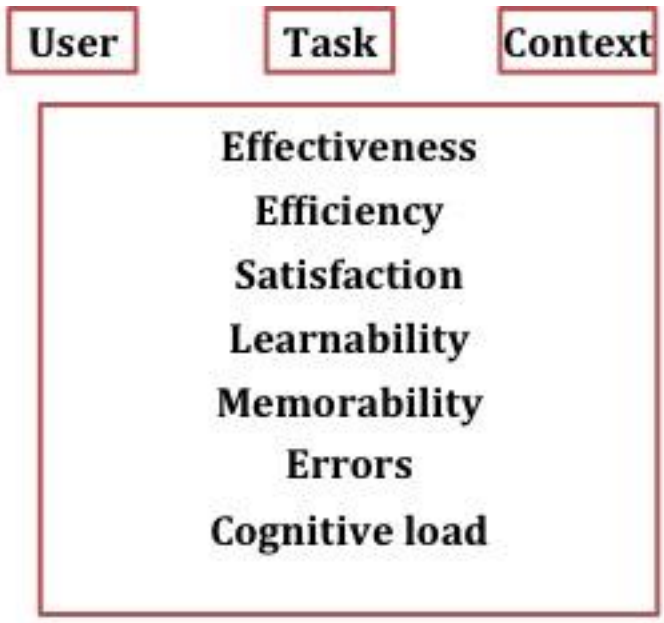

Figure 2.9 PACMAD model

2.6.9 Wang and Huang's Model

Wang and Huang's (2015) study focused on describing usability principles and interface design. They believed that the previous models of usability could be summarised into four principles: visibility, ease, efficiency and enjoyment (Figure 2.10). These include all of the usability attributes defined by Nielsen (1994), Norman (2002) and Yeh (2010). In addition to the four principles of usability, Wang and Huang outlined 16 interface attributes. They used these attributes to conduct usability testing and a questionnaire.

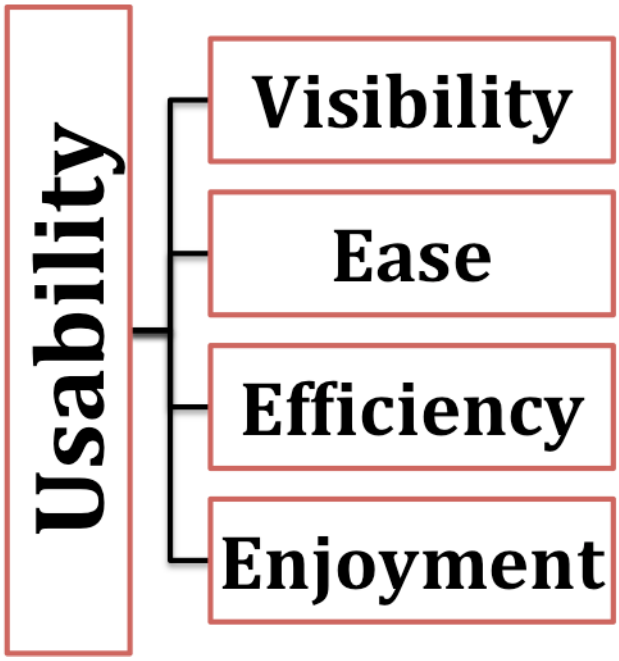

Figure 2.10 Wang's Huang's model

2.6.10 Models Evaluation

Given the discussion of the models in the previous sections, the PACMAD model is the best amongst those mentioned in relation to mobile apps. It combines factors from the ISO and Nielsen models as well as introducing a new factor: cognitive load. The PACMAD model is also superior to the other models as it takes into account the task, the user and the app's context of use. However, the literature review was somewhat lacking due to some limitations. The researchers found it difficult to find the relevant papers and this affected their results. The studies included were from 2008 to 2010 because smartphone apps became popular during this period and there had been little research done on the usability of mobile apps prior to that time (Harrison, Flood & Duce 2013).

2.7 Usability Attributes in Mobile Apps

I conducted a systematic review of usability attributes in mobile apps. I looked for articles that discussed usability attributes in mobile devices and apps. I tried to include the most recent articles starting from 2005, which were based on apps' usability. Twenty-eight relevant articles were included which have been published and peer reviewed. In Table 2.3, I evaluate the important attributes discussed in these papers.

Table 2.3 Usability attributes in mobile apps

Study	Usability Attributes	Research
Zhang and Adipat (2005)	Efficiency, learnability, error, memorability, satisfaction, simplicity, effectiveness, learning performance and comprehensibility.	This article suggests a generic framework that is useful for testing mobile apps' usability through discussion of methodologies, research questions and attributes that affect usability. This paper gives an overview of the existing studies on usability. The paper also mentions the research questions investigated in these studies. It provides detailed guidelines for conducting usability studies.
Nielsen et al. (2006)	Effectiveness, efficiency and satisfaction.	The research evaluated specific usability attributes in lab and field settings. The research demonstrated that it is worth doing field research. In field-related research, it is more useful to evaluate various usability attributes than in lab-based research because the lab-based research was unable to identify cognitive load and interaction style but field-based research was able to identify these.
Ji et al. (2006)	Learnability, predictability, familiarity, principle, structure, consistency and memorability.	A single item questionnaire was used to measure the general usability attributes in apps.
Venkatesh and Agarwal (2006)	Easy to use, content, made-for-the-medium, emotion and promotion.	The article discussed five usability attributes in the context of HCI. The authors believe that these five categories together determine user behaviour. The research found out how individual characteristics (such as age, gender and income) and product type affect the usability categories mentioned.

Hong and Tam (2006)	Ease of use.	A new class of information technology (IT) innovations was defined in this article. These innovations were named multi-purpose information appliances, which are personal and universally accessible.
Urbaczewski and Koivisto (2007)	Effectiveness and efficiency.	This study was conducted to test two usability attributes: effectiveness and efficiency. Multiple factors were used to evaluate these two attributes using performance measurement techniques such as SUS, the after scenario questionnaire (ASQ) and network satisfaction scale (NET). Researchers gathered information on the efficiency and effectiveness dimensions when a group of test users used three different input methods (multi-pad, stylus pen and a QWERTY keyboard) to write email messages.
Burigat, Chittaro and Gabrielli (2008)	Accuracy, task duration and task completion time.	The researchers compared three alternative map apps using three tasks: accuracy (error in spatial memory tasks was counted as an error if the Euclidean distance estimated by the user between a target location and the actual location was greater than the predefined threshold of 30 pixels); task completion time (grab and drag: time to perform panning through or dragging of the information displayed in the viewport); double scrollbar (time taken to complete scrolling operations by using horizontal and vertical scrollbars and time used to change the information space); task duration.
Gebauer, Tang and Baimai (2008)	Design, display, ease of use, keyboard, design, customer service, internal and external sound.	This article aimed to determine the impact of each usability attribute in overall mobile app usability. A quantitative analysis was conducted by analysing and coding user reviews.
Hummel, Hess and Grill (2008)	Delay and error rate.	Mobile apps usability was tested under environmental disturbances. The basis of the approach was the monitoring of environmental conditions during usability testing. Usability was tested under different environmental conditions (acceleration, light, temperature, sound and humidity). The results showed that environmental disturbances led to decreased user performance due to an increase in the error rate and delays.

Min, Li and Zhong (2009)	Efficiency, effectiveness, satisfaction, learnability and security.	The paper discusses usability attributes from the perspective of m-commerce. Researchers conducted an empirical study of the factors that influence a user's adoption of m-commerce. Three categories of factors are discussed: mobile devices, mobile communication networks and wireless application protocol (WAP) web. Results show that these three factors directly influence m-commerce usability and m-commerce usability influences consumers' adoption positively.
Kim et al. (2010)	Enjoyment, usefulness and ease of use.	A new user interface (UI) for mobile phones is presented that makes the use of user-generated content (UGC) services both more efficient and easier in this article. UI has two main mobile Web 2.0 technologies – multi-display buttons and tag and tag cloud – which increase the flexibility of individual users' buttons and display size. The article not only describes the new UI interface but also investigates whether it aids in enhancing exploratory browsing within mobile UGC services.
Gebauer, Shaw and Gribbins (2010)	Network connection quality, user distraction and user mobility.	The article aims to fill a gap in the field of mobile IT by coming up with clear guidelines for designing mobile information systems. Building on prior studies, this research introduces a three-step conceptual model that can be used by managers to design effective information systems. The research found that a network connection's poor quality and high user distraction are very challenging features for mobile information system (IS) design and recommends that particular attention should be paid to user interfaces.
Sonderegger and Sauer (2010)	Menu, icons, text and colour.	This article studied the effects of product aesthetics in usability testing on various outcome variables. The research asked whether changing the appearance of mobile phones has an impact upon usability. Sixty adolescents were asked to use two functionally identical mobile devices but with different visual appearances (highly appealing or not appealing) to find out if there is any relation between usability, perceived attractiveness and the performance measures of the product. The findings were that mobile devices with an appealing appearance have a more highly perceived usability, perceived product attractiveness and user performance due

		to lower task completion time, less errors and higher interaction efficiency.
Adipat, Zhang and Zhou (2011)	Presentation, adaptation of web pages, accuracy and search time.	The researchers developed and tested specific mobile apps in lab research settings. Testers' performances were used to evaluate usability attributes. The results of the research showed that presentation adaptation greatly enhanced user perception and performance of mobile Web browsing. They discovered that less complexity in information search tasks improves accuracy and reduces search time.
Leung, McGrenere and Graf (2011)	How icon characteristics could enhance usability.	The study aimed to find out how mobile devices could be made easier to use for adults over 65 years of age. Specifically, alternative mobile apps were benchmarked by manipulating icon characteristics. It was found that the elderly face more problems using icons on existing mobile devices. However, icon characteristics that have a close semantic meaning (i.e. a close relationship between the portrayed object and its connected function) and are well-known and specific were found to enhance and improve icon usability for elderly people.
Kim, Proctor and Salvendy (2012)	Customer needs, design, feedback, innovativeness, satisfaction and efficiency.	This research developed and used a questionnaire on mobile phones to find out if there was any relationship between usability and the success of the product. The researchers reviewed the factors of product success and existing usability studies to develop a questionnaire. The usability and success factors of mobile phones were evaluated by the participants. The results showed that customer needs, design and innovativeness were not only important success factors but also that increased attention ought to be given to feedback, efficiency and satisfaction in order to improve the usability of mobile phones.
Rabi'u, Ayobami and Hector (2012)	Quality attributes of apps such as screen size, colour, weight of device, text source and extra batteries.	This paper aims to highlight the expected quality characteristics of apps with a detailed and reviewed discussion mostly about usability characteristics, being external characteristics of apps as according to ISO 9126.
Aryana and Clemmensen (2013)	Errors, task completion time and effectiveness.	The article compares mobile usability in Iran and Turkey. The research concludes that usability is impacted by not only religious, ethnic and

		cultural issues but also contextual features which are specific to both Turkey and Iran.
Baharuddin, Singh and Razali (2013)	Efficiency, satisfaction, effectiveness, aesthetic, usefulness, simplicity, learnability, understandable, intuitiveness and attractiveness.	The main objective of the study is to propose a set of usability dimensions that should be considered when evaluating and designing mobile apps. The model introduced is based on the reviews of previously related studies, which were analysed by using a content analysis approach. Ten usability attributes were outlined in the model. The model introduced could be of assistance to practitioners and researchers as a guideline to design usable mobile apps.
Boja, Doinea and Pocatilu (2013)	Security	The paper discusses the relationship between security and usability in mobile platforms and how reducing various security threats can improve the usability of mobile apps
Hao et al. (2013)	Satisfaction	The approach proposed in the paper is convenient for developers as it provides a better estimate of energy consumption at code level than other approaches. Pre-instruction energy modelling and program analysis are used to achieve these results. The new approach can estimate energy consumption for mobile apps to 10% of the ground truth.
O'Malley et al. (2014)	Efficiency, user satisfaction and technical effectiveness.	The research objective of this paper was to test the usability (efficiency, user effectiveness and technical effectiveness) of a developed mobile app (Reactivate) in obese adolescents. A field study was conducted on obese children who were asked to use the app to perform tasks to test its usability. The tasks had five categories: to create a message, to enter personal settings, to use the goal-setting feature, to find and to answer surveys and to enter descriptions or details of weight and height. Standardised SUMI was completed by each participant to determine the satisfaction of the user. SUMI measures five aspects of user satisfaction: effect, controllability, helpfulness, efficiency and learnability. SUMI scores and the mean relative user efficiency were explored using descriptive statistics. The mean scores confirmed that Reactivate was a useful app and users responded to it with great interest.
Al-Wakeel et al. (2015)	Satisfaction	People with autism spectrum disorder (ASD) usually lack familiarity and experience with new technologies; therefore, the usability of apps

		developed specifically for children with autism is very important. The paper compares the usability of two Arabic apps available on the Apple Store. Various measurement tools were used to collect quantitative and qualitative data to determine the level of user satisfaction with the apps. Recommendations were then made on how further the usability of these apps can be improved.
Zapata et al. (2015)	Effectiveness, efficiency, satisfaction, attractiveness, learnability, operability and understanding.	This paper conducted a systematic literature review to investigate the empirical usability evaluation processes described in different m-health app studies. The research showed that the usability attributes evaluated the most in m-health apps were operability and effectiveness. The results showed that using automated mechanisms can improve the methods of empirical evaluation employed in usability. The paper could be useful for developers and researchers who are looking to create apps with better usability. The study also demonstrates the benefits of adapting health apps to the needs of users.
Wei, Chang and Cheng (2015)	Effectiveness, efficiency and user satisfaction.	This paper aimed to assess the usability of the Chongqing University Library App and give recommendations for improving the usability of apps. Usability testing involved pre-test questionnaires, achieving tasks and post-test surveys. Three attributes were measured: effectiveness, efficiency and user satisfaction. The results showed that app was effective, but improvement was needed for efficiency. For the user satisfaction, "Usefulness" had the highest score and "Clarity" the lowest. The descriptions were not clear and sometimes confused users. However, the services the app provided were appealing and appreciated by most users. After measuring UX, the paper recommends ways to enhance the usability of the app
Chintapalli et al. (2016)	Visibility, scrolling, navigation, interaction, satisfaction, convenience and simplicity.	The paper compared four widely used mobile spreadsheet apps: Google Drive, Documents to Go, OfficeSuite Viewer 6 and ThinkFree Online. Measures for each usability attribute were gleaned from a survey. These surveys were created to address the measures based on comparative criteria supplied in the analysis. The results also indicate that there is little difference

		between the apps in their end results and the aspects conducted in this survey.
Eraslan, İç and Yurdakul (2016)	Satisfaction and user feeling.	The article selects all touchscreen mobile devices and the various components that affect their usability. Analytic network process (ANP) and technique for order of preference by Similarity to ideal solution (TOPSIS) were used to find which mobile devices were superior and which usability features were most important
Alturki and Gay (2019c)	Satisfaction, efficiency, simplicity, errors, effectiveness, learnability, understandable, attractiveness, memorability and cognitive load	A systematic review of usability attributes in mobile apps was conducted and the results stated that satisfaction is the most highly mentioned amongst studies at 10 times and then both effectiveness and efficiency at six times. Next, learnability was cited three times while simplicity, usefulness, errors, understandable and attractiveness were named two times. All the other attributes, such as memorability and cognitive load, were only cited once.

2.8 Factors Affecting Mobile Apps Usability

There are various factors that affect the usability of mobile apps. The evolution of mobile technology has brought about a lot of diversity in mobile technology. The quality of mobile apps is a multi-dimensional concept that includes a multitude of characteristics. The research of Zhang and Adipat (2005) was based on highlighting the usability issues that have emerged with the arrival of mobile apps.

2.8.1 Mobile Context

Mobile users should not be tied to one single location when using their device. They should be able to interact with the surrounding environment, people, and objects. However, these factors can also distract them. We can define mobile context as the information that can characterise any situation associated with the interaction between users and various surroundings (Dey, Abowd & Salber 2001).

Gorlenko and Merrick (2003) categorise context awareness in the following way:

- **Location awareness**: This is usually used in location-based services. The system should have the ability to track the whereabouts of the user. The most common

apps are maps, road guidance, details of supplying important places nearby and specific objects. Apps related to location assist in data management services.

- **Environmental awareness**: This is the quality of understanding and reading interaction-setting specifics, such as one-to-one conversation, noisy crowds or enclosed spaces.
- **Mobility awareness**: The app should be able to decode the body posture of the user at each moment. For example, it should be able to determine if the user is standing, sitting, running or walking.
- **Health awareness**: This is the capacity to measure users' physical conditions: their blood pressure, the temperature of their body and their heart rate.
- **Activity awareness**: This is the ability or quality of being able to comprehend users' high-level activities such as watching television (TV), reading or writing.

2.8.2 Small Screen Size

The screen size is limited in mobile devices because they are portable and, therefore, the information that can be displayed is limited. Parsons and Ryu (2006) believe that apps that support speed-friendliness and have a vision-friendly display on small screen mobile devices have a better chance of success than those which do not. Ciurea and Pocatilu (2011) research shows that speed and display capabilities in mobile devices are important usability factors. Some researchers, such as Wentzel et al. (2005), have explored the specifications for screen size range and resolution. Their study shows that a handheld device will be suitable with a screen size range of 10 to 15 inches and with a resolution of 480 x 640 pixels. According to Gafni (2009), mobile wireless information systems bring new usability challenges and the necessity for relentless efforts to resolve the mobility challenges of being handheld as well as the difficulties of operating with tiny screens. The research of Shneiderman et al. (2010) reveals that the ease of use in mobile devices is achievable by having a screen size that aids the HCI with the apps interface.

2.8.3 Connectivity

One common hindrance for mobile apps is unreliable and slow wireless network connections with a very low bandwidth (Longoria 2001). The performance of mobile apps that depend upon connectivity will be slow and unreliable on mobile devices if this

is an issue. This problem leads to low-quality streaming media – for example, audio or video streaming – and increases download times. Signal strength and the speed of data transfer in a wireless network varies at different locations and times and can be compounded by the mobility of the user (Sears & Jacko 2000).

2.8.4 Different Display Resolution

To keep the resolution of mobile phones to the standard of desktop computers is a challenge. Designing and developing a useable mobile app and device needs a deep consideration of resolution features (Andreou et al. 2002). According to Nah, Siau and Sheng (2005), the value of mobile apps can be enhanced by ensuring information can be fully displayed on mobile devices.

2.8.5 Limited Processing Capability and Power

Mobile devices are portable but they often have less power and processing capability than desktop or laptop computers. This limits the apps that are suitable for a mobile device. The research of Shneiderman et al. (2010) shows that the ease of use of mobile devices may be achievable with the incorporation of extra batteries. Nah, Siau and Sheng (2005) state that the value of mobile apps can be enhanced by increasing the length of uninterrupted usage and increasing the operating duration of mobile devices.

2.8.6 Data Entry Methods

Mobile devices have input methods that not only differ from desktop computers but also require certain skills and a high level of proficiency. The issue increases input data error probability and decreases data entry rate. Nah, Siau and Sheng (2005) believe that the value of a mobile app can be enhanced by facilitating keyboard input, providing handwriting recognition features and simplifying input mechanisms. Users' data entry efficiency and effectiveness are limited by small labels and buttons, which not only increase the quantity of errors but also decrease the speed of data entry (MacKenzie, Zhang & Soukoreff 1999; William Soukoreff & Scott Mackenzie 1995; ZHANG 1998). Data entry problems are further exacerbated by the user's status (for example, walking versus sitting; whether they put the device on a table or are holding it in their hand). These problems should be addressed so as to improve the usability of mobile apps.

2.9. Obesity

Obesity is defined as an excessive storage of energy in the form of fat (SIMOPOULOS & VAN ITALLIE 1984). According to Roche et al. (1981), men with a body fat of more than 20%, compared with the normal value of 15% to 18%, of their weight can be considered fat or women if the value is more than 30% of their normal weight. One way to define obesity is through sums of scapular and triceps skinfolds. The BMI is the best approximation for the degree of obesity in population-based studies (National 1985). One can measure BMI through calculating a person's weight in kilograms divided by their square height in metres, as first proposed by Quetelet (1869). International and national health departments and authorities use BMI measures to determine cut-off points to classify weight categories such as normal, overweight and obese. Table 2.4 shows how different values of BMI are categorised (ROCHE 2001).

Table 2.4 BMI categories

Body Mass Index	**Status**
Under 18.5	Underweight
18.5 - 24.9	Normal weight
25.0 - 29.9	Overweight
30.0 - 39.9	Obese
40 and over	Severely obese

Obesity and overweight are the most popular nutritional disorders that affect the majority of adults in the US. Troiano et al. (1995) research showed that the prevalence of obesity has doubled since 1976. According to the study by Flegal et al. (1998), the prevalence of obesity in US increased by 75 % in last 18 years. Whilst the range of BMI from 18.5 to 24.9 is considered to be normal weight, as shown in the table above, the percentage of the overweight adult population (BMI values of between 25 to 29.9) is 34% and the percentage of obese adults (BMI values of more than 30) population is 27% in the US (NCHS 2005). A Study by Hales et al. (2017) pointed out that the percentage of obese adults in the US is increased to reach almost 40%.

There is an established relationship between obesity and various medical conditions such as hypertension, osteoarthritis and type 2 diabetes, which is one reason why obesity

and overweight concerns health professionals around the globe (Billington et al. 2000). The National Institute of Health has issued evidence-based guidelines for weight loss both in obese and overweight individuals with two or more risk factors for diseases related to obesity (Panel 1998).

A report by the US Surgeon General's Office has shown that obesity or overweight are the causes of as many deaths and diseases as smoking (Al-Marzouki 2009). Several studies demonstrate that obesity is a leading factor in both mortality and morbidity amongst men and women in many societies (Calle et al. 1999; Fontaine et al. 2003; Manson et al. 1995; Sjöström 1992; Stevens et al. 1998). Fortunately, reducing one's weight back to a normal range helps to reverse the health hazards that are related to overweight and obesity (REISIN et al. 1983; Sjöström et al. 1999; Stevens et al. 1993). Research by Al-Marzouki (2009) showed that obesity has increased rapidly over the last couple of decades throughout the world due to the increasing number of people who are adopting a sedentary life. He also predicted that this trend would continue.

According to the WHO, obesity is the one of the most blatantly visible yet one of the most neglected problems in public health and it remains a great threat as it continues to overwhelm both developed and developing countries (Consultation 2000). The problems related to obesity and overweight have achieved global recognition over the last decade or so, in contrast to underweight, infectious diseases and malnutrition, which previously dominated the thinking of public health planners. WHO now considers a BMI of greater than 25 to be abnormal and categorises individuals with a BMI of 30 or greater as obese (World Health Organization 2019). A BMI of about 21 increases the risk of hypertension, diabetes and dyslipidaemia, thereby greatly increasing the societal economic and health burdens and reducing life expectancy (James et al. 2004). Ezzati et al. (2002) study found that excess bodyweight is the sixth most significant risk factor that contributes to the disease globally. According to Khashoggi et al. (1994), the prevalence of obesity in a population is a rough indication of its general health status because obesity is associated with several major diseases.

2.9.1 Obesity in Saudi Arabia

According to World Health Organization (2016), obesity is a huge concern in the Kingdom of Saudi Arabia (KSA) because of the significant prevalence of obesity in men (29.5%) and women (39.5%). The prevalence of those overweight in the kingdom was

found to be 69.2% for women and 67.5% for men. Another study found that 35.5% of the people in KSA were obese, which means every third person in the country suffers from obesity (Obesity Research Center 2016) Beside this, (AL-KINANI 2019) states that the percentage of obesity in Saudi Arabia is increased to reach more than 40%. This is backed up by the World Health Organization's (2014) report, which found rates of obesity have proliferated globally by more than 50% since the year 1980. This worldwide pandemic, when considered in conjunction with the documented prevalence of the condition in Gulf countries, means that the spread of obesity has become a major public health issue in the KSA (ALNohair 2014). Al-Nozha et al. (2005) conducted research to find the extent of obesity amongst Saudis. 17,232 Saudi subjects from various households participated in the study. The data obtained shows that 36.9% of the individuals were overweight and the prevalence of overweight males (42.4%) was greater than females (31.8%) ($p<0.0001$) (Al-Nozha et al. 2005).

2.9.2 Factors Contributing to the Increase of Obesity in Saudi Arabia

There is a great concern about obesity and illnesses associated with the condition in Saudi Arabia as well as the factors responsible for it, which include cultural and social environments, physical activity, education, difference in income and time expenditure, diet and nutrition (ALNohair 2014). Industrial development has increased the prevalence of obesity, which, in the Gulf, is associated with the huge increase in wealth and income resulting from rich and vast deposits of oil. This has led to improved living conditions and rapid urbanisation (Papandreou et al. 2008). The increase in wealth and greater development in the KSA has brought with it a change in lifestyle. Easier access to cars, international fast food chains and the increased acceptance of processed food have all led to a rapid rise in obesity (Alturki & Gay 2019b). Other important factors are the disproportionate consumption of salty, processed and fatty foods as well as a lack of exercise (Al-Mahroos & Al-Roomi 1999).

Moreover, technical advancements and urbanisation in the KSA has increased the obesity rate in towns and cities. Children from the south-western rural region of the kingdom have a lower obesity rate of 4%, because these children have an active lifestyle due to the fact that they are involved in agricultural work and fishing, whereas children from cities of the eastern provinces have obesity rate of 14% and children in cities of

western provinces have an obesity rate of 10% of the only three cities mentioned in the research, 34% of children in Hail; 22% in Riyadh; and 12% in Jizan were considered to be obese (Al Hazzaa 2004; El-Hazmi & Warsy 2002). In Riyadh more than 57% of boys between the ages of 7–12 years are not involved either in slight or moderate physical activity. Furthermore 81% of males in Riyadh are found to be physically inactive (Faostat 2010). This was due to the fact that in these cities, high-fat fast food consumption and sedentary lifestyle are common.

Income is another vital factor that has led to prevalence of obesity. For example, consumption of meat in Saudi Arabia increased by five from 1973 to 2007 (Al Othaimeen, Al Nozha & Osman 2007). Another reason for obesity could be the extremely high external temperatures, which leaves the kingdom with a barren landscape void of vegetation and forestation and which forces people to limit outdoor activities and remain indoors. Furthermore, cars are used for commuting even only for very short distances (Al-Kandari 2006). Various studies have also indicated that married people have more chance of being obese and overweight. A possible reason provided by many studies is that married couples usually eat together which reinforces more food intake and that these couples are less active (Olson et al. 2003). In some Arab traditions, being overweight or even obese is considered a sign of high social status, beauty, prosperity and fertility (Caspersen, Powell & Christenson 1985).

Body movement produced by skeletal muscle is considered a physical activity that leads to energy expenditure. However, fast-paced economic development in the KSA has brought about major changes in lifestyle and socio-economic status, such as the increased availability of cars, extensive road networks, an increase in the usage of mechanised appliances as well as that of televisions, computers and electronic gaming that limit body movement. These changes have resulted in a sedentary lifestyle, which results in a greater fat accumulation in consumers' bodies (Faostat 2010).

The traditional and cultural restrictions upon women's lifestyles in the KSA are reasons for increased obesity rates amongst the female population. Furthermore, women do not have much access to exercise and sports activities. For example, in the Asir province, 99.5% of adult females do not involve in any kind of physical activity (Faostat 2010). Most households have cheap migrant labour to help out in household tasks, which means women have the tendency to become even more inactive. For example, most families in

the KSA employ maids and cooks, which leads to a sedentary lifestyle (Al-Shammari et al. 1994).

Another important factor of obesity amongst women is that their main leisure activities are watching TV and using the Internet (ALNohair 2014). A further factor is multiple pregnancies, as women can gain 4.5 kg or more in one year postpartum. This is due to various combined factors such as decreased physical activity, gestational weight gain and increased food intake (Khashoggi et al. 1994). There is also the possibility that the traditional comfortable, long and wide clothes worn by Saudi Arabian women means they do not notice any gradual weight gains they are making (Musaiger 1987).

Another factor could be the attitude of people toward obesity. According to Musaiger (1987), most men in the Gulf region found obese women to be sexually attractive. This encourages a woman to maintain her obese figure in order to fulfil the desires of her husband. Furthermore, an obese woman is desirable because she is considered to be fertile and has the right figure to bear children (Ammar 1998).

2.10 Research Gaps

The literature review shows that usability in mobile apps has been discussed from various points of views by many authors. Some of the studies introduce a framework for testing usability, some provide general recommendations for improving usability and some compare usability attributes among different apps. Usability has been discussed from numerous angles. Some recent work focuses specifically on improving usability in apps related to various fields ranging from health to social networking. Usability criteria are always evolving, and the needs of people are changing rapidly. Therefore, some recent research discusses the new dimensions of usability. The review of the existing work shows that there are numerous usability attributes and it is difficult for designers to include or consider all the usability attributes in one app. The best they can do is improving the usability of the app while keeping the nature of the app in mind.

Most of the research discussed adding features or enhancing the usability of mobile apps to help people to be motivated and to meet the app's desired goals. However, one very important aspect is lacking in the extant research, which is consideration of social and cultural norms. For example, for an app to be truly usable, it should meet with the social and cultural norms for users - be in the users' native language and considering the social

customs. Soroa-Koury and Yang (2015) recruited 343 participants in their study to find how traditional views and social customs play a part in the prediction of a user's response to mobile apps. The study demonstrated that social norms predicted perceived ease of use (PEOU) and perceived usefulness (PU). Many researchers in the past have found that social norms affect human behavior (Cohen & Sherman 2014; Lapinski & Rimal 2005; Rimal et al. 2005). Various studies are available which show that social norms have been used to intervene in the reduction of undesirable behaviors such as drinking, smoking and sexual proclivity. Researchers investigating the acceptance of technology have incorporated social and cultural norms as important predictors of user behaviour when adopting a particular technology (Venkatesh & Davis 2000).

Despite the importance of social and cultural norms on the success of a mobile app, there are very few apps in the field of health and fitness that consider the impacts of cultural and social norms when designing the apps. Research by Alnasser et al. (2016) involved the development of the Twazon app, which they claim considers the social and cultural norms of Saudi users. However, they have not mentioned any specific features or attributes that make the app socially more acceptable or more culturally relevant. Mostly, they have used cultural norms as a reason why women are not physically active. They also only consulted female users regarding their use and requirements. Therefore, the only thing that makes this app culturally and socially aware is the use of Arabic language. For example, the app does not include any special timetable and diet plan for the month of Ramadan. Ramadan is one of the most important religious periods in the Islamic year during which Muslims are not allowed to eat from dawn until dusk. No efforts have been made or research done to find design features or provide an app layout that will make it culturally and socially more relevant and acceptable.

Even though there are many Arabic fitness and weight loss apps available, none of them is considered as an effective app that helps obese users to lose weight (Alnasser et al. 2015; Alturki & Gay 2017a, 2017b). The reason for this is that for weight loss management, certain evidence-informed practices are required. The Centers for Disease Control and Prevention, National Institutes of Health, the Food and Drug Administration and the US Department of Agriculture identified 13 evidence-informed practices required for weight loss as follows (Alturki & Gay 2017a, 2017b; Breton, Fuemmeler & Abroms 2011):

1. BMI is determined and explained;
2. Fruits and vegetables are recommended and tracked for daily servings;
3. Physical activities are recommended for daily use;
4. Recommendations for drinking water and tracking the daily consumption;
5. Recording and tracking the daily consumption of food;
6. A calorie tracker is provided for maintaining calorie balance;
7. Advising goal-setting to lose 1 to 2 lb (0.5 to 1 kg) per week;
8. Portion control information is provided;
9. Advising users about ways to read and understand nutrition labels;
10. A weight-tracking feature should be provided;
11. Physical activities are tracked for daily use;
12. Recommending and providing a tool for planning meals;
13. Providing a social network among users or allowing users to share via popular social networks, for example Facebook, Twitter, Instagram or Snapchat.

The results from recent studies state that there is no Arabic fitness and weight loss app that has more than 10 of these evidence-informed practices (Alnasser et al. 2015; Alturki & Gay 2017a, 2017b).

The population of obese and overweight individuals in Saudi Arabia is increasing at an alarming rate. Moreover, the increasing use of mobile apps in Saudi Arabia is seen as an opportunity to develop a new weight loss app that contributes in overcoming obesity in the country. There is ample research discussed in the literature review, which shows that high level of usability can motivate users to spend more time on an app. Therefore, and based on the previous discussion, it is concluded that there are many Arabic fitness and weight loss apps available but to my knowledge none of these apps have been built including the features that would help and encourage people with obesity to be active, change their lifestyle and keep them motivated to overcome obesity. Moreover, there is no Arabic fitness and weight loss app available that includes the tools and features to address all the 13 evidence-informed practices for weight-loss interventions. In addition to this, there is no Arabic fitness and weight-loss app available that is designed with the aim of enhancing the level of usability of the app by addressing usability attributes and factors to help users to lose weight. Finally, there is no Arabic fitness and weight loss app that was developed after consulting potential Saudi users (males and females)

regarding their use and requirements and none of the available Arabic fitness and weight loss app was developed in collaboration of health professionals (dietitians and physical activity experts) to ensure the accuracy of its contents.

2.11 Research Question

Based on the previous section, this research addresses a problem, which is described as the following question:

How to improve mobile fitness and weight loss apps usability guidelines and features to help Saudi users overcoming obesity?

In order to answer the aforementioned question, solve the research problem and achieve the mentioned objectives in Chapter 1, these sub-questions need to be answered as well:

Sub-question 1:

What are the most important fitness and weight loss app features that would help and encourage obese people, in particular Saudis, to be active, change their lifestyle and keep them motivated to overcome obesity?

Sub-question 2:

How can the 13 evidence-informed practices required for weight loss management be incorporated and implemented within a weight loss app?

Sub-question 3:

What are the needs and requirements of Saudi obese users from a fitness and weight loss app?

Sub-question 4:

What usability attributes and factors should be considered to make mobile fitness and weight loss apps easier to use for Saudi users?

Sub-question 5:

How can the new developed weight loss app ‘Akser Waznk’ be evaluated to show it has a better usability level and motivational features to overcome obesity in comparison to the existing fitness and weigh loss apps?

2.12 Conclusion

This chapter presented a comprehensive literature review on the role of mobile fitness and weight loss apps and the importance of usability and features in motivating and helping obese users to overcome obesity and change their lifestyle. The literature review focused on three main dimensions. It started by explaining how fitness and weight loss apps can act as motivational tools in influencing human behaviours to lose weight and achieve their fitness goals. Next, it identified the importance of usability and its role in motivating users to use apps. Moreover, the literature provided an extensive review on usability, starting with its definition and identifying the factors that affect it. Furthermore, it discussed obesity and its related factors that have contributed increasing the obesity rate in Saudi Arabia. Finally, the research gaps and questions were identified.

The next chapter presents an overview of the research methodology. It explains in detail the research framework and justifies its selection.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter further explains the design and structure of this study. I will start by describing the framework that guides this research, presenting a justification for its choice. The chapter then outlines in detail the methodology used for this research work and how each component of the framework is linked and applicable to this study. It also discusses the research sequence and the approach made to ensure the trustworthiness of this research.

3.2 Research Framework

"The Research Onion" is used as a framework for this study (Saunders, Lewis & Thornhill 2009). The research onion and nested method are the major research frameworks and are used widely in a lot of research (Kagioglou 1998; Saunders, Lewis & Thornhill 2009). Figure 3.1 shows the research onion framework. Each layer of the framework covers one specific aspect of the study, demonstrating the variety of paradigms, strategies and choices that researchers use throughout their investigations. It shows all the significant issues that need to be taken into consideration during any research project. The model has six layers: the researcher's philosophical position; the approach; research strategies; choices; research time lines; and the data collection techniques employed by the researcher.

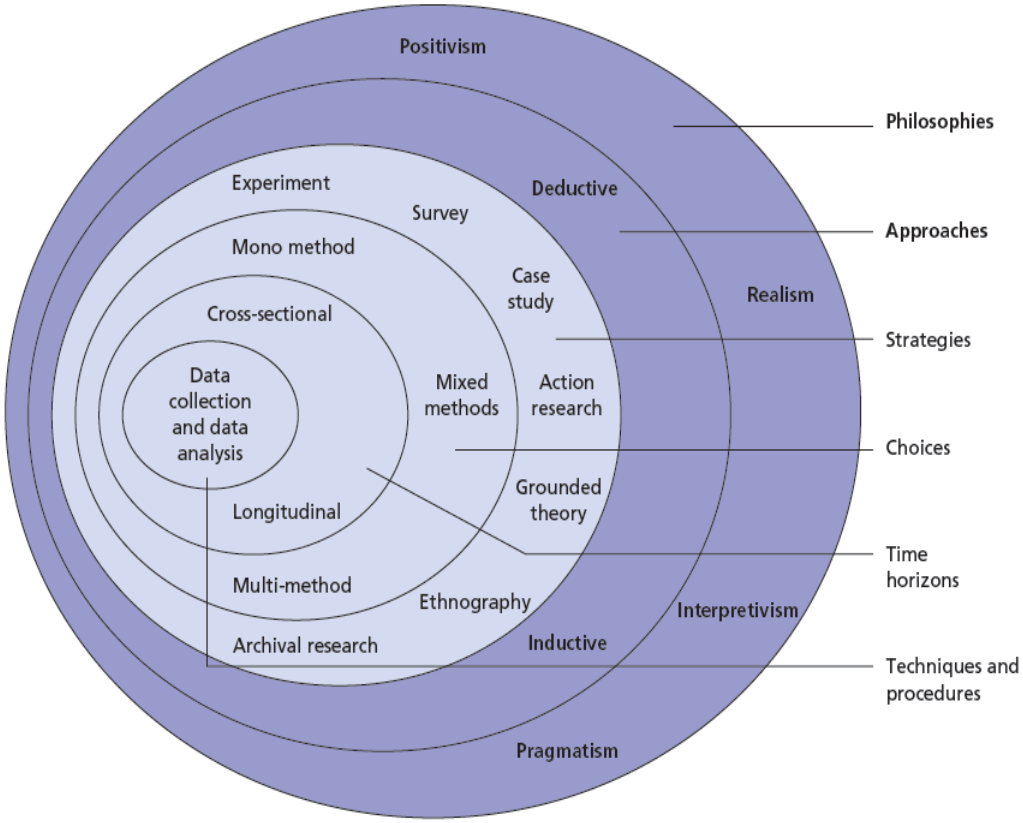

Figure 3.1 The research onion framework

This framework has a powerful multi-disciplinary application, which makes it appropriate for this research. This framework has been used successfully in previous studies related to mobile apps and technology (Iqbal & Muwonge 2012; Karaseva 2014; Meller 2013; Wei, Liu & Koong 2006). Karaseva (2014) used this framework to figure out what features of mobile apps and their releases influence apps' popularity. Wei, Liu and Koong (2006) used the research onion to analyse m-Commerce security requirements and explore how system security performance can be improved. Iqbal and Muwonge (2012) used this framework to demonstrate how online advertising impacts consumer behaviour. Meller (2013) used the model to examine how the use of technological tools by project managers can affect the chances of a project's success. This framework has also used been used in various research projects, such as Noor (2011), who utilised it in a PhD thesis at the Royal Melbourne Institute of Technology (RMIT). Omotayo and Kulatunga (2015) used Saunder's model to form a research strategy for developing a framework called "kaizen costing" that is both suitable and helpful for construction firms in Lagos, Nigeria. Their research follows a systematic approach and builds upon a research philosophy that uses an approach that is based upon a variety of research techniques and strategies. In this research, I use the research onion

framework to improve mobile fitness and weight loss apps to help Saudis overcoming obesity.

3.3 Research Philosophy

According to Saunders, Lewis and Thornhill (2009), research philosophy is an overarching term that is related to the character of knowledge and its development in the research context. The research philosophy shows how the researcher views the topic and contains important assumptions on which the researcher will base their work. The research philosophy is the basis for the strategy that will be adopted by the research: it determines the methodology that will be used to answer research questions, the data collection procedures and techniques, the analysis of the findings as well as the presentation of those results derived from data analysis.

There are various research philosophies that can be adopted, such as realism, interpretivism, pragmatism and positivism. According to positivists, reality is stable and constant and an objective viewpoint can help describe and observe it; for example, there is no need for inferring with the phenomena that is under study (Levin 1988). They believe that there should be repeatable observations or that the phenomena should be isolated. To find the relationships between different variables and identify regularities, positivists may vary or manipulate a single independent variable. Previously explained and observed realities and their interrelationships can be used to make predictions.

Interpretivists believe that reality can be understood through subjective interpretation and intervening in reality (Davison 1998). Their philosophy involves the study of phenomena in their natural environments. Furthermore, they consider that there could be more than one interpretation of reality. On the other hand, realists are of the opinion that certain objects can exist independently of their being observed (Phillips 1987). Scientific realism states a scientific theory must refer to real objects in the universe. Reality is anything in the cosmos, such as structures and forces that cause phenomena that are perceived with our senses (Schwandt 1997).

According to pragmatism, philosophy means an idea or a concept that has practical consequences. Peirce (1878) argues that we can reach something that is tangible and practical to every real distinction to make our ideas clear. In science, the pragmatic approach is about using the methods that are best suited to the problem the research is

addressing and therefore avoiding the debate of which approach is the best. This is the reason that pragmatic researchers are at liberty to make use of any techniques, methods or processes that are involved with qualitative or quantitative research. They understand that every procedure has its strengths and limitations and that different methods sometimes pair well together (Alzheimer Europe 2009).

3.3.1 Pragmatism

Bawden (1904) believes that pragmatism has a central idea that is if it is worked, it can be said then it is true. Even in this century, the meaning of pragmatism as to do what works well is supported by many researchers (Nissen & Snider 2002). From the point of view of academia, pragmatism as a research philosophy has the definition, which debates that the correct and the right idea is the one that has successfully proved in a practical way (Ormerod 2006; Saunders, Lewis & Thornhill 2009; Ulrich 2007). Beside this, pragmatic as a research philosophy supports the build of a conceptual foundation on a real-life practice and believes that there are multiple correct answers for any research study (Saunders, Lewis & Thornhill 2009).

One key advantage of this philosophy is that it allows for a combination of research approaches, methods and strategies so that research questions can be answered more appropriately for better applicability. However, this advantage has been criticised by various authors as a failure of this philosophy to adhere to theory and as a sloppy way of thinking (Ormerod 2006). However, what these critics forget is that this philosophy was dominant in the latter half of 19th century, a time during which the US emerged as a significant power due to unprecedented political, knowledge and economic growth. If there were serious flaws in pragmatism, then it would not have allowed for that rise and growth to take place. In addition to this, multiple realities exist in real life; thus, a philosophy like pragmatism is needed, which has the ability to contain diverse views.

I believe pragmatism is an appropriate philosophy for this research for the following reasons:

- The nature of this research is practical as the usability of fitness and weight loss apps has a conceptual foundation that is greatly linked to UX or real-life practice. Pragmatism is different from other philosophies because it is not restricted to explanations and understanding, as is the case in positivism and interpretivism

respectively. Pragmatism has the advantage that other knowledge forms such as normative, prescriptive and prospective are essential to it (Dewey 1938). This is why pragmatic philosophy is adopted for explaining, understanding and suggesting usability characteristics in fitness and weight loss apps to enhance the UX. I will try to incorporate these diverse knowledge forms into this research within a pragmatist epistemology as constructive knowledge. In turn, this will provide both descriptive and explanatory knowledge about usability. The empirical focus of this study is actions and changes, and this is inherent in pragmatic philosophy (Goldkuhl 2012). This research is an inquiry into how fitness and weight loss apps can be improved.

- The data required to conduct this study is existed not only in different forms but also is spread in different sources as well. The pragmatic approach advocates a variety of data collection tools. This research relies mainly on qualitative data but there will be some quantitative data used, and a pragmatist approach allows for this combination. Therefore, and to reach accurate conclusions out of this investigation, I will need to collect and examine both types of data.
- Pragmatism holds to the basic principle that there could be more than one correct interpretation. Usability studies of mobile apps can have more than one interpretation; for example, a certain feature enhances the UX and this could be because that feature improves the performance and/or even the satisfaction of the user. Given the fact that there can be more than one correct interpretation of the feature, the use of both objective observation as well as subjective meaning might lead to creating a knowledge that is accepted. This study needs the use of not only objective observation, but also subjective meaning as well in order to build the inferences from the data.
- Pragmatism argues that the role of the researcher is to engage in change. In pragmatism, interpretation is instrumental and closely linked with any change of existence (Dewey 2007).

Because of the reasons mentioned above, I believe pragmatism as a research philosophy is an appropriate one in order to build a solid philosophical foundation within this study.

3.4 Research Approach

There is a strong link between research and theory. The research approach is the movement trend between researches and theories. Inductive and deductive are considered as the major research approaches that are existed (Saunders, Lewis & Thornhill 2009). In deductive reasoning, the researcher moves from more general to more specific (Burney 2008). The deductive approach starts with a compelling theory and then the implications of that theory are tested with the data. The deductive approach is therefore associated with scientific investigation (Blackstone 2012) (Figure 3.2).

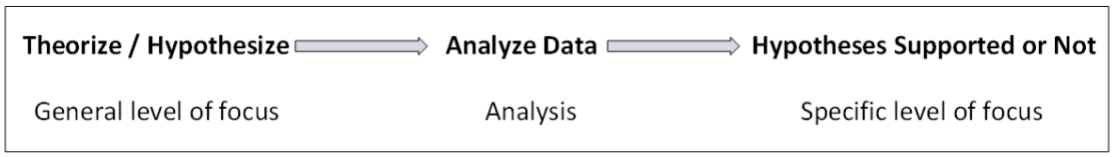

Figure 3.2 The Deductive approach

The deductive approach is considered a top-down approach due to the fact that the conclusion must arise logically from the premises (Figure 3.3).

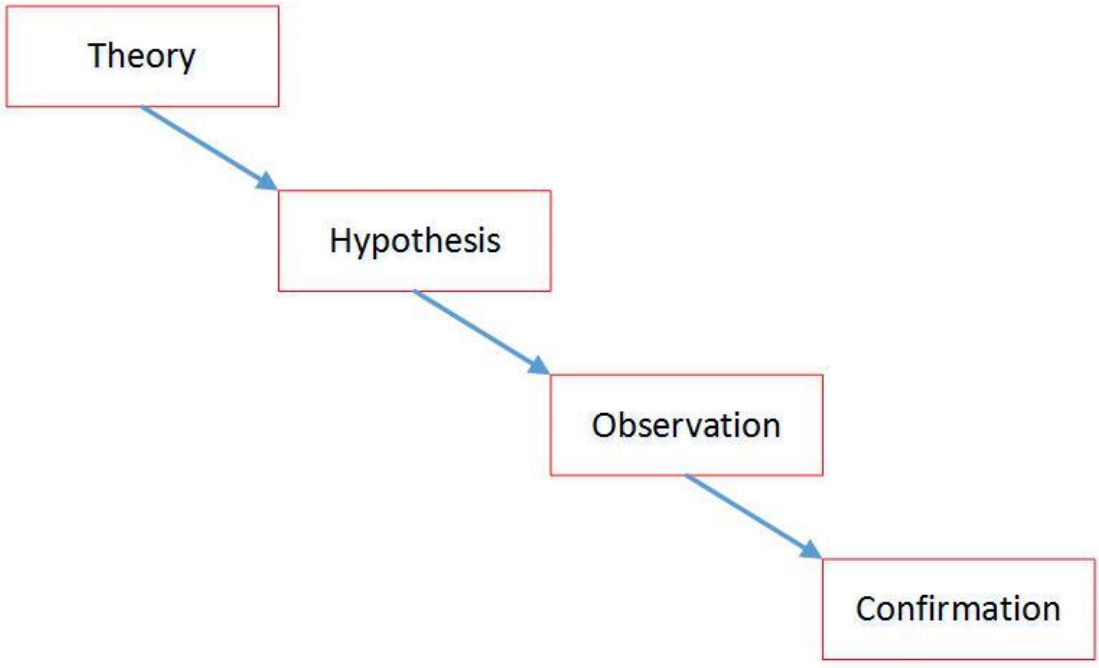

Figure 3.3 A model of a top-down deductive approach

Inductive reasoning moves in the opposite way, starting with specific observations and moving towards broader theories and generalisations. When using an inductive approach, the researcher collects the data and then figures out the data patterns and tries

to develop a theory to explain those patterns. An inductive approach begins with a set of observations and then moves towards a general set of propositions. It is sometimes described as bottom-up approach.

Figure 3.4 The Inductive approach

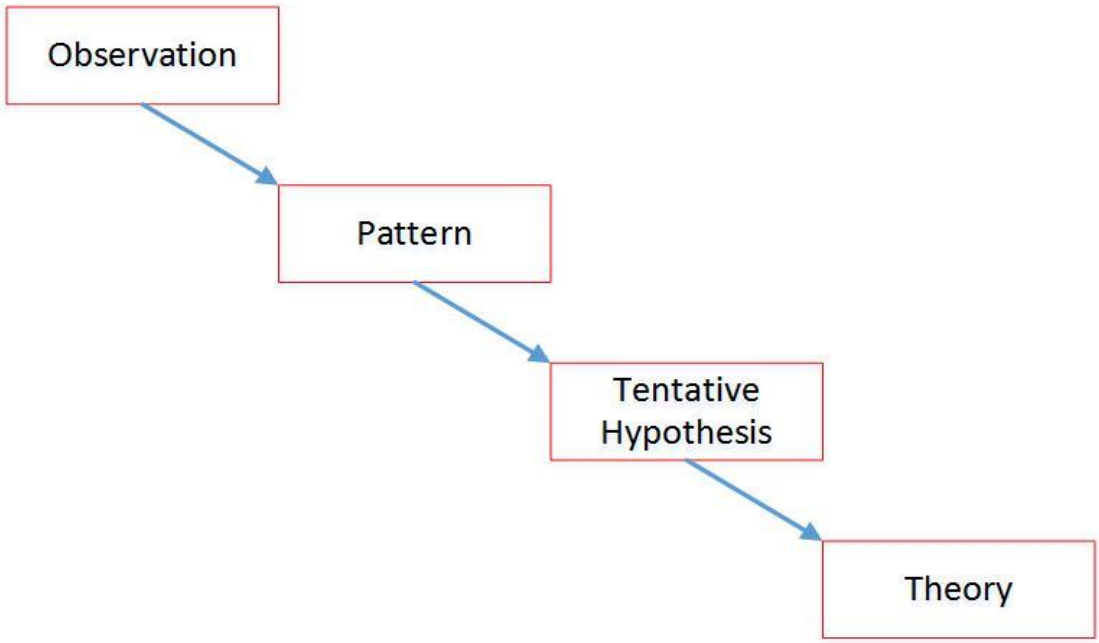

Figure 3.5 A model of a bottom-up inductive approach

Table 3.1 summarises the differences between the two approaches as described in the work of Saunders, Lewis and Thornhill (2009).

Table 3.1 Differences between the inductive and deductive approaches

Inductive approach	Deductive approach
Based on understanding the meanings humans attach to events. The researcher should have a detailed and complete understanding and knowledge of the research context. It involves collecting qualitative data. Adopts a flexible structure that allows for changes or variations in research	It is based on scientific principles. The approach moves from theory to research. The researcher explains and finds out casual relationships between variables. It involves collecting quantitative data.

emphasis along with the progress of the research. The researcher has an evident realisation that they are part of the process. The researcher is less concerned about generalisation.	The researcher introduces and applies controls to ensure and protect the validity of the data. To ensure clarity of data, the concepts are operationalised. It is a very structured approach. The researcher has a lot of independence. There is a need to have a large enough sample size to make conclusions.

These two approaches can be used independently but can also coexist in some research work (Saunders, Lewis & Thornhill 2009). In this study, I will combine the two approaches. The advantage of combining both approaches is that it will allow us to understand all the usability attributes, factors, users' social and cultural norms, motivational features and design elements that can impact the usability of the mobile fitness and weight loss apps. It will also help us to find the link among the app's success and the attributes or characteristics causing such hit. Another advantage of using these approaches together is that it will enable us to utilise and take advantage of not only qualitative data but also quantitative data as well.

A combination of the two approaches also has the advantage in that it provides the flexibility required for both the exploratory and explanatory part of the research. This study has an exploratory beginning, where I will evaluate various fitness and weight loss apps to see which usability attributes and factors, social and cultural norms, motivational features and design elements make these apps successful. Therefore, I will be exploring something where I will need a flexible approach. Once I know the aspects that are required for a successful fitness and weight loss app, I will adopt a more structured approach and I will use the inductive–deductive combined approach in this study. Many researchers have used this combined approach extensively. Anderson, Burford and Emmerton (2016) used inductive and deductive thematic analysis to reduce the data into various themes so that they could explore the benefits of health apps for health monitoring and suggest improvements in health apps. A study was conducted by Georgsson and Staggers (2016) with the aim of coming up with a multi-method approach and a feasibility test for data collecting and analysing data for patients' usability experience when using a m-Health system that was meant for the self-management of

type 2 diabetes. The authors used usability problem taxonomy (UPT) and the framework analysis (FA) to code, design and analyse the findings. After classification, the scholars assigned a rating based upon usability severity. They used the inductive approach for coding usability descriptions and problems, then used deductive coding using UPT classification. Freeney (2014) used both deductive and inductive reasoning in his research work to explore the relationship between usability and persuasion.

In this research, an inductive approach is used that is based on the observation that some fitness and weight loss apps in Saudi Arabia are very popular and investigates how these apps can benefit the health and fitness of obese individuals. The observation allows us to find and compare some of the most successful apps in order to determine the reason for their success. This leads us to finding out the usability attributes, motivational features and design elements that are most sought after in fitness and weight loss apps, thus helping us build usability guidelines for mobile fitness and weight loss apps. I then develop a weight loss app and use the deductive approach to test its usability level.

3.5 Research Strategy

In a research framework, the research strategy or methodology is used in the research process to assist in the investigation of a particular problem and to answer research questions in a more systematic way (Saunders, Lewis & Thornhill 2009). There are various research strategies, such as experimental studies or case studies, which can be utilised in diverse kinds of researches. Nevertheless, none of the strategies are inherently superior. Rather, the context in which the strategy is used and its ability to answer particular research questions gives it a certain superiority (Saunders, Lewis & Thornhill 2009). While there are different strategies, researchers are enabled to utilise a strategy within another strategy. For example, a study that involves a case study strategy can have an experimental strategy included within it.

The selection among various strategies can be guided or influenced by the philosophy, approach and the kind of questions that a study aims to answer. One must also consider the data, time, resources and tools availability as well as ethical issues and the expertise of the researcher. In the next section, I will introduce the research strategies that are suitable for this study.

3.5.1 Experimentation as a Research Strategy

I use experimentation as the main research strategy in this research. I will discuss the strengths and weaknesses of this approach in the following sub-sections. I will also present the justification for choosing experimentation as the most appropriate strategy for this research.

3.5.1.1 Concept and Implementation

Experimental research has a long tradition in medicine, technology, education, psychology and various other fields (Ross & Morrison 1996). The purpose of experimental research design is to help the researcher to establish a cause-effect relationship with a lot of credibility. Experiments have a particular nature; they are conducted in a systematic way and under controlled conditions. An artificial situation is formed and events that go together or have something in common are pulled apart (Rao & Shah 2002). The experimental method is a scientific and systematic approach in which the researcher uses controlled and manipulated testing to gain an understanding of the causal processes. A widely used definition for experimental research strategy is where scientists actively influence something to observe the consequences (Blakstad 2008). This is the best strategy to use when:

- The researcher is trying to find out whether the cause precedes effect or is investigating the effect of changing conditions on objects/subjects.
- A causal relationship exists between variables as one variable impacts others.
- The magnitude of correlation between two variables is great.
- An accumulative method of inductive inference is required.
- It is required to explore the unknown.

Experimental research strategy can be categorised into the following types of experiments (Rao & Shah 2002):

- **Laboratory experiments**: These are carried out in settings that are specially created and the experimenter has the ability to control a variety of extraneous variables.
- **Natural experiments**: These are referred to as quasi-experiments. These studies are conducted when a natural event or social policy creates situations suitable for

the experiment. The investigator has no control over independent variables. The subjects are neither matched in groups nor randomly assigned.

- **Field experiments**: In these experiments, independent variables are manipulated by the researcher in a field environment.

Experimentation as a research methodology has been used in a lot of work related to usability. The experimental study of usability started in the 1980s. One of the most influential works to be published during that period was by Eason (1984), who examined a computerised banking system using an experimental design. The study presented a summary of variables that affect the usability of the system. The paper also examined the methodological implications of using an experiment as a research framework and advocated the use of field experiments to better understand the concept of usability. Odescalchi (1986) did an experimental study to find out if a user demonstrates greater efficiency and success in tasks when given product or task-oriented instructions. The research findings showed that clear and improved instructions improve usability. Similar research was conducted by Holt, Boehm-Davis and Schultz (1989), who discovered that structured or multi-levelled manuals help users understand and teach accurate mental models of a computer system better than detailed or global manuals. Research by Buchanan et al. (2001) showed how mobile Internet usability can be improved; in this case, the methodology adopted was experimental design. Borys and Milosz (2015) research tested mobile app usability using mobile eye-tracking glasses. Finally, Hussain and Kutar (2012) presented a study to examine the usability of mobile apps running on different platforms with the aim of improving understanding of the influence of devices on the usability of mobile apps.

In this research, I will use usability testing in a laboratory setting as this is the most appropriate strategy. Usability testing is an immensely popular tool to evaluate mobile apps' usability. I will use the "think aloud" protocol, which is based on the work of Ericsson and Simon (Ericsson & Simon 1984; Ericsson & Simon 1980). Traditionally, usability tests are conducted in laboratories. A laboratory is a peaceful environment where the user can easily concentrate on the tasks provided to them. The details of this will be outlined in the next section.

3.5.1.2 Strengths and Weaknesses of Experimentation as a Research Strategy

There are various advantages of using experimentation as a research strategy. If properly conducted, it is considered one of the most accurate and efficient ways to compare apps and their usability and reach conclusions (Flow Psychology 2015). First of all, in experimental research, the researcher has control over many of the independent variables. This control of independent variables helps the researcher to remove those that are unwanted and extraneous. This type of experimental design gives an advantage to the experimenters to find a cause-and-effect relationship through manipulating the independent variables (OCCUPYTHEORY 2014). This research design also has the benefit of being able to be used in many different ways and has been used in a wide range of research from pharmaceutics to education. It may be basic, but it is an efficient research strategy (Flow Psychology 2015). Using experimentation as a research strategy has another advantage in that it can be tailored to suit each situation. Experiments usually start with randomly assigning conditions to produce equivalent groups where one group is subject to conditions different from other groups. Isolation and the manipulation of independent variables to find causal effect is therefore another necessary component of experiments.

While the experimental strategy might produce results that are less realistic or natural than other research strategies, it is still useful in identifying a causal relationship, which might be difficult to do while using other research methods. It is primarily chosen by researchers if they want to identify or establish a causal relationship between variables (Zen 2000).

However, as a research strategy, experimentation has various disadvantages. Experimental research is subject to various errors such as human, systematic or random errors. These can at times affect the credibility or validity of the results from the experiment (OCCUPYTHEORY 2014). Another major disadvantage of adopting this research strategy is that it involves at times controlling variables that are irrelevant, which can create situations that are unrealistic or artificial (Flow Psychology 2015). Many confusing variables in a usability experiment come from the fact that it is related to UX. For example, imagine someone is invited to be part of a usability experiment even they do not know anything about usability. They would want to know what the

experimenter is trying to find through this experiment. There are expectations by the experimenters from the results that are to be achieved from the experiment (Holah 2006).

3.5.2 Justification for Choosing Laboratory Experiment as a Research Strategy

There are various arguments for choosing laboratory testing as the research strategy for this research. Firstly, laboratory testing has been used in a lot of usability research. Beck et al. (2003) outlined and evaluated six techniques for usability testing in a laboratory environment. These techniques facilitated the systematic collection of data and identified usability problems experienced by mobile users. According to them, the laboratory testing methodology has many advantages. Christie, Klein and Watters (2004) conducted a comparison of option layouts on small-size screens using laboratory testing as their research methodology. A single layer grid and a simple hierarchy layout were compared to basic interface designs. The results showed that the grid interface was better than the simple hierarchy interface and that when task complexity was of a higher level, the size of the screen had more impact on the performance of the task than the complexity of the task. Parush and Yuviler-Gavish (2004) used laboratory testing in their usability study that aimed to discover the impacts of the small screen size of mobile devices upon web browsing and navigation. They tested both structures with personal computer (PC) and cellular phone emulation. The results showed that it is time-consuming to learn a new stylus keyboard layout but it is highly rewarding because enhanced virtual keyboards can improve an expert user's performance. Lee and Zhai (2004) discovered that the learning curve of a new stylus keyboard can be decreased by using top-down learning strategies. They undertook a laboratory experiment in which one group was taught how to use a stylus keyboard layout with top-down methods and the other group learned to type using sentences. The participants who were taught about the keyboard using the top-down method with a stylus learnt the layout of the keyboard more effectively and were observed as being more efficient than the other group. As demonstrated through these examples, laboratory testing is often used for comparing usability. This research also compares two fitness and weight loss apps. This comparison will help us find which features best enhance the usability of such apps.

Secondly, usability testing in a laboratory gives experimental control to the researcher which is essential for the collection of high-quality data. Mobile apps are often used in

a very dynamic context where many people and objects might be distributed in a user's surroundings (Kjeldskov & Skov 2003). Therefore, although field-testing is an indispensable and appealing approach to determine the usability of apps, field-testing can be difficult. Firstly, it is extremely complicated to have realistic studies that can capture context-use richness (Rantanen et al. 2002). In addition to this, field-testing limits the control over users and the physical environment, which can complicate data collection (Johnson 1998). There, laboratory testing allows the researchers to obtain data about users' behaviour without the distractions of field-testing. Furthermore, laboratory testing allows us to use evaluation techniques such as think aloud and observation that cannot be applied through other means. These techniques are not possible in any other research choice such as the field setting (Sawhney & Schmandt 2000).

Finally, laboratory testing can reveal a lot about usability, even with the minimum number of participants. According to previous usability guides, 80% of the problems related to usability in any product can be revealed by having four or five participants in the experiment. Similarly, other studies showed that 90% of all usability problems can be detected using 10 participants (Dumas & Redish 1999; Nielsen 1994; Rubin 1994). Given the reasons outlined in this section, laboratory testing is the most appropriate choice as a research strategy for this study.

3.5.3 Experiment for this Research: Usability Testing for Fitness and Weight Loss Apps

Two Arabic fitness and weight loss apps were chosen to test their level of usability. The tests were conducted in a typical usability test environment. Laboratory settings were controlled in order to ensure that there were no external interruptions such as varying lighting conditions or disturbing noises. Test sessions can be recorded using a microphone and three video cameras. The cameras record the keyboard and the mobile display, the overall picture of the user and the user's face. A brief introduction of the mobile apps was provided to the users and they were instructed during the test to think aloud while they are performing certain tasks. Predefined wording was used orally to deliver the tasks to the users.

Traditional usability testing can be improved by using technology, for example through the use of Apple's wireless AirPlay technology. A MacBook was used for recording by

installing Reflector, a wireless streaming and mirroring receiver that converts a laptop into an AirPlay receiver. Reflector allows the user to mirror their smartphone's screen onto their laptop, eliminating the need to have an external camera to record events and helping minimise distractions for the user. The purpose of using this software and technology is to create the friendly and quiet environment that is essential for usability testing (Mifsud 2016; Walsh 2015).

3.5.3.1 Selected Fitness and Weight Loss Apps in Saudi Arabia

The apps in Google Play and Apple Store are available using different payment structures. Fitness and weight loss apps can be divided into three levels:

- **At Level 1**, apps are free to download but they do not have all the features. The user needs to subscribe and make payments to access extra features;
- **At Level 2**, the apps are not free. The user must pay to download the apps; and
- **At Level 3**, the apps are completely free to be downloaded.

I selected two fitness and weight loss apps to examine their usability and identify how the features in each app affect UX. The apps selected are popular in Saudi Arabia and have high ratings on both Google Play and the Apple Store, so I expect these apps to have special features and to be usable. The study of the two apps will help us determine how the usability in fitness and weight loss apps can be increased. The apps selected are free so that the participants in the usability testing can access them without cost to themselves. The apps are Twazon and Aded Surat.

I chose Twazon because it is an app developed by academics that aims to overcome obesity specifically in Saudi Arabia. Also, it has ten evidence-informed practice out of 13. Another advantage of using the Twazon app is that I can measure the impact of language on the UX. The app is built to make it simpler to make the necessary changes in key diet and exercise behaviours amongst Saudi adults whilst also considering cultural norms. It is also compatible for integration with the Health app on the iPhone. The app is compatible both with Android and iOS operating systems. At the time of selecting this app in October 2016, it had a 4 rating on both Google Play and Apple Store (Al-Maarik 2016; Alnasser et al. 2016; Google Play 2016b; Twazon 2016).

Aded Surat: This app has more than 3,500 android users as of October 2016 (Google Play 2016a). Also, it has nine evidence-informed practice out of 13. According to Apple store, it was 'the best health and fitness app' for 2014 and 2015. It is also compatible for integration with the Health app on the iPhone. On both Google Play and the Apple Store, this app has a rating of more than 4.5 as in October 2016. It also has one of largest databases of Arab and local food, which is updated daily. It is a very popular Arabic app for monitoring one's consumption of calories and performed exercises (Arab Mobile Content 2016; Google Play 2016a; Hmiate 2016).

Both apps were designed and developed with the goal of helping obese users to lose weight. They provide users with several features that aim to motivate them to make better changes in their lifestyle. Table 3.2 provides a comparison regarding their features. As it outlined within the table, a '✓' means including the feature whereas '✗' means not including the feature.

Table 3.2 Features' comparison between apps

Feature	Twazon	Aded Surat
Allow users to add information regarding their health	✗	✓
Calculate user's BMI value	✓	✓
Recommend a daily calorie intake of food for users	✓	✓
Calculate user's ideal weight	✓	✗
Allow users to set up a goal to lose either 0.5 or 1 kilogram per week	✗	✓
Provide users with the duration (in days) to reach their ideal weight	✓	✗
Recommend users drink water	✓	✓
Allow users to plan meals	✗	✓
Provide users with the number of calories for a food item	✓	✓
Provide users with the total number of calories per meal	✗	✓
Provide users with a self-assessment tool	✓	✗
Recommend users burn a certain number of calories daily	✓	✓

Provide users with exercises	✓	✓
States the benefit from each kind of exercise	✗	✓
Allow users to add food items in a favourites list	✓	✓
Allow users to add exercises in a favourites list	✗	✓
Count the number of steps walked daily	✓	✗
Monitor and track users' food consumption	✓	✓
Monitor and track users' water consumption	✓	✓
Monitor and track users' performed exercises	✓	✓
Monitor and track users' weight loss progress	✓	✓
Use shapes to show users the tracked information	✓	✓
Allow users to retrieve previous days' saved information	✗	✓
Provide users with a chart to show their weight loss over time	✗	✓
Provide users with their start, current and ideal weight	✓	✗
Provide users with a daily summary for their usage of the app	✗	✓
Provide users with a built-in chat feature	✓	✗
Allow users to participate in group discussions regarding users' enquiry	✗	✓
Allow users to share their weight loss development via social media apps	✗	✓
Sign in to use the app with social media accounts	✗	✓
Allow users to set a reminder	✗	✓
Helps users to understand and read labels on food products	✓	✗
Helps users to learn how to improve nutritionally poor meals	✓	✗
Provide users with general health advice	✗	✓
Allow users to contact app supporting team for enquiry or suggestion	✗	✓
Total	**20**	**27**

3.6 Research Choice

This research can be described in two ways: quantitative and qualitative. The main difference that separates the two types is the procedures and techniques, which focus on either verbal (words) or numeric data. Quantitative studies have a numeric focus and utilise quantifiable techniques of collecting data (questionnaires, for example) or numerical procedures of data collection (including graphs or statistics). Qualitative studies are focused on words, and they adopt methods for collecting data that are non-quantifiable (such as videos and interviews) and the results generated by data analysis procedures (like content analysis) are non-numerical.

In their research onion framework, Saunders, Lewis and Thornhill (2009) describe the choice between the qualitative and quantitative types or a combination of both in research procedures and techniques as the research choice. The possibilities available in the framework outlined by Saunders, Lewis and Thornhill (2009) are shown in Figure 3.6 and described in Table 3.3.

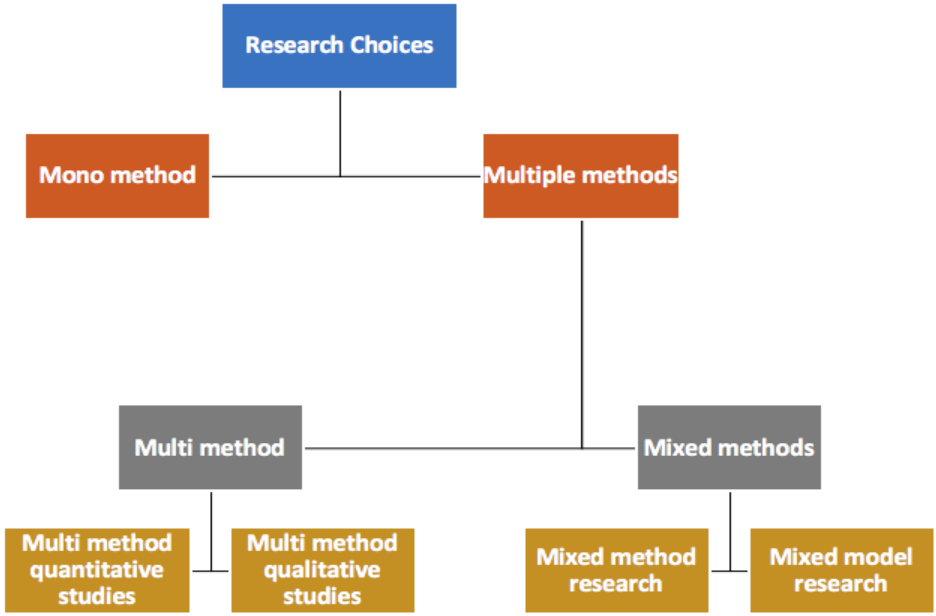

Figure 3.6 Options for Research choices

Table 3.3 Explanation for research choices

Choice		Description
Mono method		Uses only one method of collecting data and procedure for its analysis that are corresponding
Multi-method		A combination of different techniques of data collection that is either qualitative or quantitative
	Multi-method quantitative study	Involves more than one quantitative techniques for collecting data and doing analysis
	Multi-method qualitative study	Uses multiple qualitative techniques for collecting data and doing analysis
Mixed methods		Uses both quantitative and qualitative techniques for collecting data and doing analysis
	Mixed-model research	A mixture of data collection strategies that are both qualitative and quantitative and used for analysis
	Mixed-method research	Involves both qualitative techniques and quantitative techniques for collecting data and analysing procedures either in parallel (same time) or sequential (one after another)

In this usability research, I am looking at both technical aspects and some cultural and social norms; therefore, purely qualitative or quantitative procedures may not reveal some important aspects of real-life situations. According to Mifsud (2016), after each usability test session, data needs to be compiled, analysed and presented as a list of recommendations or suggestions that are possible to be implemented. Moreover, it is advised to divide the data into two different kinds, quantitative and qualitative. In order to calculate the different types of usability metrics, for example, success or completion percentage, satisfaction ratings, time is taken to complete a task and number of errors made by users, the quantitative data is recommended to be utilised. In order to compile insights in regard to which paths or patterns that were followed or used by users within the usability testing, the obstacles that were faced during the usability testing and the responses which were given within a post-test, the qualitative data is recommended to be utilised.

This research is largely qualitative. The data needed is qualitative and was collected based on verbal details. However, there is also quantitative data which, were existed

within the data set that were extracted through usability metrics and a questionnaire. In this research, I make use of multiple data collection techniques as well as various methods of analysis and presenting results. Therefore, this research is placed within the mixed-methods research choice.

3.7 Research Time Horizon

Any research can have two time horizons (Saunders, Lewis & Thornhill 2009). The two time horizons can be distinguished between through the following question: *"Is the research a 'snapshot' taken at a point of time or it is a series of snapshots over a given period?"*

The time horizon can be defined as a specific period of time that is covered by a study alongside the time that data were collected and related analysis was conducted. A single snapshot in a specified period of time is named a cross-sectional time horizon, whilst a longitudinal time horizon has multiple snapshots over a certain time period (Rindfleisch et al. 2008). A cross-sectional time horizon assists in capturing the immediate link among causes and effects whilst a longitudinal time horizon assists in capturing the changes and in testing the constancy of the inferences over a period of time.

This research has a cross-sectional time horizon. Usability testing is used to reveal the relationships between various features of mobile apps and their effects on the apps' usability. Experimental studies are usually done as a snapshot to find the cause and effect of certain features.

3.8 Research Techniques and Procedures

In this part, three primary inquiries will be discussed:

- What methods are utilised in order to collect data;
- From which sources are the data collected; and
- How to analyse the obtained data.

Usability testing is the information system's evaluation (Laurel 2003). It involves three techniques (Collins 2014):

- Observing participants while they are performing a task;
- Asking participants to think aloud while they are performing a task; and

- Asking participants questions to probe about the task.

According to Borriello and Holmquist (2002), usability testing is an empirical data collection process that observes users while they are completing a certain task with the app under evaluation. Usability testing methods fall into two categories: analytical (presence of user who is not involved) and observation (user is involved) (Marcus 2011). In this research, I use the observation method of usability testing. Placing the user in front of the apps and observing them perform tasks is useful in evaluating an app's design because it allows the person conducting the usability test to examine the problems the users are facing when a service or product is being used (Goodwin 2011).

3.8.1 Interviews

Saunders, Lewis and Thornhill (2009) describe a research interview as a deliberate discussion that aims to collect reliable and valid data that is relevant to the research inquiry. Research interviews are categorised based on many aspects, for example, question kinds and interviews' flow. One of the most known classifications for kinds of interview classifies it as the following (Gill et al. 2008):

- **Structured interview**: The interviewer uses standardised or pre-determined questions and records the interviewee's response in a pre-designed format. There is limited or no difference in the format of both a question or an answer. Structured interviews can be useful for gathering quantifiable data and are therefore usually regarded as quantitative research interviews. Structured interviews are easier to conduct because of their nature; however, they lack the ability to provide more depth because there are no follow-up questions (Gill et al. 2008).
- **Unstructured interview**: In an unstructured interview, questions are not pre-arranged because it is a non-directive interview (Kawin, Paterson & Reeves 1945). It is the opposite of a structured interview, which has a standardised format and questions (Thorpe & Holt 2007). These interviews are more informal and free flowing. Probing differentiates the in-depth, unstructured interview from a normal everyday conversation (Klenke 2008). The probe questions of unstructured interviews are as open as possible (Bailey 2008). It is a research method with a qualitative orientation as it prioritises the depth and validity of the interviewees' answers (David & Sutton 2004).

- **Semi-structured interview**: The semi-structured interview is laid between the previously mentioned two types of interviews. In such type of interview, the respondent and interviewer engage in a formal interview. The interviewer follows a formal guide but sometimes follows the topical trajectories, which may stray from the guide (Robert Wood Johnson Foundation 2008). It is best to use semi-structured interviews when the interviewer only has one chance to interview the respondent and when there are several interviewers collecting the data (Bernard 2011). Semi-structured interviews overcome the drawback of structured interviews as they allow for more elaboration. They also overcome the drawbacks of unstructured interviews as they provide guidelines on what should be discussed and achieved throughout the interview. The open-ended questions provide the opportunity to determine new ways of understanding and gaining a new perspective on particular topic (Robert Wood Johnson Foundation 2008). These interviews provide comparable and reliable qualitative data.

Semi-structured interviews are used for usability testing in this research. The reason for this is that in order to collect the feedback of different users, I need to have guidelines on what should be discussed and achieved but, at the same time, participants within the interview might need to have more space for elaboration. In usability testing, user interviews assist in giving feedback related to the design of a service or product. In usability testing interviews, the developer of the product does not influence the user. They instead collect user feedback that demonstrates the user's perception about the service or product as well as the problems they face while using it (Laurel 2003).

The structure of the interview conducted for testing usability usually has a standardised format. The interviews start with general information then specific information is gathered to comprehend the overall perspective. The interview is concluded with a summary. The standard interview can be divided into six main phases (Goodman, Kuniavsky & Moed 2012):

- **Introduction**: In the first phase, participants introduce themselves. The purpose of the introduction phase is to establish a comfortable interaction between the interviewee and interviewer.
- **Warm-up**: In this phase, participants are encouraged to concentrate on thinking about the apps and answer questions related to their usability.

- **General issues**: The third phase focuses on asking initial questions related to UX as well as about user's expectations, assumptions and attitudes in relation to the app. This phase helps the interviewer understand what users are expecting and how they value the app. Individuals should therefore be allowed to express their true feelings.
- **Deep focus**: During this phase, the users use the app while focusing on what it is doing, how it works, how it can be used and the experience of using the app. In the interview process, deep focus is the most substantial part.
- **Retrospective**: In the penultimate phase, participants review the product in a broader sense.
- **Wrap up**: In the final phase, the participants focus on general topics and interviewer concludes the discussion. This is a shortest phase in the whole process of the interview.

3.8.2 Think Aloud

According to (Nielsen 2012a), the think aloud technique is the best method for usability testing. This is a technique where the researcher encourages users to think out loud while they are performing a set of tasks (Van Den Haak, De Jong & Jan Schellens 2003). In order to implement a think aloud technique within the usability testing, the researcher needs to do two important things:

1- Give the users a list of tasks to perform; and
2- Remain silent and allow the users to do the aloud thinking.

This technique has the advantage of enabling the researcher to know what a user thinks about the app. If the researcher hears users' misconceptions about the app, they can convert this feedback into actionable recommendations for redesigning the app. In the case that the design elements within an app are misinterpreted or criticised by users, they need to be changed. Moreover, the researcher will learn the reasons why users made wrong guesses regarding elements within UI and why they found other elements easy to understand and use (Nielsen 2012a).

3.8.3 Observation

Observing users while they are completing their task is an effective technique for eliminating self-reporting errors (Goodwin 2011). However, this technique could

possibly result in the users' behaviour being affected by the observer. Observation has an advantage in that it helps the experimenter understand the problems that the users face while they are using an app (Goodwin 2011). The disadvantage of this technique is that the observer may spend too long observing the participants. Furthermore, it is necessary to observe participants from beginning to end so that the observer does not miss recording many of the significant phases.

3.8.4 Usability Metrics

The most important part of the research methodology is to measure usability using appropriate testing methods. It is important to measure usability so that I can compare the apps and determine how to improve them. One of the most frequent methods used to measure usability is usability metrics. I can use a number of quantifiable and observable metrics in order to help us solve the problem of relying upon instinct alone.

It is evident that focusing on UX and usability is a key element in creating successful high-quality apps. However, there are few clear guidelines on how to measure the usability of apps. Usually developers tend to employ familiar methods, although some of the methods are not always appropriate for every app (Hussain & Kutar 2009). Unique features and the novelty of mobile apps are the main challenge in the usability measurement activity of mobile devices. There are various models for such measurement; for instance, the quality in use integrated measurement (QUIM) was introduced by Seffah et al. (2006). Bevan and Macleod (1994) developed the metrics for usability standards in computing (MUSiC), which was combined with the original ISO 9241 standard. Kirakowski and Corbett (1993) extended the MUSiC model by including learnability and satisfaction in the model. For this research, I use the revised ISO 9241-11 standards by Bevan, Carter and Harker (2015). ISO 9241-11 identifies usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (International Organization for Standardization 1998). Bevan, Carter and Harker (2015) have extended their definition to include systems, products and services.

Effectiveness, efficiency and satisfaction are the key aspects of usability according to the ISO 9241-11 Bevan et al. (2016). Attributes such as memorability, errors, cognitive load and learnability are linked to the efficiency and effectiveness of the app and it is recommended they be considered (Alturki & Gay 2017a, 2017b, 2019c; Harrison, Flood

& Duce 2013). Whilst each of these attributes measures the effectiveness and efficiency of these apps, they do so from a specific perspective. If an app has few errors, it means that it is effective because the user can perform more tasks in less time without repeating the tasks with errors. Similarly, if an app has better learnability and memorability, it helps the user undertake more tasks accurately even though they might not regularly use the app, so it is more effective. The user therefore becomes more efficient in their completion of these tasks. Moreover, when apps have a better cognitive load level, users will be able to perform several actions while using apps, for example, a user might drink coffee and speak to friends while using an app. Thus, apps become easier to use. Each of the above attributes, therefore, enhances the usability and user satisfaction.

3.8.4.1 Usability Metric for Effectiveness

Effectiveness can be measured using the completion rate of tasks. Another measurement that can be used is the number of mistakes that users make when trying to finish a task. Effectiveness can therefore be defined as a percentage by utilising the simple equation represented below (Alturki & Gay 2017a, 2017b; Mifsud 2015).

$$\text{Effectiveness} = \frac{\text{Number of tasks completed successfully}}{\text{Total number of tasks undertaken}} \times 100\%$$

3.8.4.2 Usability Metrics for Efficiency

Efficiency is used as a tool to measure the time taken to finish a task. It is usually the time taken by participants to complete a task. Efficiency can be calculated using two methods: time-based efficiency and overall relative efficiency (Alturki & Gay 2017a, 2017b; Mifsud 2015).

$$\text{Time Based Efficiency} = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N}\frac{n_{ij}}{t_{ij}}}{NR}$$

$$\text{Overall Relative Efficiency} = \frac{\sum_{j=1}^{R}\sum_{i=1}^{N} n_{ij} t_{ij}}{\sum_{j=1}^{R}\sum_{i=1}^{N} t_{ij}} \times 100\%$$

Where:

- R: number of users
- N: number of tasks.
- n_{ij}: result for task (i) by user (j). If the task is completed successfully, then n_{ij} = 1, otherwise n_{ij} = 0.
- t_{ij} = time spent by user "j" to complete task "i". If the user does not complete the task successfully, then the time will be measured until the moment the user gave up from the task.

3.8.4.3 Usability Metrics for Satisfaction

Users' satisfaction can be determined through standardised questionnaires that measure satisfaction. These can be dispensed after each task or following the usability testing session. Once the user attempts a task, they are given a questionnaire to measure the difficulty of the task and the task level satisfaction. Post-task questions can take various forms: ASQ, subjective mental effort questionnaire (SMEQ), single ease question (SEQ) and the usability magnitude estimation (UME). In this research, I am using SEQ as recommended by Sauro (2010). SEQ has the advantage in that it is brief and simple to answer as well as being easy for the experimenter to conduct and then tally the results. The SEQ in this case is, "Overall, how easy or difficult did you find this task?" This SEQ has a rating scale of 7 points where 1 is very easy and 7 is very difficult. The level of satisfaction is found via a formalised questionnaire to users to gain an overall idea of how the app is to use. There are different types of questionnaires available; however, the choice depends on the budget as well as the degree of significance placed upon the user's perceived level of satisfaction as a factor of the overall project (Garcia 2013).

3.8.4.4 Usability Metrics for Cognitive Load

Cognitive load is the measure of mental activity on working memory at any particular instance (Tracy & Albers 2006). To determine each app's cognitive load, I use the

National Aeronautics and Space Administration (NASA) task load index (TLX) test (Hart & Staveland 1988). NASA-TLX is a two-stage test utilising weights and ratings that enables users to assess the condition of the workload once an examination is completed. It measures the overall task demands by identifying three broad scales, which are task, behaviour and subject-related. Each of the scales has factors. The task-related scale includes mental, physical and temporal demands. The behaviour-related scale includes performance and effort, while the subject-related scale includes frustration. The questions below will be asked to participants utilising a ranking system between 5 to 100 where 5 is very low and 100 is very high for all the factors, except performance where 5 is perfect and 100 is a failure. A user will need to have description for each of the factors as demonstrated below (Alturki & Gay 2017a, 2017b; Hart & Staveland 1988):

- **Mental demand**: To what extent did you need to perform mental and perceptual activities (such as thinking and calculating)?
- **Physical demand**: To what extent did you need to perform physical activities (such as pushing and pulling)?
- **Temporal demand**: To what extent did you feel a time pressure while performing tasks?
- **Effort**: How hard did you have to work hard (mentally and physically) to perform tasks?
- **Performance**: How satisfied are you with your performance?
- **Frustration level**: How stressed or annoyed did you feel while performing these tasks?

The NASA-TLX test contains two stages: weights and ratings. In the weighting procedure, each user is required to evaluate the influence of each factor regarding a task. There are 15 potential pairs of factors about which a comparison is made. Each is given 15 cards, with each card containing a pair of the factors. They are then asked to select the most relevant factor regarding the task. Each time the user selects from a pair, the examiner counts it. The scale for a factor for each user can range from 0 to 15. The total comparisons for all factors should equal 15. In the second stage, a user needs to rate each of the factors above in a scale that is divided into 20 equal intervals and each interval equals 5 points with a total of a 100 on the scale. As it is a post-event test, it is an effective one as it captures the thoughts and interaction of the users.

3.8.4.5 Usability Metrics for Errors

Another usability measurement is measuring the amount of errors made by the user when completing a task. Errors are defined as the mistakes, omissions, unintended actions or oversights that are made by the participant when attempting a task. Counting the errors provides excellent diagnostic information and it should be mapped into usability problems (Alturki & Gay 2017a, 2017b; Sauro 2011).

3.8.4.6 Usability Metrics for Learnability

Learnability is the ability of an interface to help the user accomplish tasks on the first attempt (Alturki & Gay 2017a, 2017b; Sauro 2013c). Learnability can be measured through establishing the task performance of users who have not been exposed to an app before. Another way of looking at usability is through perceiving how usability or task performance has improved after repeated trials.

3.8.4.7 Usability Metrics for Memorability

Memorability measures how easy it is to remember how to perform a task on an app after a casual user returns to the app after a certain period of not using it (Alturki & Gay 2017a, 2017b; Harrison, Flood & Duce 2013). Memorability has the same tests as efficiency and effectiveness but these are repeated after some period of time in order to determine whether the user has remembered how to perform the same task and hence whether this has improved the usability of the app.

3.8.5 Data Analysis

After data collection, the next step is data analysis that can be defined as the procedure which extracts meaningful outcomes, decisions and inferences from the collected data. There are many techniques and procedures in data collection. Some techniques which are applied involve the collection of qualitative data and others of quantitative data.

3.8.5.1 Preparation of Data

It is very important to prepare the data for analysis. This can be done by creating detailed observation notes from audiotapes, videotapes or screen recordings for each testing session. The experimenter should edit the notes and data logs taken during usability session to make them more concise and understandable (The University of Texasat Austin n.d.-b).

3.8.5.2 Organising the Data

In this research, I have the option of organising the data using either bottom-up or top-down approaches. As I have a predefined set of categories for analysis, I am using the top-down approach. The observational data and notes for each task were organised as shown in Table 3.4.

Table 3.4 A model of a Top-down approach for analysis data

Categories	Description	User	Time	Notes
Ease of navigation	User could not find information easily	User 1	12:01	User spent around 5 minutes finding the correct information but gave up.
		User 2	13:44	User was on the correct page but couldn't find the information he was searching for.
	User did not know where to click	User 3	9:22	User mentioned that he was not sure which button to click so he clicked all of them and eventually found the information he was looking for.
Density of text	Text is very dense and discourages reading	User 4	6:54	User simply quit the page and did not look for the information when he saw a long page filled with text.

3.8.5.3 Analyse the Data

In the data analysis phase, qualitative and quantitative data are transformed into results that can be used for making recommendations about the usability of the app (The University of Texasat Austin n.d.-a). Descriptive statistics are used to analyse quantitative data to identify errors and difficulties as well as when tasks do not meet acceptable criteria. Thematic coding is used to analyse qualitative data to identify categories of users' behaviour and general trends of user behaviour. Qualitative data can also identify opinions of the technology's usability and users' general perceptions.

After analysing the qualitative data, the themes that emerged in the data are identified and conclusions drawn from them. After they are prepared and analysed, the results from all the data sources are compared. The process is called triangulation and it improves

the validity and reliability of the conclusions (Connaway 2005). If there is a conflict between the results from the observation and any other data (such as interview answers), then the observation results are considered more valid because behaviour observed directly has more validity than the attitudes and behaviours perceived through a survey. Evaluation of the results is based upon how well and to what level the interviewees answer the main topic questions. Any conclusion should reflect the results from the data analysis and recommendations from the researcher should be included.

3.8.5.5 Report Results

The results should be prioritised according to the usability features that are considered to have the most importance in terms of problem frequency or error severity. The results should provide all of the recommendations for building a usability guide for fitness and weight loss apps. Using the guidelines from the recommendations, a new app is developed and tested to find out if the changes have helped the new app improve its usability. The report includes the quantitative and qualitative results that have been organised thematically. To report quantitative results, I present frequencies graphically. Tables, diagrams, and graphs are used to report the results. Screenshots and pictures showing where users were facing problems are also included to make a strong case for recommendations.

3.9 Challenges and Utility of the Usability Methods

This research work includes some challenges. There is a lack of synchronisation between the two different fitness and weight loss apps to evaluate and compare their performance. Each kind of fitness and weight loss app has several features which might not be included in the other app. Due to the lack of similarity between apps, it is difficult to undertake a performance evaluation of each app. Beside this, there might be a need to have certain skills or mobile devices to use the fitness and weight loss apps. Thus, it is very important to take into account the feedback from the target users in terms of how each app was rated. Furthermore, since a user's experience might change when changes are made with new versions of apps, usability testing technique can help to understand users' experiences. Without any feedback from users, app developers find it difficult to identify the shortcomings, loopholes and drawbacks in their apps. Pre-launch or pilot

studies have their own benefits but in usability testing their benefits are limited as they lack the ability to identify limitations and challenges of apps in an exhaustive manner. Usability testing methods are useful because they can address the limitations and challenges of various apps.

In this study, I include the following usability methods: interview, observation, think aloud and usability metrics. The main aim in this study is to help us improve fitness and weight loss app's usability and features. The interview methodology helps in understanding the users' perceptions of fitness and weight loss apps and allows observers to learn about their experience without the alteration of users' perceptions. The think aloud method is chosen because it benefits our understanding of the users' experience with fitness and weight loss apps. It allows the observer to know users' opinions regarding the design elements within app UI.

Testing through observation assists in removing the self-reporting errors that arise due to the observer's impact upon users' thinking process and perceptions. The main benefit of this method is that the user has the freedom to use the product without the observer's interference. The usability metrics method measures the seven usability attributes (effectiveness, efficiency, satisfaction, cognitive load, errors, learnability and memorability). Through their quantitative results, a comparison can be made between the tested apps and the new app to determine whether the level of usability has improved or not.

Therefore, the different usability testing methods each have their own advantages. In this study, their combination will help us study the usability and features of fitness and weight loss apps through direct observation of and interaction with participants.

3.10 Research Ethics

Ethics are the most important foundations for any research to be considered as professional and well received. UTS has created stringent guidelines and standards in order to safeguard ethical research. According to the UTS Human Research Ethics Committee (HREC) guidelines, there is a need to attain official ethical approval as the research require conducting usability testing and interviews with potential users. Therefore, I had submitted a human ethics application form which contains detailed

information in regard to the data collection process and the informed consent form, invitation letter and participant information sheet were attached. The HREC assessed the application and an official ethical approval had been generated (UTS HREC REF NO. ETH16-0833).

3.11 Conclusion

The research design and methodology had been the main subject of this chapter. The research onion framework is the basis of this research. The framework has six main layers, starting with philosophy and ending with techniques and procedures. This chapter provided a comprehensive explanation regarding each of the framework layers and justified the chosen element within each layer for this research study. Two Arabic fitness and weight loss apps which are popular among Saudi users, Twazon and Aded Surat, were selected to test their level of usability. As the research requires usability testing and semi-structured interviews with potential users (Saudi citizens who experience obesity), based on the UTS research ethics requirements, an official ethical approval was attained.

The next chapter presents the quantitative results for the usability testing of the two Arabic fitness and weight loss apps. It explains in detail the usability testing environment, analysis process and discusses the results.

CHAPTER 4
USABILITY TESTING

4.1 Introduction

This chapter further explains the tools and methods used to analyse data to obtain the quantitative results for the usability testing of the Twazon and Aded Surat apps. It outlines in detail the quantitative results for both apps in terms of seven usability attributes and describes how each attribute was analysed. It starts with a brief explanation regarding the meaning of a quantitative analysis and when and why this type of analysis used. It then provides information regarding the participants and the usability testing environment in this research. Following this, it explains the analysis process and the procedures that are used to extract the quantitative data. Next, the quantitative results of for both the Twazon and Aded Surat apps are presented and then organised and categorised by the usability attributes. The chapter then concludes with a discussion of the results.

4.2 Quantitative Analysis

A quantitative analysis can be defined as a systematic approach that aims to investigate a situation while a researcher collects numeric data or during the converting of the collected or observed data to numeric forms (Labaree 2009). Such analysis describes situations or events and aims to answer questions such as “what” or “how many.” It is an approach that measures or counts attributes. This approach is concerned with finding evidence that either supports or contradicts ideas or hypotheses. Hypotheses are the places where predicted answers to research questions are proposed. In the case that researchers are interested in hypothesis testing, experiments will be conducted in order to collect data (Analyse This 2008; Bryman 2006).

4.3. Participants

Twenty-six participants (13 males and 13 females) were tested to explore the usability of both apps. The Armed Force Hospital in the Taif Region of Saudi Arabia provided candidates who experienced obesity and were motivated to lose weight in order to have

a healthier lifestyle. Prior to agreeing to be in the study, all participants had received a "Participant information sheet" and "Invitation letter" that asked them to be a part of the usability testing and explained to them what the research is about, what it would involve if they agreed to participate and the purpose of conducting such usability testing. After they agreed to participate in the usability testing, an informed consent form was giving to each participant to be signed before the usability testing is started. All the three forms can be found in the appendix. The participants' information is presented in Table 4.1.

Table 4.1 participants' information

User	Gender	Age group	Occupation	Type of phone	Operation system
1	Male	35 to 44	Self-employed	iPhone 7	iOS
2	Male	25 to 34	High school teacher	iPhone 7	iOS
3	Female	25 to 34	Unemployed	OnePlus 3	Android
4	Female	45 to 54	Government employee	iPhone 6S	iOS
5	Female	25 to 34	Government employee	HTC 10	Android
6	Female	Preferred not to say	Preferred not to say	iPhone 7	iOS
7	Female	25 to 34	Accountant	iPhone 7 Plus	iOS
8	Female	25 to 34	Hospital receptionist	iPhone 6S	iOS
9	Female	Preferred not to say	Preferred not to say	iPhone 7	iOS
10	Female	Preferred not to say	Preferred not to say	iPhone 7	iOS
11	Male	18 to 24	Student at university	iPhone 6	iOS
12	Female	18 to 24	Unemployed	iPhone 7 Plus	iOS
13	Female	45 to 54	Unemployed	iPhone 6S Plus	iOS
14	Male	25 to 34	Teacher at university	Galaxy S7	Android
15	Male	Preferred not to say	Preferred not to say	iPhone 7	iOS
16	Male	18 to 24	Student at university	OnePlus 3	Android
17	Male	25 to 34	Unemployed	iPhone 6S	iOS

18	Male	45 to 54	Self-employed	iPhone 7	iOS
19	Male	55 to 64	Retired	iPhone 7 Plus	iOS
20	Male	25 to 34	Employee in a company	iPhone 7	iOS
21	Male	25 to 34	Works in a family business	iPhone 7	iOS
22	Female	18 to 24	Student at university	iPhone 6S Plus	iOS
23	Male	25 to 34	Government employee	iPhone 7	iOS
24	Male	35 to 44	Employee in a company	iPhone 6S	iOS
25	Female	45 to 54	Unemployed	iPhone 7 Plus	iOS
26	Female	Preferred not to say	Preferred not to say	iPhone 7	iOS

4.4. Usability Testing Environment

As described in Chapter 3, the tests were conducted in a typical usability test environment. Laboratory settings were controlled in order to ensure that there were no external interruptions such as varying lighting conditions or disturbing noises. Test sessions were completed via Apple's wireless AirPlay technology. A MacBook was used for recording. The first step was to install Reflector, which is a wireless streaming and mirroring receiver that converts a laptop into an AirPlay receiver. This allowed the user to mirror their smartphone's screen onto their laptop. It also eliminated the need to have an external camera to record events. Moreover, it also helped to minimise the distractions for the user. The purpose of using this software and technology was to create the friendly and quiet environment that is essential for usability testing (Alturki & Gay 2017a, 2017b).

Twenty-six participants tested the Aded Surat app; however, the Twazon app was only tested by the first nine participants as the app stopped working. While they tested them, their mobile screens were recorded through the Reflector software. All participants were asked to use both apps three times. Each time using an app, all participants were asked to perform 14 tasks, which were the same for all users but different for each app. A list of the tasks can be found in the appendix. The time difference between the first and

second sessions was one hour. Between the second and the third sessions, there was a one-week interval.

The usability test was divided into five phases, as follows:

- **Introduction**: In the first phase, both the participants and the examiner introduced themselves. The purpose of the introduction phase was to establish a comfortable interaction between the examiner and participants.
- **Warm-up**: In this phase, participants were asked to download the apps Twazon and Aded Surat and to fill out a brief questionnaire that aimed to collect participants' information, such as age group. The questionnaire form can be found in the appendix.
- **Deep focus**: During this phase, the examiner gave the users a list of 14 tasks. The participants used the apps with the focus being on what they were doing, how they worked and how the apps could be used. The examiner encouraged the participants to think aloud while they were performing the tasks. When participants finished a task, they were asked to rate it in an SEQ questionnaire.
- **Retrospective**: In the penultimate phase, the examiner explained the NASA-TLX questionnaire and asked participants to fill it out.
- **Wrap up**: In the final phase, the examiner thanked the participants and answered any enquiries.

4.5. Analysis Process

After the usability testing, there were 101 recorded videos (76 videos for the Aded Surat app and 25 videos for the Twazon app). These videos recorded the mobile screens of participants while they were performing in the trial. I examined all 101 videos. All users who successfully completed a task scored 1. I also measured how long it took to complete each task. Users who completed a task in the wrong way or gave up on a task received 0 and the time spent on each task was also measured. After this, the equations for effectiveness, overall relative efficiency and time-based efficiency were applied, then all errors that the participants had made while performing tasks were calculated. Regarding the learnability attribute, I compared participants' performances in the first session with those of the second. Memorability was then measured by comparing participants' performances in the second session with those in the third. Both satisfaction

and cognitive loads were applied only in the first session as they measured the performances of participants who had not previously been exposed to an app. If these loads had been applied in the second and third sessions, this condition could not have been met. Next, I examined the data from the SEQ questionnaire that was used to measure satisfaction. The rating for each user was calculated and then divided by 14 to determine the average satisfaction value for each user. I then examined the data from the NASA-TLX questionnaire and applied the roles to determine the total user score for the cognitive load (Hart & Staveland 1988).

4.6. Twazon's Results

4.6.1 Effectiveness

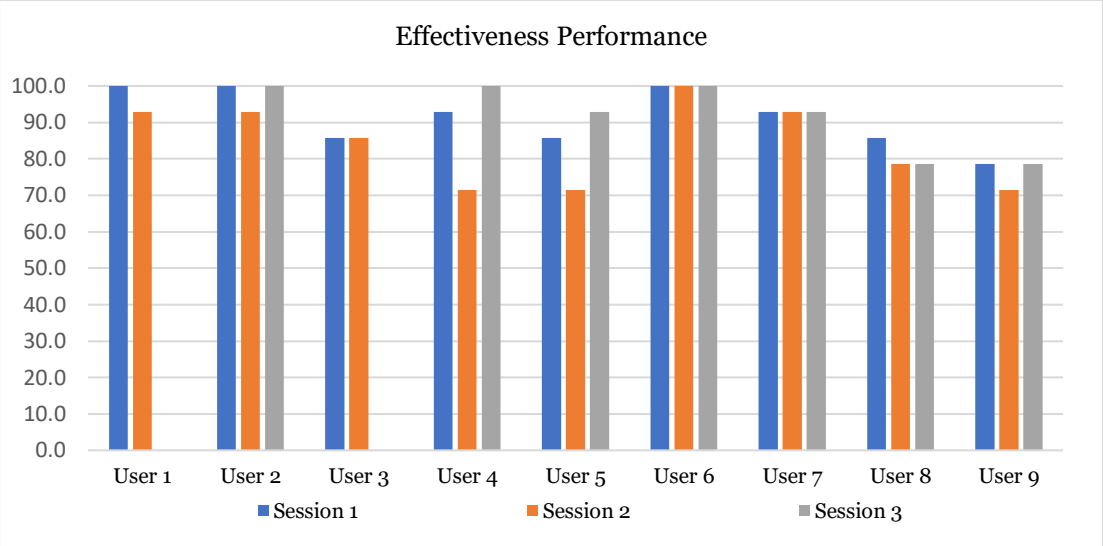

Figure 4.1 Twazon's effectiveness performance

Figure 4.1 shows each user's effectiveness performance over the course of the three sessions. User 6 had the highest percentage of value each time, with 100% in session 1, which remained constant for sessions 2 and 3. User 7 similarly received the same percentage in all three sessions, although the value is lower at 92.85%. Users 2, 4, 5 and 9 showed positive progress across the three sessions. However, Users 1 and 3 had a negative performance because in session 3 they both scored 0%. User 8's effectiveness performance also slightly decreased.

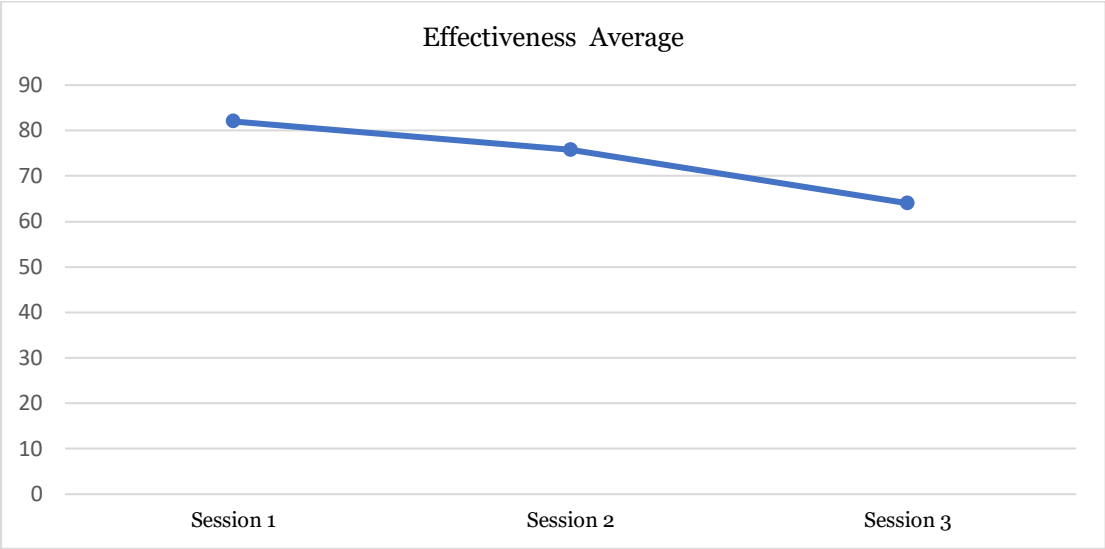

Figure 4.2 Twazon's effectiveness average

Figure 4.2 shows the effectiveness performance average, which decreased over the three sessions. In session 1 it was 82%, then it fell to 75.71% and finally in session 3, it reached 64%.

4.6.2 Efficiency

4.6.2.1 Overall Relative Efficiency

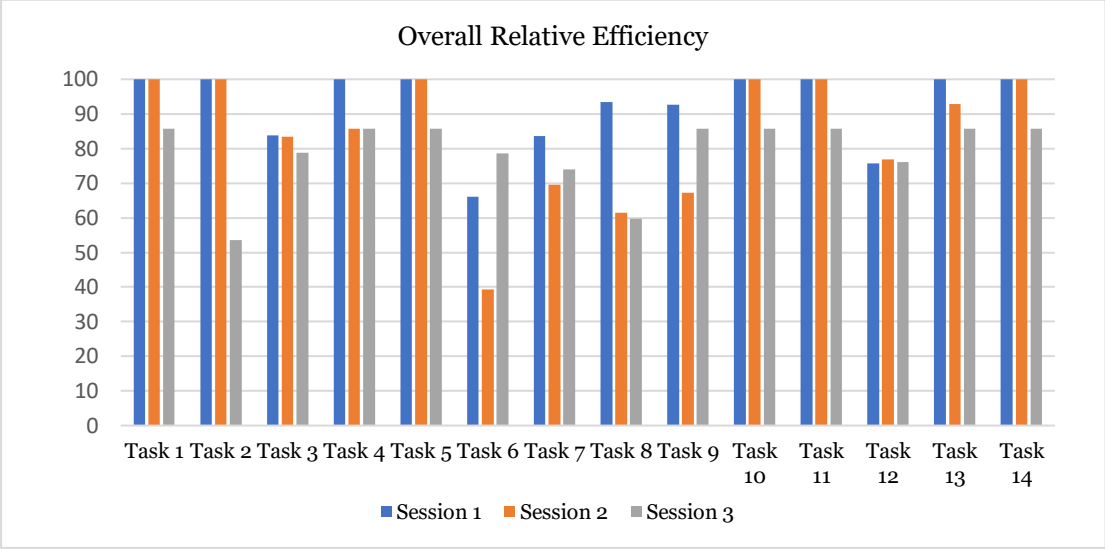

Figure 4.3 Twazon's overall relative efficiency

Figure 4.3 shows the overall relative efficiency for the tasks for the three sessions. In session 1, among the 14 tasks, eight tasks scored 100% whereas in session 2 and session 3 it was six and 0 respectively. Only in tasks 6 and 12 did the overall relative efficiency

percentage improve over each session. However, all the other tasks dramatically decreased between the first and final sessions.

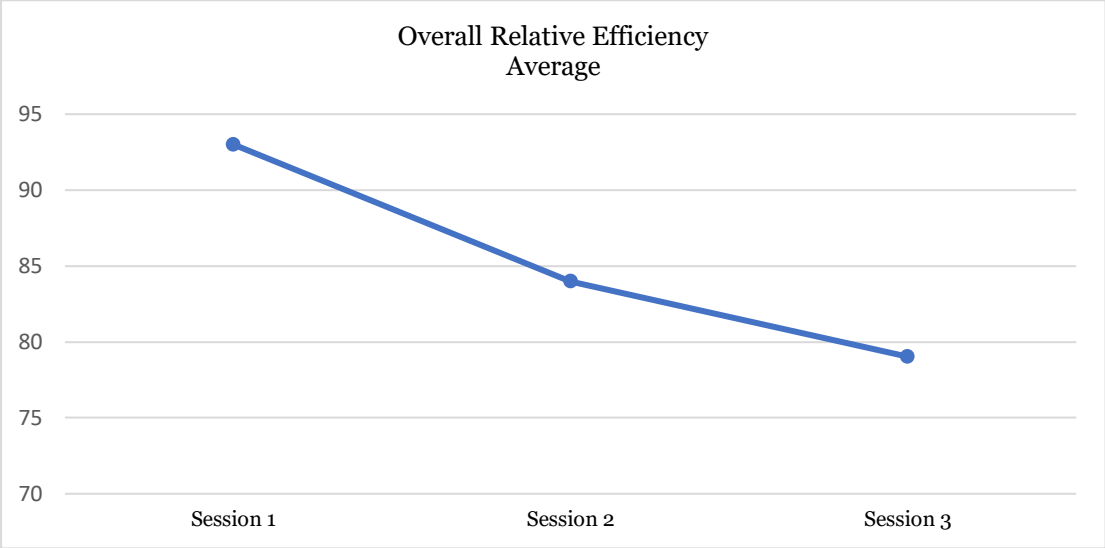

Figure 4.4 Twazon's overall relative efficiency average

Figure 4.4 shows the overall relative efficiency average, which decreased over each of the three sessions. In session 1 it was 93%, then it fell to 84% and in the final session it dropped to 79.03%.

4.6.2.2 Time-Based Efficiency

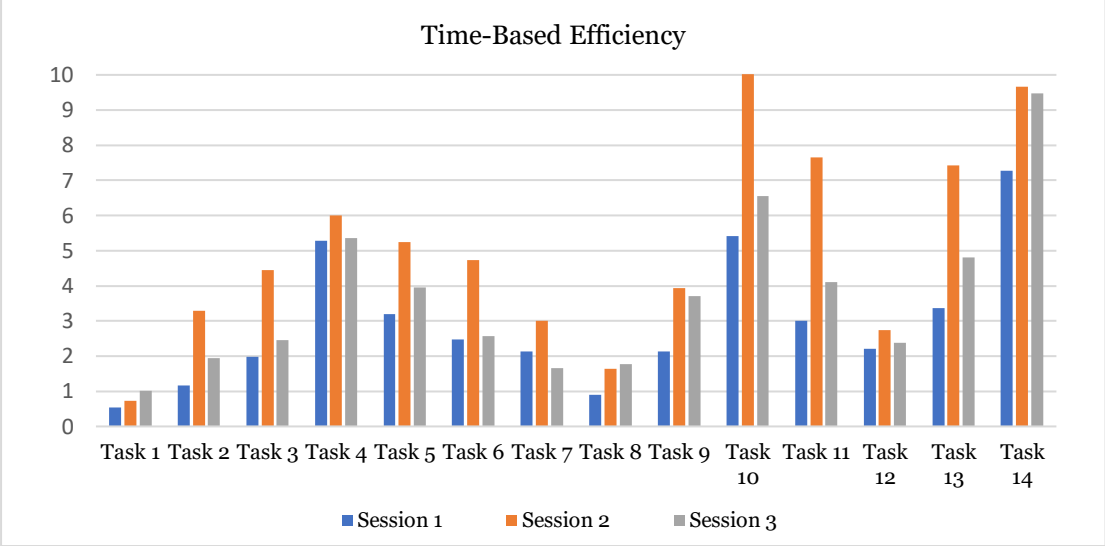

Figure 4.5 Twazon's time-based efficiency

Figure 4.5 shows the time-based efficiency for tasks among the sessions. Task 14 had the highest time-based efficiency score among all tasks. In sessions 1, 2 and 3 it was 7.28 goals per second, 9.66 goals per second and 9.48 goals per second respectively. Task 10 had the second highest time-based efficiency score followed by tasks 4 and task

13. Interestingly, task 10 reached 10.02 goals per second in session 2, which was the highest value in all sessions. On the other hand, task 1 got the lowest time-based efficiency followed by tasks 2 and 8.

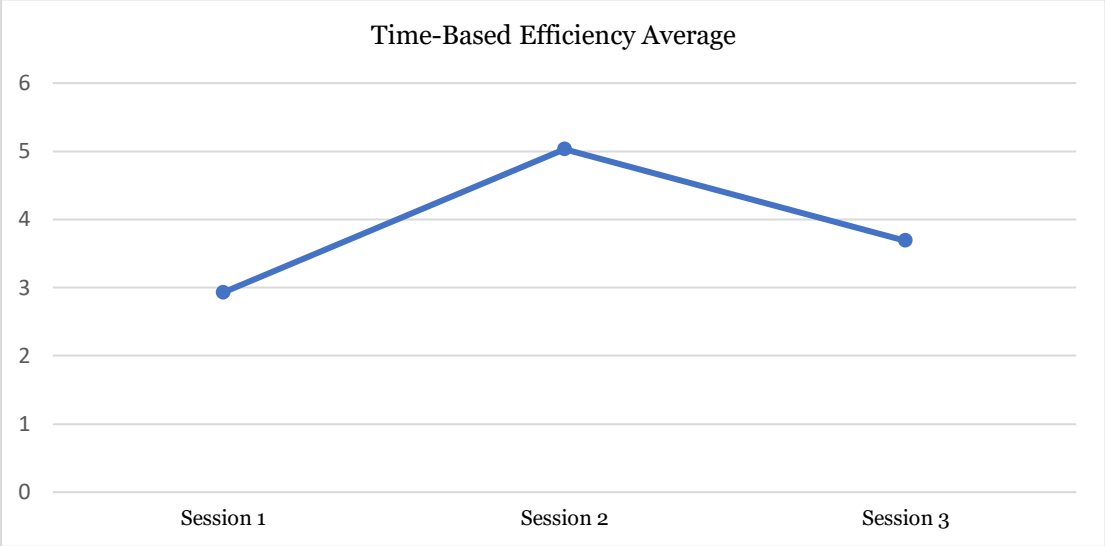

Figure 4.6 Twazon's time-based efficiency average

Figure 4.6 shows the time-based efficiency average, which fluctuated across the sessions. In session 1 it was 2.93 goals per second, then it increased to 5.03 per second and finally in session 3 it decreased to 3.69 goals per second.

4.6.3 Satisfaction

Figure 4.7 Twazon's average satisfaction score

Figure 4.7 shows each user's average satisfaction score for all tasks. User 5 had highest score at 3.86. Users 4 and 9 scored 2.21 and 2.36 respectively. Users 1 and 8 had the lowest scores at 1.50 and 1.00 respectively.

4.6.4 Cognitive Load

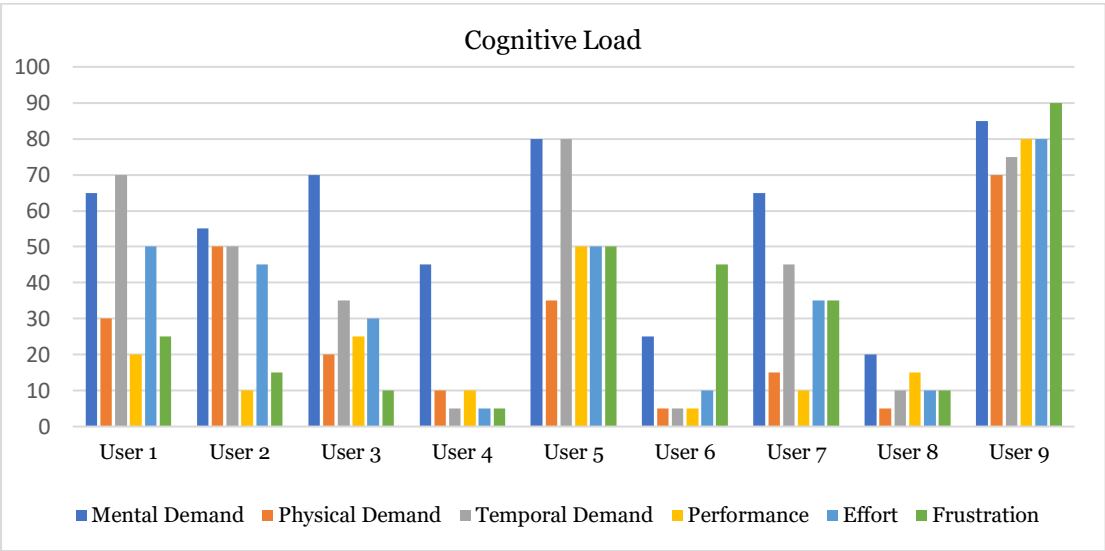

Figure 4.8 Twazon users' rating for each subscale in cognitive load

Figure 4.8 shows each user's rating for each subscale in the cognitive load. User 9's cognitive loading is the most consistent, with scores lying between physical demand at 70% to frustration at 90%. Users 4 and 6 had a high score gap within their cognitive load

subscales value. Mental demand and temporal demand scored the highest value amongst all the subscales, while performance and physical demand scored the lowest values.

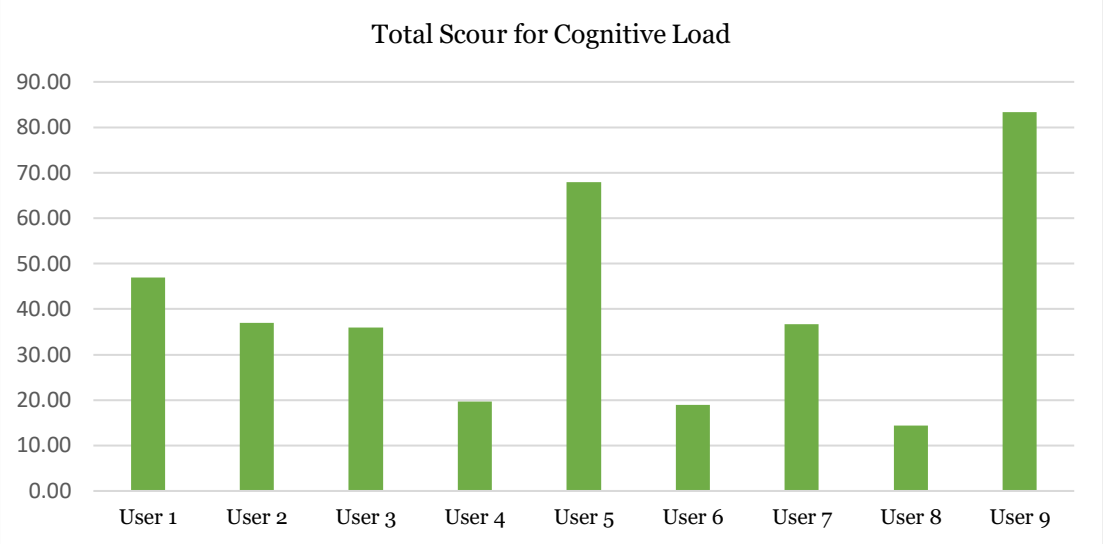

Figure 4.9 Twazon's total score for cognitive load

Figure 4.9 shows the total score for cognitive load amongst users. User 9 had the highest value at 83.33%. Users 1 and 5 scored 47% and 68% respectively. User 8 had the lowest score at 14.33%.

4.6.5 Errors

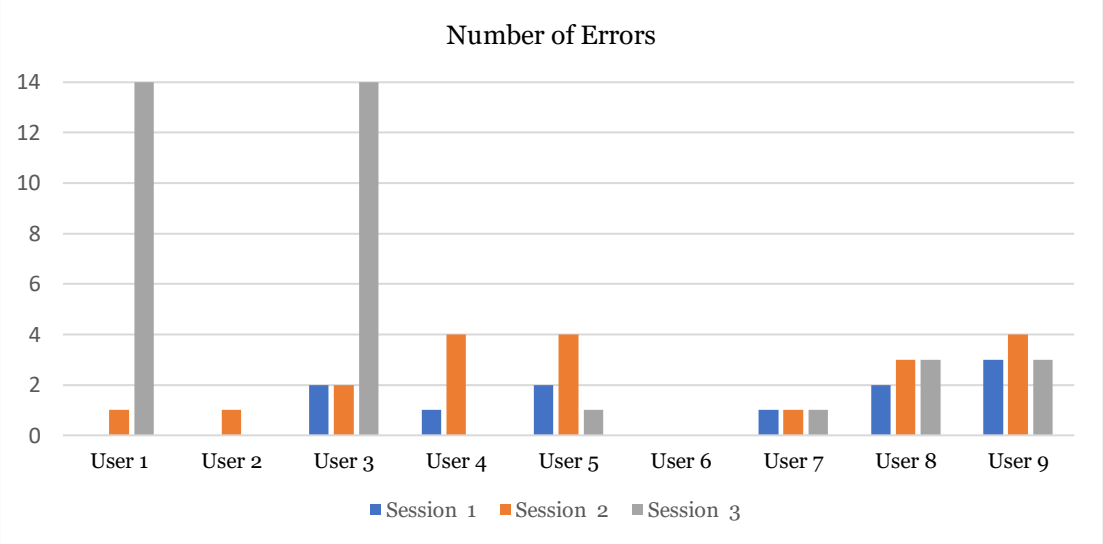

Figure 4.10 Twazon's number of errors

Figure 4.10 shows the number of errors made by each user. User 6 is the only user who did not make any errors in any of the three sessions. User 2 has the second lowest number

of errors with just one in session 2. Users 1 and 3 had the highest number of errors at 15 and 18 respectively.

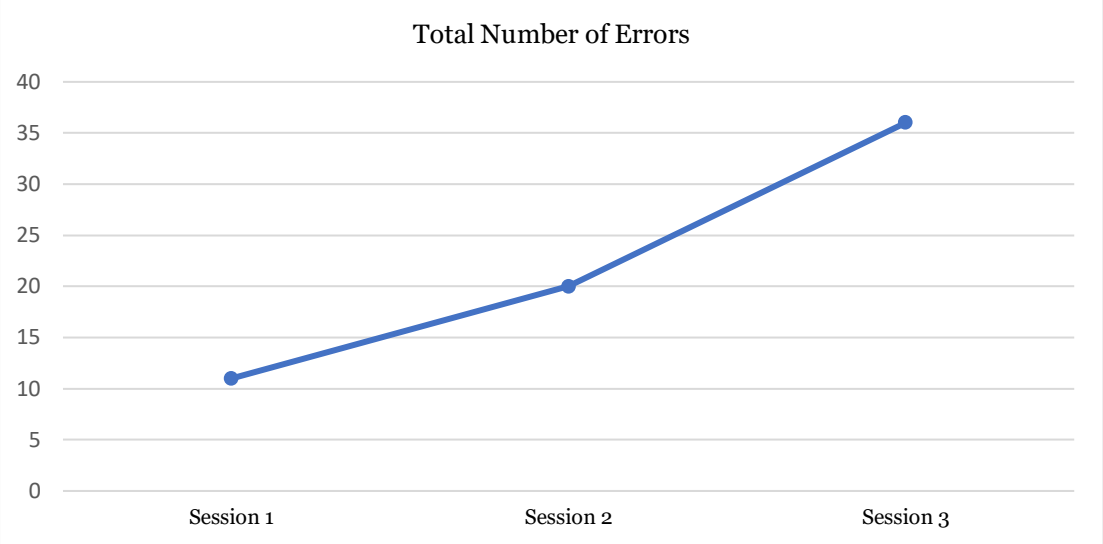

Figure 4.11 Twazon's total number of errors

Figure 4.11 demonstrates the total number of errors made by all users, which increased over each session. In session 1 it was 11, then it sharply increased to 20 and finally in the third session, it increased to 36.

4.7. Aded Surat's Results

4.7.1 Effectiveness

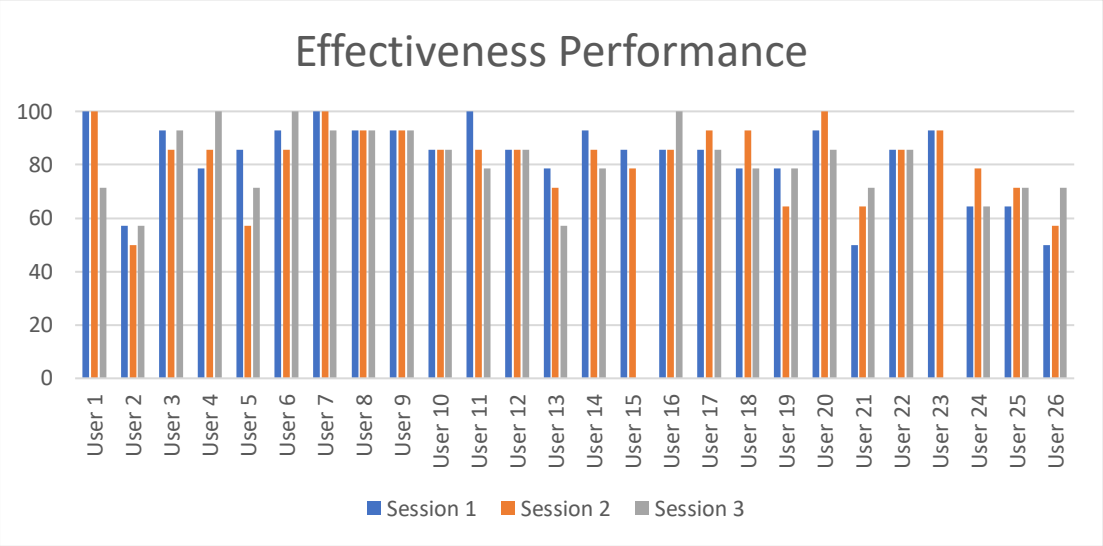

Figure 4.12 Aded Surat's effectiveness performance

Figure 4.12 shows each user's effectiveness performance over the course of the three sessions. Out of the 26 participants, only six participants (users 4, 6, 16, 21, 25 and 26)

showed positive progress across sessions. However, these users differed in their pattern of improvement. While users 4, 21 and 26 improved across the three sessions, scoring higher in each session that the previous one, users 6, 16 and 25 showed a pattern of overall improvement on average across the three sessions. For example, users 4, 21 and 26 had the value of 78.57%, 50% and 50% respectively in session 1, which increased to 85.71%, 64.28% and 57.14% respectively in session 2 and then increased again to 100%, 71.42% and 71.42% respectively in session 3. In contrast, user 6 had the value of 92.85% in session 1, but this decreased to 85.71% in session 2 and then increased to 100% in session 3. User 16 had the same value in both session 1 and session 2 at 85.71% but this then increased to 100% in session 3. User 25 had the value of 64.28% in session 1 and then increased to 71.42 % in both session 2 and session 3.

Five other participants, users 8, 9, 10, 12 and 22, had the same value over the three sessions, while users 8 and 9 had the value of 92.85% and users 10, 12 and 22 had the value of 85.71%. Six participants, users 2, 3, 17, 18, 19 and 24, had the same value in sessions 1 and 3, while the values users 2, 3 and 19 received decreased in session 2 compared to sessions 1 and 3. The values of users 17, 18 and 24 increased in session 2 compared to their values in sessions 1 and 3.

Nine participants, users 1, 5, 7, 11, 13, 14, 15, 20 and 23, showed negative progress across sessions, with their effectiveness decreasing over the three sessions. User 7 had the highest percentage of value each time. In session 1, it was 100% and remained constant in session 2 and yet it decreased in session 3 to 92.85%. Moreover, user 1 showed the same pattern though the value was lower at 71.42% in session 3.

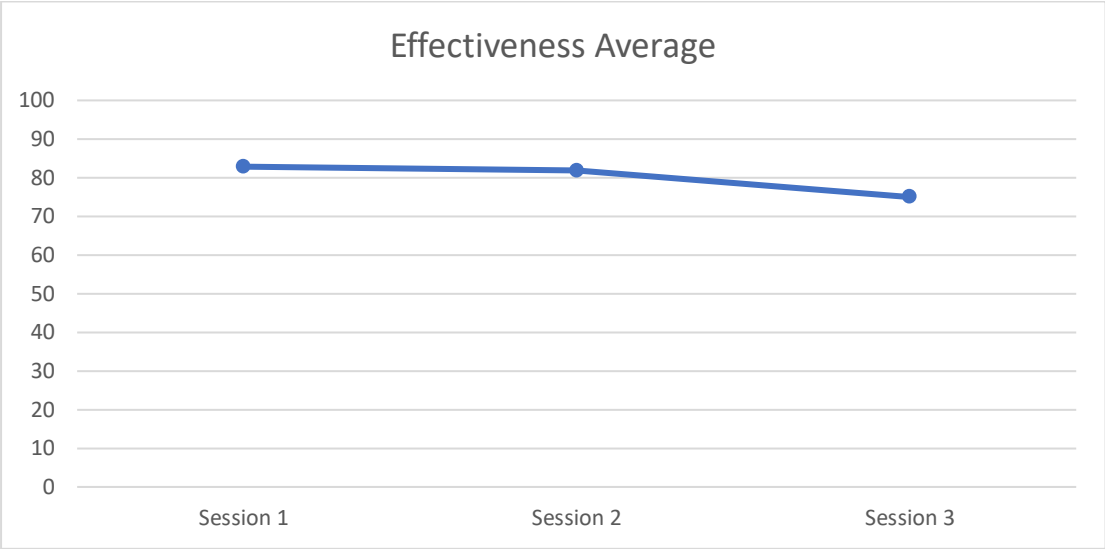

Figure 4.13 Aded Surat's effectiveness average

Figure 4.13 shows the effectiveness performance average, which decreased over each session. In session 1 it was 82.86%, then it fell to 81.86% and finally in session 3, it reached to 74.99%.

4.7.2 Effectiveness

4.7.2.1. Overall Relative Efficiency

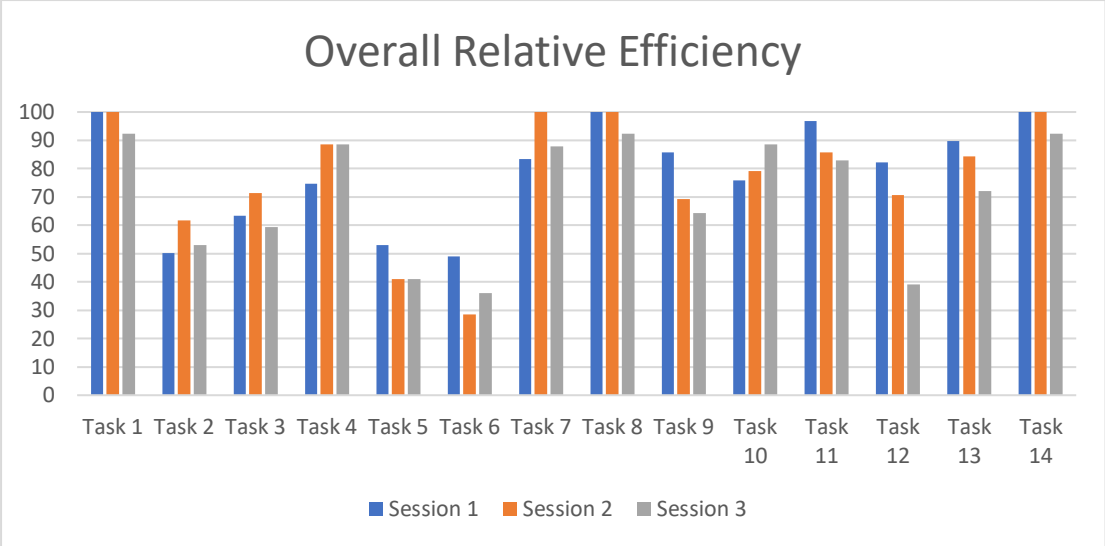

Figure 4.14 Aded Surat's overall relative efficiency

Figure 4.14 shows the overall relative efficiency for the tasks for the three sessions. In session 1, among the 14 tasks, three tasks scored 100% whereas in session 2 and session 3 it was four and 0 respectively. Only in tasks 2, 4, 7 and 10 did the overall relative

efficiency percentage improve over the three sessions. However, all the other tasks dramatically decreased between the first and final sessions.

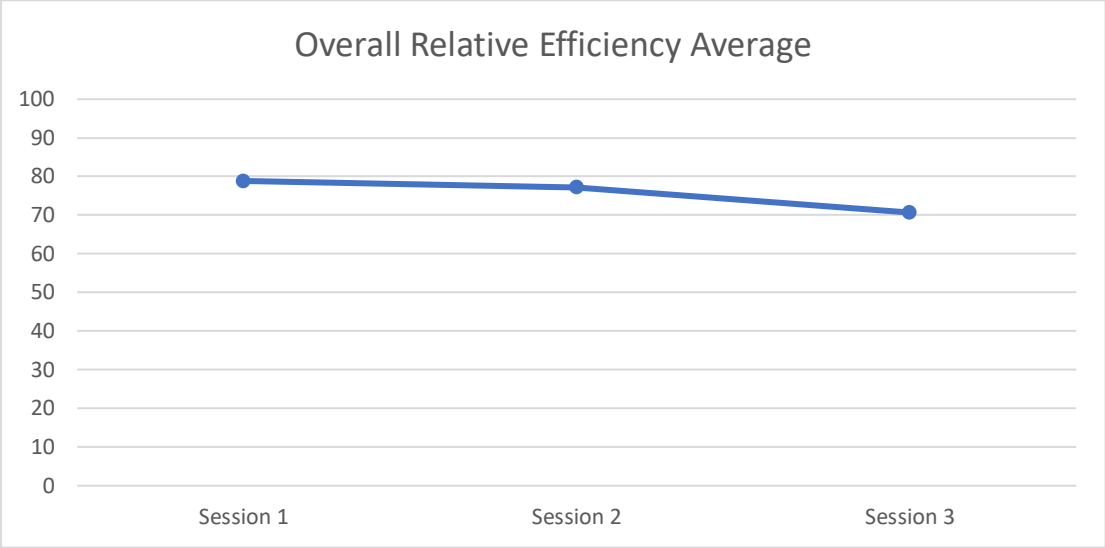

Figure 4.15 Aded Surat's overall relative efficiency average

Figure 4.15 shows the overall relative efficiency average, which decreased over each of the three sessions. In session 1 it was 78.84%, then it fell to 77.16% and in the final session it reached 70.67%.

4.7.2.2 Time-Based Efficiency

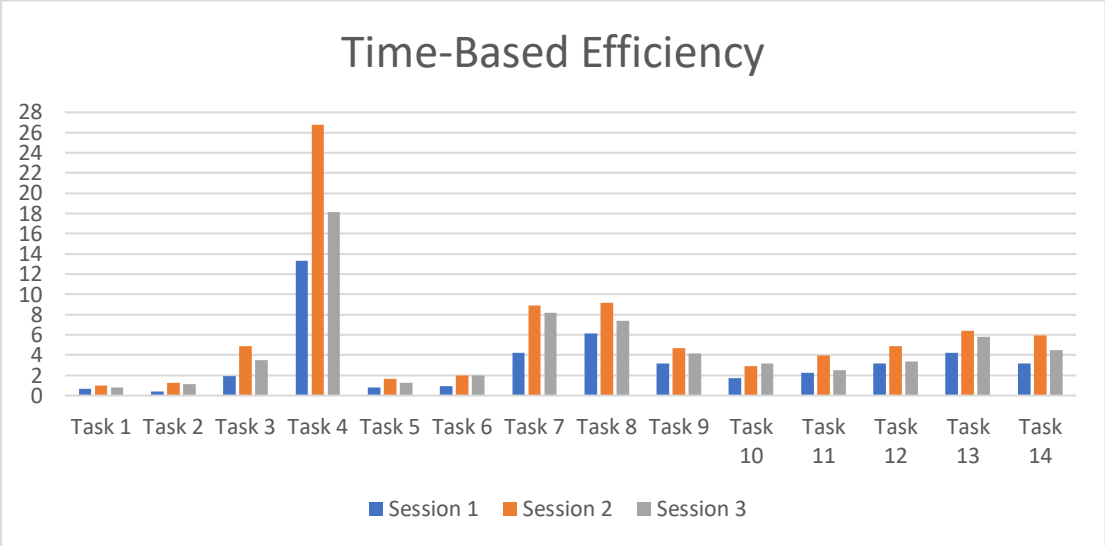

Figure 4.16 Aded Surat's time-based efficiency

Figure 4.16 shows the time-based efficiency for the tasks across the sessions. Task 4 had the highest time-based efficiency score among all tasks. In sessions 1, 2 and 3 it was 13.35 goals per second, 26.8 goals per second, which is the highest value for a task in

all sessions, and 18.12 goals per second respectively. Task 8 had the second highest time-based efficiency score followed by tasks 7 and 13. Task 1 got the lowest time-based efficiency followed by tasks 2 and 5.

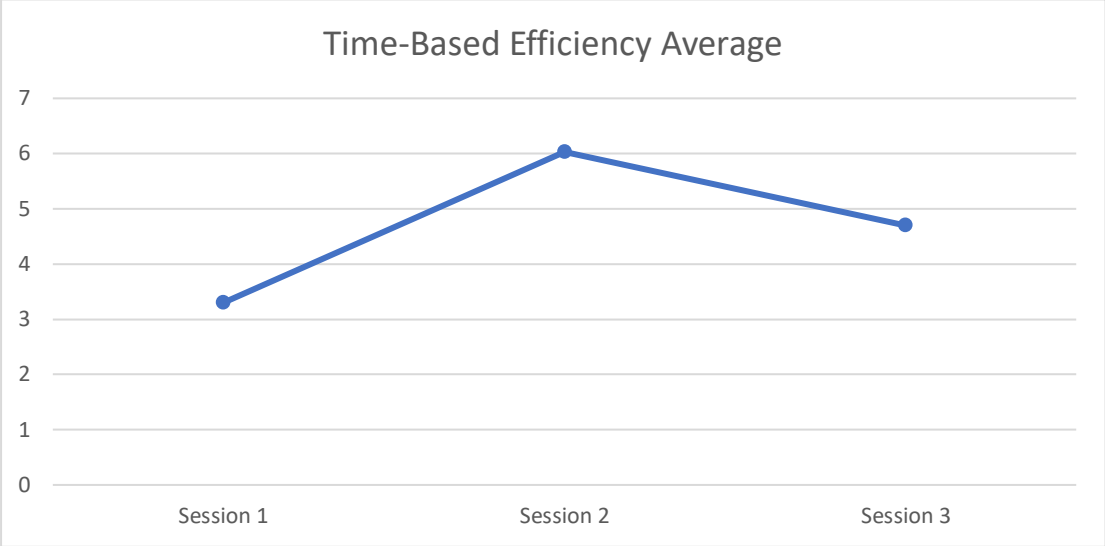

Figure 4.17 Aded Surat's time-based efficiency average

Figure 4.17 shows the time-based efficiency average, which fluctuated across sessions. In session 1 it was 3.3 goals per second, then it increased to 6.03 goals per second and, finally, in session 3 it decreased to 4.7 goals per second.

4.7.3 Satisfaction

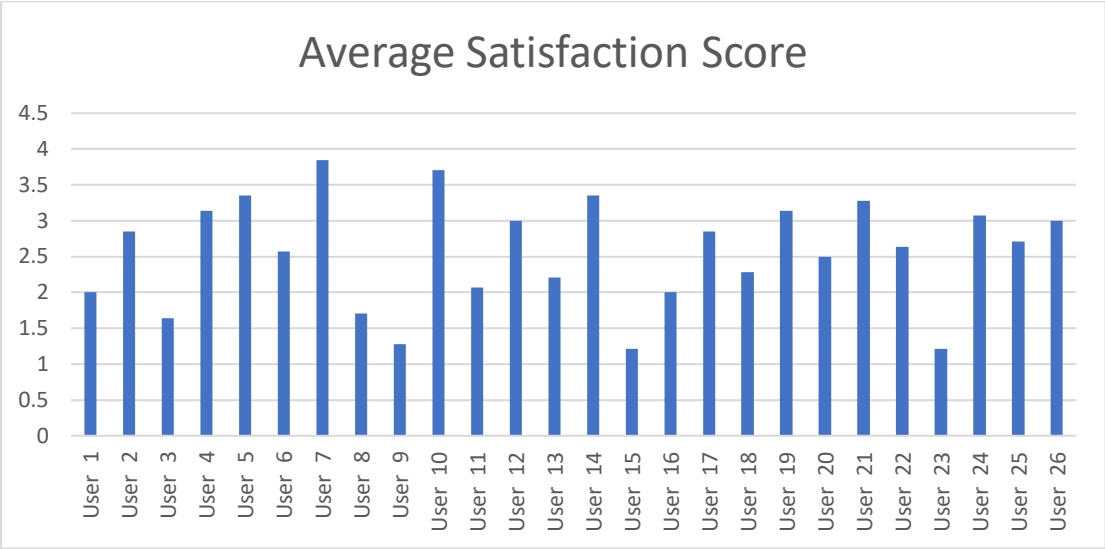

Figure 4.18 Aded Surat's average satisfaction score

Figure 4.18 shows each user's average satisfaction score for all tasks. User 7 had the highest score at 3.85, followed by user 10 at 3.71 and then users 5 and 14 both scored 3.35. Users 3, 9 and 23 had the lowest scores at 1.64, 1.28 and 1.21, respectively.

4.7.4 Cognitive Load

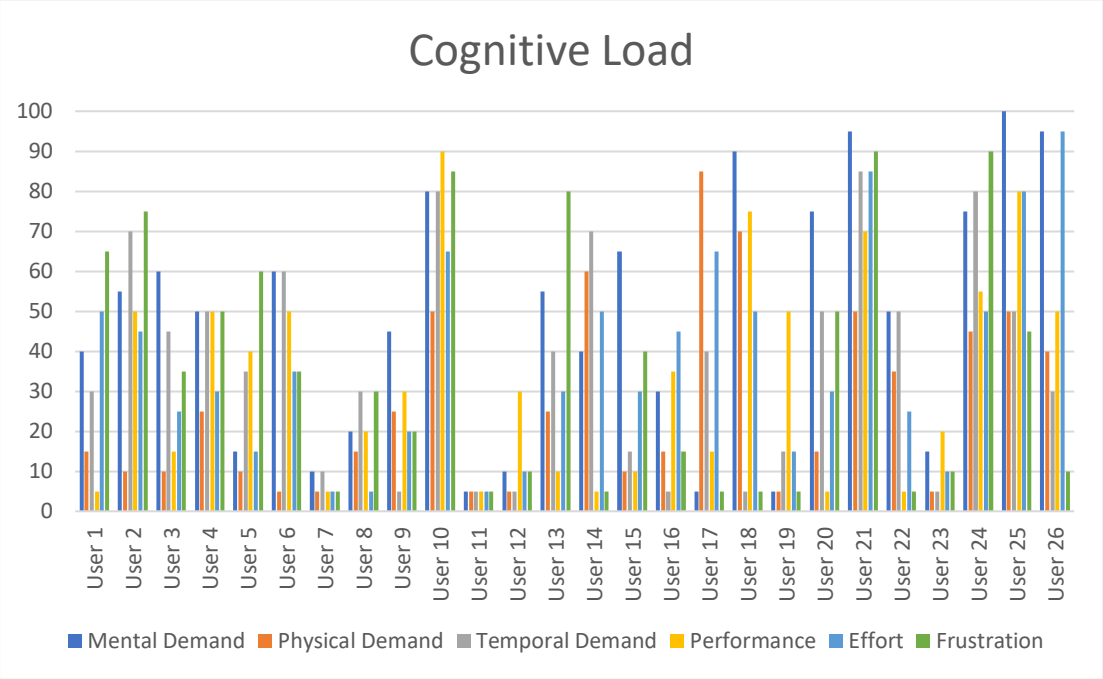

Figure 4.19 Aded Surat users' rating for each subscale in cognitive load

Figure 4.19 shows each user's rating for each subscale in the cognitive load. User 11's cognitive loading is the most consistent, with scores of 5% for all the six subscales. User 7's cognitive loading is the second most consistent. Scores lie between physical demand, performance, effort and frustration at 5% to mental and temporal demand at 10%. Users 13, 17 and 18 had a high score gap within their cognitive load subscales value. Mental demand and effort scored the highest value amongst all the subscales, while physical demand and performance scored the lowest values.

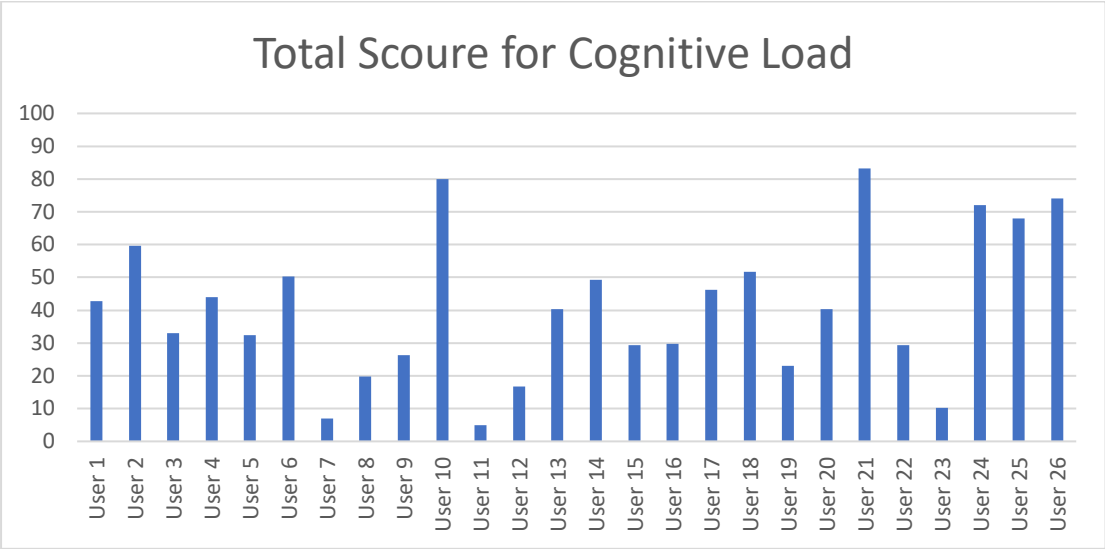

Figure 4.20 Aded Surat's total score for cognitive load

Figure 4.20 refers to the total score for cognitive load amongst users. User 21 had the highest value at 83.3%. Users 10 and 26 scored 80% and 74% respectively. User 11 had the lowest score at 5%, followed by users 7 and 23 with 7% and 10.3% respectively.

4.7.5 Errors

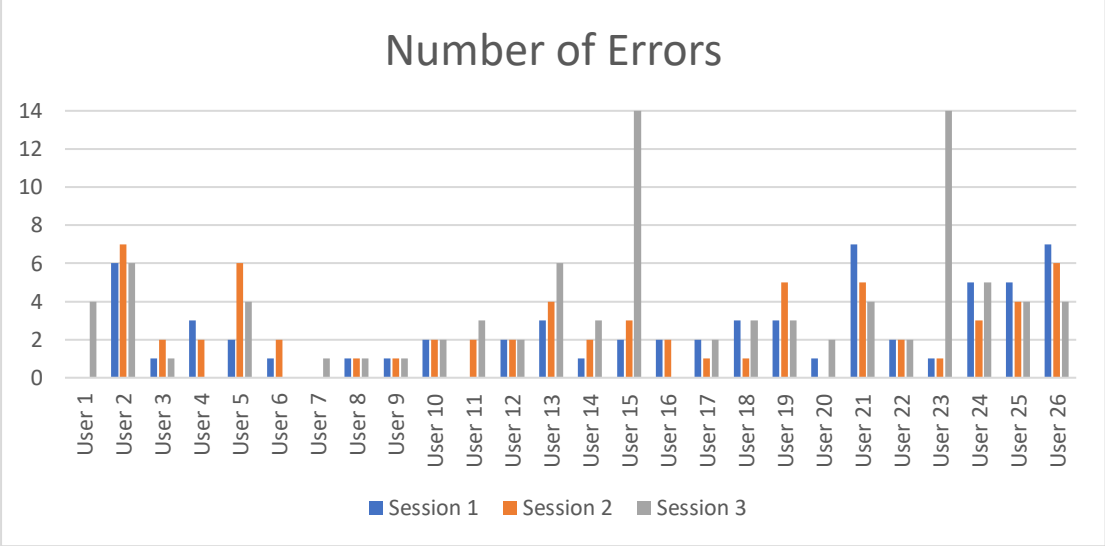

Figure 4.21 Aded Surat's number of errors

Figure 4.21 shows the number of errors made by each user. User 7 had the lowest number of errors with just one in session 3. Users 6, 8, 9 and 20 had the second lowest number of errors with three errors over the three sessions. Users 1, 3 and 16 had the third lowest number of errors with four errors over the three sessions. Users 2 and 15 had the highest number of errors at 19 over the three sessions.

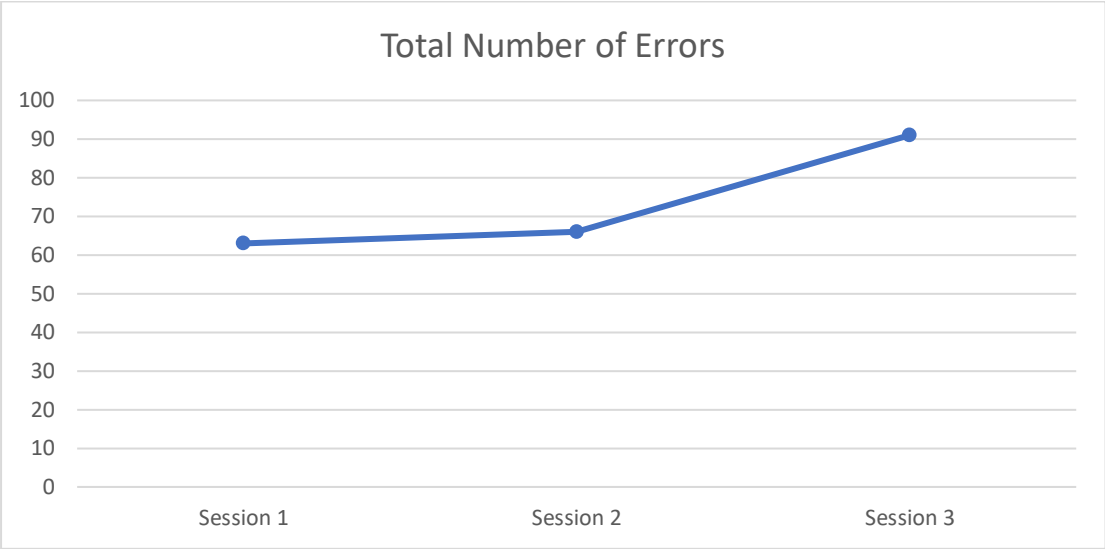

Figure 4.22 Aded Surat's total number of errors

Figure 4.22 demonstrates the total number of errors made by all users, which increased over each session. In session 1 it was 63, then it slightly increased to 66 and finally in the third session, it sharply increased to 91.

4.8 Discussion of the Results

This experiment had two limitations. The first one was that while testing Twazon, the app stopped working. Users 10 to 26 were not able to test the app and users 1 and 3 were not able to perform the third session. The second limitation was that while testing Added Surat, users 15 and 23 were not able to participate in the third session as they faced a technical issue with the app. The app did not respond to them when they started performing the first task and, after several attempts, they gave up. However, the overall trial for testing the usability of both apps succeeded as the level of usability was determined.

Despite the positive increase in the overall score for time-based efficiency between session 1 and session 3 for both apps, the percentage score for user's effectiveness and overall relative efficiency decreased over time. Moreover, the number of errors for both apps increased from the first session to the second session and did so again from the second to third sessions. As a result of this, both apps had a negative association with both learnability and memorability attributes.

Furthermore, several participants scored a high percentage in the satisfaction questionnaire, which is negative as a high score means they found it difficult to use the

apps. Only one participant rated the whole task in Twazon as very easy and scored 1 as an average. However, out of the 26 participants, no one rated the whole task in Aded Surat as very easy and scored 1 as an average.

In addition to this, the overall cognitive load score for both apps was high as the lowest percentage scored by a participant while testing Twazon was 14.33% and, out of the 26 users who tested Aded Surat, only three users scored a percentage that is less than 11%. This means that several participants were not able to perform tasks correctly while doing other activities; for example, speaking to examiners.

The five usability attributes (effectiveness, efficiency, learnability, memorability and errors) did not improve over time. Moreover, both satisfaction and cognitive load scored high percentages because the majority of participants found both apps difficult to use. Therefore, the results show that Twazon and Aded Surat apps had a low level of usability, which is expected since they were designed and developed without considering usability attributes and factors.

4.9 Conclusion

In this chapter, a quantitative analysis for Twazon and Aded Surat apps was presented. The analysis aimed to determine the level of usability for both apps. Twenty-six participants tested the Aded Surat app and nine of them tested the Twazon app. Participants are asked to use each app three times and each time they were asked to perform 14 tasks that were the same for all participants in all the three sessions. While they used the apps, their mobile screens were recorded using the Reflector software and a MacBook. The usability metrics from Chapter 3 for seven usability attributes (effectiveness, efficiency, satisfaction, cognitive load, errors, learnability and memorability) were applied in order to form quantitative results. Based on the results, it is concluded that both apps had a low level of usability.

The next chapter presents a comprehensive qualitative analysis for both apps that aims to investigate the low level of usability. It explains in detail the reasons and factors that are resulted in such level of usability.

CHAPTER 5
USABILITY GUIDELINES

5.1 Introduction

This chapter presents and discusses the qualitative findings of this research. It provides usability guidelines for developing efficient and usable culturally aware weight loss apps in the future. The qualitative analysis process is divided into four main parts: interaction design, graphic and visual design, health professionals' analysis and user interviews. Each part includes findings and suggested guidelines based on the testing trials' results for the Twazon and Aded Surat apps, using the research techniques explained in Chapter 3. The various kinds of visual designs, functions, pages and contents within both apps are illustrated by using figures. Based on the findings and suggested guidelines, the chapter concludes with recommendations that will be used while developing a new weight loss app.

5.2 Interactive Design

Interactive design is an important component of user experience design (UXD) (SIANG 2019). Kolko (2010) defines an interaction design as creating a dialogue between an individual and a product, system or service. However, such interaction is not limited to software products, for example mobile apps. The main objective of interactive design is to make a product which enables users to accomplish their goals in the easiest and best way.

This section explains UXD from start to finish for both the Twazon and Aded Surat Apps; that is, from the time a new user starts to use the Twazon and Aded Surat apps to the time the tasks they have been allocated and are actually done. The process is divided into twelve sections. All sections are discussed in detail regarding their functionality, contents and buttons and the discussion is supported by quotations from the participants within the usability testing. The sections are

1. Sign-up process;
2. Homepage;
3. Assessing and reaching ideal weight;

4. The diet;
5. Self-assessment;
6. Physical activities;
7. Self-monitoring, tracking and feedback;
8. Social communication;
9. Reminders;
10. Educational features/functions;
11. Editing users' information; and
12. Effect of advertisements.

5.2.1 Sign-up Process

When the Twazon app is opened, two options are provided: "sign in" and "new user" (Figure 5.1 left). When the Aded Surat app is opened, three options are offered: "new user", "sign in" and "start a tour" (Figure 5.1 right).

Figure 5.1 Twazon and Aded Surat interfaces for signing in/up

Several users reported being confused when they started using Twazon as the choice between "new user" and "sign in" was unclear to them. Six out of nine users selected the top option when asked to create a new account, then they realise that they selected the wrong option. They recommended that both options should have the same visibility and the option for "new user" should be above the "sign in" option. User 1 said, *"The*

new user option should be the first option as in the majority of other apps that I use." User 9 reported:

> *There are two options when I open the app. One of them is much clearer in comparison to the other and, at the same time, is presented as the first choice. However, when I selected it, it turned out that this option is for signing in not for signing up. I found this a bit confusing because as a new user, I'd like to sign up to start using the app and the option for that must be presented clearly.*

There was similar confusion when opening the Aded Surat app. A few users found the "start a tour" option in Aded Surat was difficult to recognise. User 7 stated, "*At the beginning, I didn't see it and I only noticed it when I was using the app the second time.*" User 19 stated that, "*I wasn't sure if this was a choice or just a text*." Moreover, several users stated that the tour option is misleading as it does not provide any guidance or instruction of how to use the app. Figure 5.2 shows three pages that includes general texts and pictures highlighting some features of the app which aim to encourage users to use the app, with the third page repeating the signing up and signing in options from the opening page. Moreover, the tour option's first screen misses the page indicator comparing to the second or third pages. User 9 said, "*I was expecting it would show me how to use the app and give me information about the features of the app*." User 13 said, "*It is just telling me to use the app, not giving me a real tour*." User 19 pointed out that, "*It is not what I was expecting to see*."

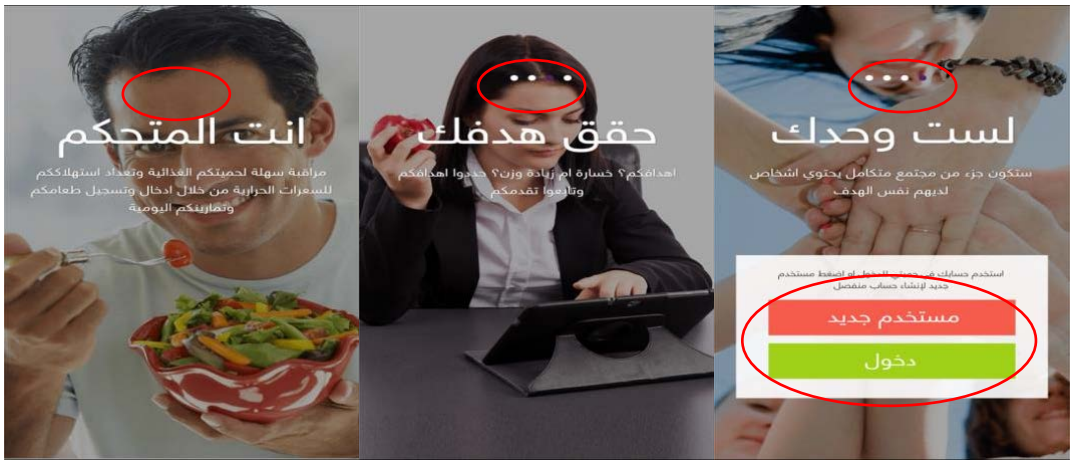

Figure 5.2 Aded Surat's three screens for the "start a tour" option

New users of Twazon are required to complete a five-step registration process (Figure 5.3). Each fitness app requires data from users. Some of these data are common to all users in the sign up process and some are unique to a specific app. For example, Twazon requires users to input their name/nickname, email, password, gender, date of birth, weight, height, the circumference of their waist and their physical activity status.

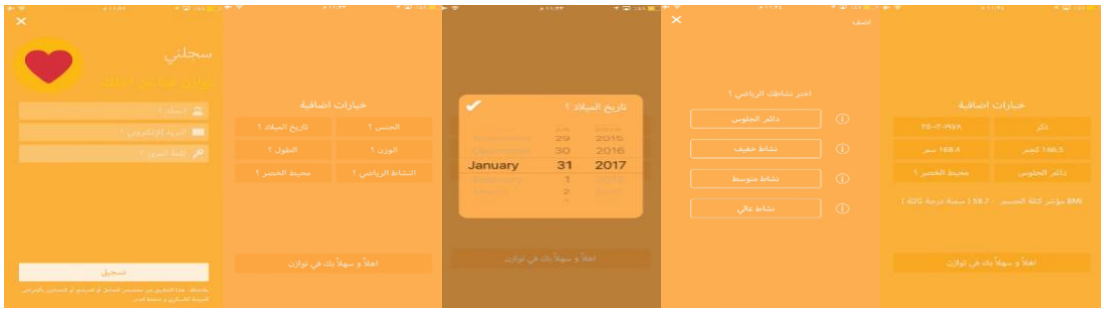

Figure 5.3 Twazon's screens for registering a new user

Based on the interviews, think aloud and observation techniques, the majority of users were not happy with the overall registration process and its functions, contents and screen design. The first screen of the registration process states that this app is not to be used by users who have any chronic diseases, for example diabetes. Two users found such information disappointing and it gave them a negative impression of the app. User 3 said, "*I suffer from both obesity and diabetes and the app is telling me that I can't use it. Everyone knows that with obesity there is a big chance that several chronic diseases might come as well which, in my case, is diabetes."* User 8 said, "*It can't be used by people who have some chronic diseases, for example, diabetes. So, I can't use it*." The second registration screen is titled "Extra Choices" which was seen by a few users as a misleading title. User 1 said, "*I don't think providing my current weight and height is an optional choice, when I know is that the weight and height is used to calculate my BMI*." User 3 said:

> *Once the screen appeared and I read the extra choices, I tried to skip it because I wanted to start using the app. But the app didn't allow me to do that. So, these options are not extra choices, they are essential to start using the app*.

In addition to this, three users faced difficulties while providing their date of birth, as the app uses the Gregorian Calendar instead of the Islamic one and uses the English language to display the date. User 4 reported:

> *Everything in the registration process was written in the Arabic language except for the date of birth. I can't read English and I thought there was something wrong with the app, so I kept clicking on the date of birth option until I gave up and chose a random month.*

User 1 said:

> *I only know my date of birth in the Islamic calendar and my English is not that good. I was trying to change the language and the months to Arabic, but I couldn't. I found it frustrating to spend much time just only to input my age.*"

During the observation, five users clicked on the wrong button when they were trying to confirm their selection on the option of the circumference of their waist and physical activity status. The reason this occurred is the difference in location and icons for the confirmation function in comparison to the other options (Figure 5.4). On the one hand, when users want to confirm their gender, date of birth, weight and height, they select the "✓", which is located on the top left corner of the screen. However, when users want to confirm the circumference of their waist and their physical activity status, they select the word "Add" which is located on the top right corner of the screen.

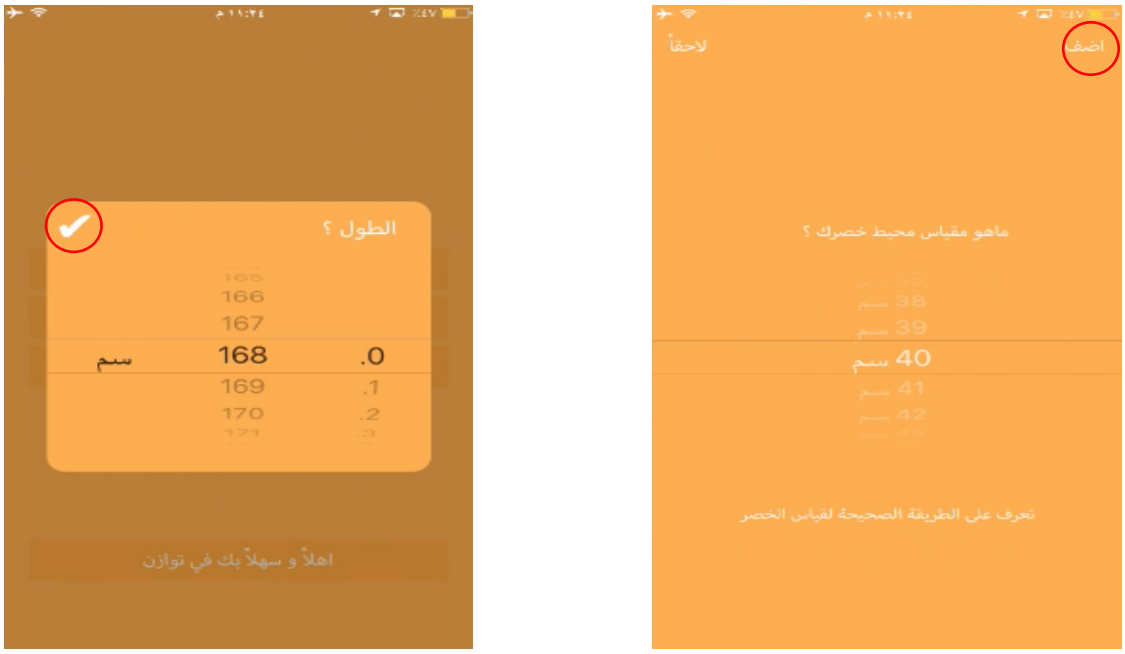

Figure 5.4 Twazon's different icons and locations for confirming a selection

After users inputted their gender, date of birth, weight and height, the app calculates the users' BMI value and displays it in the middle of screen. Users can then finish the registration process. However, users were not happy that the app did not identify which fields are mandatory for completing the registration process, such as weight, and which fields are optional, such as waist circumferences. User 8 said:

> *I wasn't sure about my waist circumferences and the app allows me to select "Later" to determine it. Therefore, it seems to me that such field is not a mandatory for the registration, so why the app didn't notify users which fields are mandatory and which fields are not*?

In contrast, Aded Surat requires its new users to complete a six-step registration process (Figure 5.5). It asks users to register with an email address or to sign in via their Facebook account, determining the goal from using the app that is losing weight, indicate how many kilograms a user wants to lose, set up a goal to lose a specific number of kilograms per week, provide a user's gender, age, weight, height, whether the user is a smoker or not, email address, set a password, re-inputting the password, nickname, country and determine whether the user is allergic to legumes, lactose, seafood, nuts and eggs or not allergic.

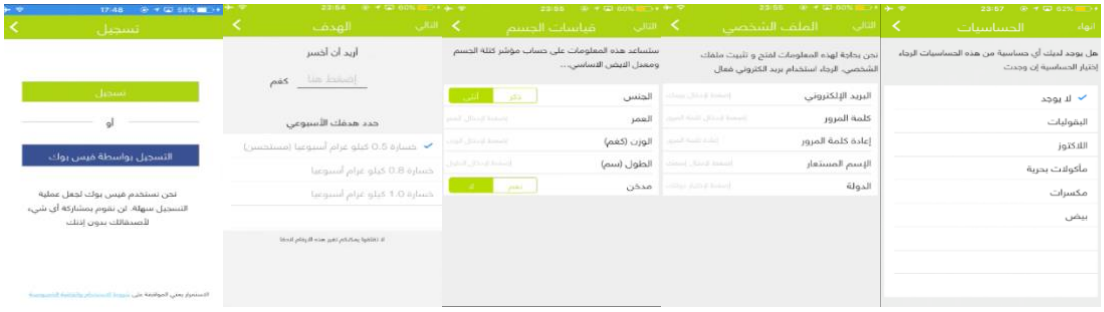

Figure 5.5 Aded Surat's screens for registering a new user

Based on the interviews, think aloud and observation techniques, the majority of users were happy with the overall registration process in terms of its functions and screen design but also believed that the app requires much more information to complete the process than other similar apps. User 5 said:

> *I liked the way in which the registration process screens were categorised. A screen for my personal information like name and email, then a screen for my body information, like weight and age and so on. It's better than Twazon, where there's only one screen and all options are next to each other*.

17 out of 26 users liked the feature of signing in to the app via their social media app account and they recommended adding other social media platforms to sign in with, for example Twitter, Instagram and Snapchat. User 2 said, "*I liked the idea of signing in with my Facebook account*." User 13 stated, "*I don't have an account in Facebook, but I'm on Twitter, so why just Facebook – what about other popular social media apps?."* However, several users stated that the app requires some information without informing the users why they need to provide it, for example, whether the user is a smoker or allergic to specific kinds of food. User 8 said, "*Some information that is required – I don't know way the app need it, for example whether I'm a smoker or not. If smoking has a relation with losing weight, the app should explain that to the users*." User 23 stated:

> *In the final step in the registration process, the app asked me if I'm allergic to seafood. Yes, I'm allergic to it and selected the seafood option from the list. But when I used the app, I was able to add many kinds of seafood to my diet. So, what is the point of asking me if I'm allergic to seafood and then the app not exclude it from my diet?*

In addition to this, several users found it inappropriate that the app does not determine how many kilograms users should lose to reach to their ideal weight. User 3 said, "*I was surprised that I had the option to choose how many kilograms I want to lose. I think the app should tell me 'You should loss that much weight,' which is determined based on the information that I provide*." User 21 also stated, "*Why do I need to say how many kilograms that I want to lose? The app should determine the healthy weight for me*."

A few users stated that typing the information such as, weight and age in Aded Surat (Figure 5.6 left) is much better than in Twazon (Figure 5.6 right). User 4 said, "*I prefer it this way with Aded Surat. It is much better. I don't need to select my weight and age from the picker and then confirm my selection*." User 8 said, "*It is much easier than Twazon. I just type my age and that's it*."

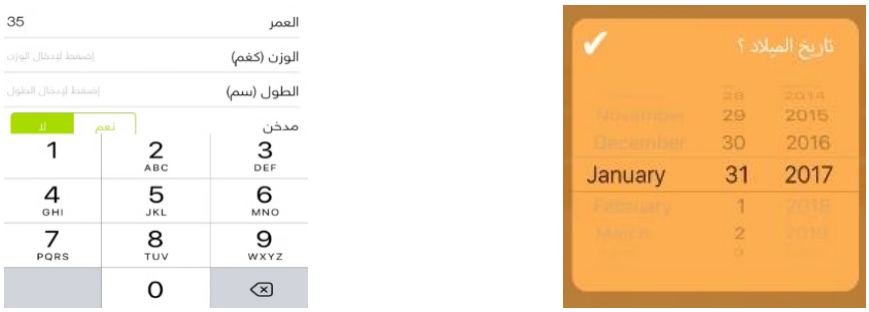

Figure 5.6 Age input functions: Aded Surat's typing function and Twazon's picker function

5.2.2 The Homepage

If fitness apps had a human form, then their homepage would be their faces. The homepage is the screen that users see first and it strongly influences their decision on whether they or not like the app. It is the screen where users make their first judgement about an app. The homepage is the main and most important screen in an app. Through this screen, users start using the app and discover its functions and abilities. Based on the interviews, think aloud and observation techniques, users were satisfied with the overall design of Twazon's homepage screen and stated that it is easy to use and understand; however, they believed it could be improved in a variety of aspects. These aspects are discussed in the coming subsections as they relate to different features, such as monitoring and tracking. Figure 5.7 shows the homepage screen for Twazon.

Figure 5.7 Twazon's homepage screen

The homepage screen is divided into three main sections:

1. The top section "Navigation bar" has two options, which are the "plus" and "settings" icons. By clicking on "plus", users can add physical activates, add meals and notes. By clicking on the "settings" icon, users can change their personal information, body measurements, check notifications and sign out from the app;
2. The section in the medial is for monitoring and tracking. Users are able to monitor their weight loss progress as this page shows the weight users were when they started using the app, their current weight, their goal weight and how many days remaining to reach to their ideal weight. The homepage has four circles to help users to track their daily walking (number of steps), calories burned from doing exercises, water and food consumption; and
3. The last section "Tab bar" has five options: the logo of the app, which navigates users to the homepage; the "watch" icon, through which users can communicate with other app users; the "note" icon, which allows users to do the self-assessment; the "check note" icon, which helps users to understand how to read a food label; and the "board" icon, which shows users how to plan healthy meals.

21 out of 26 users did not liked the homepage design for Aded Surat and criticised several elements of it. Figure 5.8 shows Aded Surat's homepage screen.

Figure 5.8 Aded Surat's homepage screen

The homepage screen is divided into three main sections:

1. The top section "Navigation bar" has only one option: the word "extra". This enables users to change settings, invite people via Facebook and Twitter to use the app, contact the support team and follow the app's account on Facebook and Twitter.
2. The middle section is the part of the screen where users are able to monitor and track their daily usage and their weight loss progress as that section shows the user's current weight, target weight and the difference between these figures in kilograms. Users can also add physical activities, meals and water consumption.
3. The last section has five options: advice, community, articles and my diet and an advice ticker. Each of these options has a unique colour for the background, for example, the article section is coloured green and "my diet" is coloured red. Users can access a range of advice related to eating habits by clicking on the advice button. The community option allows users to share their experiences and opinions with other app users via the app's social network. In the article selection, users can read articles related to healthy lifestyles. Users can get information related to developers' other app by clicking on "my diet."

The majority of users reported that the homepage screen is overcrowded with options, which make it awkward to use. User 2 said, "*The homepage screen has too many options and when I looked at it, I had a bad impression regarding the app*." User 14 stated," *The home screen is crowded with selections and there are some options I think can merge with each other, for example, articles and advice*." User 21 reported:

> *The app has a disappointing homepage as it is not well organised and I believe this is because of the number of options on the screen. In addition to this, there is a large advice ticker at the button of the screen which made me feel like I'm watching a news channel rather than using an app*.

5.2.3 Assessing and Reaching Ideal Weight

Both apps assess users' current weight and recommend daily calorie and water intakes based on the information that users input while creating their profile. The aim of this is to determine the ideal weight for users. However, neither of the apps explain to the users how the recommend daily calorie and water intake and ideal weight is calculated. One user questioned both apps' calculations and suggested providing users with the equations that are used. User 12 said:

> *I know that there is more than one way to calculate how many calories we need to have per day and what our ideal weight is. I think it's better if apps tell their users how they reach their recommendations*.

Both apps calculate the users' BMI. Twazon does this when its users create an account, which the majority of users liked. User 1 said, "*It is good that I found out my BMI value when I signed up.*" User 3 said, "*The is the first Arabic fitness app that I have used which provided my BMI value*." However, when users provided their waist circumferences and physical activity status, the calculated BMI value did not change and the way in which the BMI value was determined is not provided. One user raised concerns regarding the need to provide a waist circumference and physical activity status and the way their BMI was calculated. User 3 reported that:

> *I noted that when I inputted my gender, age, height and weight, my BMI was provided but after inputting my physical activity status and waist circumferences, the BMI value remained the same. So, what is the point from*

providing extra information if it doesn't have any effect? Another thing is how did the app calculate my BMI value?

In contrast, Aded Surat allows users to set up a goal to lose 0.5 kg, 0.8 kg or 1.0 kg per week, which was appreciated by several users. User 9 said, "*It is great, I can start my diet by aiming to lose 0.5 kg per week and then I can increase it to 1.0 kg per week*." User 17 said, "*Other apps don't let you decide how much weight you want to lose per week, but this app give you the choice to determine and it's a good sign for me to use the app*.

5.2.4 The Diet

Both apps aim to help users to plan their daily meals and recommend they have four meals in a day, which are breakfast, lunch, dinner and a snack. The majority of users found adding a meal and water consumption in both Twazon and Aded Surat is easy but they highlighted several drawbacks. Below are Twazon's screens for adding a meal (Figure 5.9).

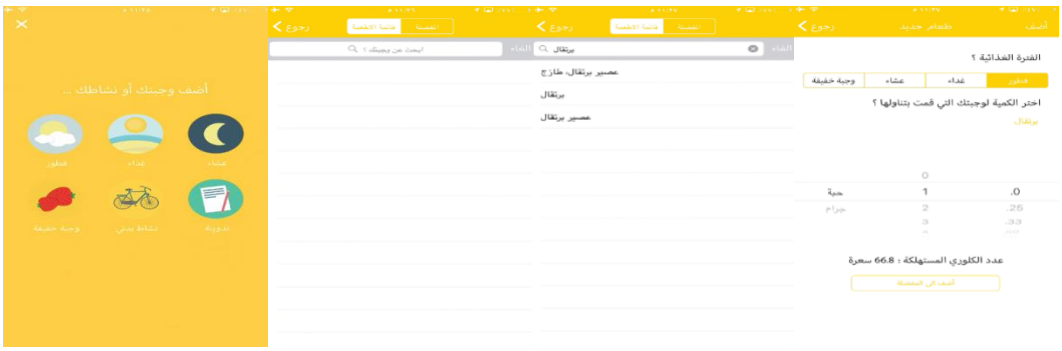

Figure 5.9 Twazon's screens for adding a meal

After users clicked on the "plus" icon on the homepage screen, users are navigated to the "add food" function, where users can select to plan one of the four meals. In the usability testing, all users were able to successfully locate the "add food" option and selected the option of starting to plan the breakfast meal. Then, the "food selection options" screen appeared. This was empty, as users need to type which kind of food they want to add to their meal. This was confusing for three users, who thought there was something wrong with the app and so they gave up on completing the task. User 2 said," *I chose the breakfast meal, but I couldn't add any kind of food on it. The screen was empty*." User 9 said, "*I think the app needs to have an update. There was no food in the food selection option. It's weird*."

It was required that all users add an orange to their breakfast meal. After typing the kind of food, the app starts to search for it and three results appeared, fresh orange juice, orange and orange juice. Users then selected the orange option. All users did not like that they needed to type the name of food and then select from the results. User 1 said, "*It should provide me with kinds of food to choose from them*." User 5 reported:

> *When I chose the breakfast meal, I expected to see a variety of food for that meal. Instead, I typed what I want to have for breakfast. So, what is the point of using the app if it does not give me recommendations for what I can have for a meal?*

Then, a screen titled "New Food" appeared which allows users to change the meal, determine the quantity of the food in pieces or grams, know how many calories will be consumed and add the food to the meal. Two users did not like the design of the screen as they stated that the "pickers" for determining the quantity of food are close to each other. User 1 said, "*I was trying to select that I want to add one piece of orange, but several times and by mistake I clicked on the gram option. They are really close to each other, which makes it annoying*." User 5 said, "*The options on the screen for determining the quantity of foods are too small for me*."

Moreover, based on the usability testing, Twazon's users cannot actually plan a complete meal; instead, they only able to report eating single items of food and must keep repeating the process until they have added all the components of a meal. A few users criticised this process and recommended the app allow users to plan and add a complete meal at a time. User 3 stated:

> *I can't add a full meal to the app. Every time I need to type what I will have or had for lunch. I mean, if I have rice and chicken, I'll need to add that I eat rice and then add that I eat chicken and so on. It's a long process and the app doesn't enable me to save a full meal. I'll be bored from repeating it.*

In contrast, Aded Surat has more functions regarding the diet option. Figure 5.10 shows its screens for planning and adding a meal.

Figure 5.10 Aded Surat's screens for adding and planning a meal

In the usability testing, all users successfully located the "add food" option and selected to start plan the dinner meal. Then, the food selection options screen appeared. This screen has 35 food categories, with a variety of different kinds of food in each category. Users were asked to add "two chicken shawarma with normal bread." Nine users could not locate the requested dish and, after trying, they ended up adding a wrong dish or giving up the task. Based on the observation, think aloud and interview approaches, the reason for this is because the food category names were misleading and there was a very large selection of food. User 2 said, "*I spent a long time searching for the chicken shawarma. There are too many kinds of food and I don't think chicken shawarma is one of them*." User 24 said, "*I chose the sandwiches category and it wasn't there. It's a sandwich and it should be there*."

After selecting the required dish, a screen titled "Meals" appears that enables users to type the quantity of the selected food, add it to the favourites list, provides them with the total number of calories, carbohydrates, protein and fats per gram and add it to the meal. The majority of users liked the design of the screen and stated that it provides the nutrient value of food. User 7 said, "*I can see the nutrient information for any kind of food that I choose*." User 11 said, "*It is good that we know the food's nutrients*." User 26 said, "*It's the only Arabic app that provides detailed nutrient values for foods*."

After adding the requested food to the meal, users are able to continue to plan the meal and add extra dishes, save the planned meal and are told the total calorie intake for the meal and each dish's individual calorie intake.

In the usability testing, users were asked to plan the dinner meal for the next day and add the previous mentioned dish of "two chicken shawarma with normal bread" to it. However, 13 users were not able to complete the task as they stated the app did not allow them to change the date to start planning the dinner meal. User 3 said, "*I was trying to change the date from the meal screen, but the app didn't respond*." User 15 said, "*Can't change the date*."

All users found it easy to locate the water consumption option in both apps. Also, almost all users were successfully able to add the requested water consumption in all apps, which is six cups in Twazon (Figure 5.11 left) and three cups in Aded Surat (Figure 5.11 right).

Figure 5.11 Twazon's and Aded Surat's screens for adding water consumption

Only one user within Aded Surat app was not able to save the inputted water consumption. User 24 said, "*I selected three cups of water and then I couldn't find the save button. I kept clicking on the cups on the screen to find a way to save but nothing happened*."

5.2.5 Self-Assessment

Only Twazon includes a self-assessment feature that allows users to assess themselves regarding their progress. All users in the usability testing were successfully able to locate the option. Below are Twazon's self-assessment screens (Figure 5.12)

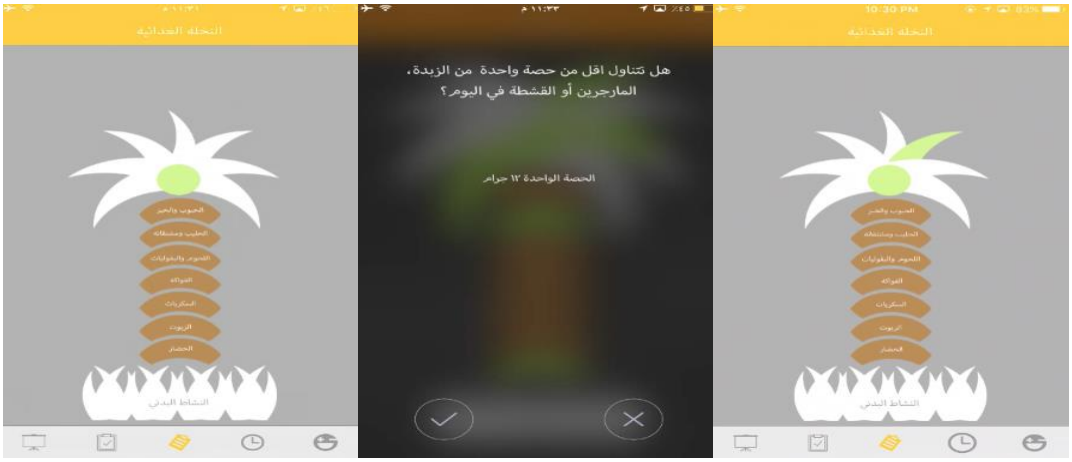

Figure 5.12 Twazon's self-assessment screens

The assessment has eight main sections, which are cereals and bread, milk and dairy products, meat and legumes, fruits, sugar, oils, vegetables and physical activity. Each section has a total of 17 related questions. The assessment is presented as a palm tree and when users' answers meet the recommended level, the leaves of the tree change to green. All users liked the self-assessment feature but the design of the screen as well as not including water intake within the assessment was criticised. User 1 said, "*I didn't like the palm*." User 5 reported, "*For me it doesn't look like I'm assessing myself. Maybe if they use more professional shapes as graphs, I'll take it seriously*." User 6 stated, "*The assessment doesn't ask me about my water consumption. Drinking plenty of water is important, especially in such hot weather*."

5.2.6 Physical Activities

Both apps aim to encourage users to burn a specific number of calories by providing a variety of exercises which users can choose from. The majority of users successfully located the physical activities section in both Twazon and Aded Surat, but several users were not able to select the requested type of exercise while testing in Aded Surat. There were numerous drawbacks highlighted by users within both apps. Figure 5.13 shows Twazon's screens for adding an exercise.

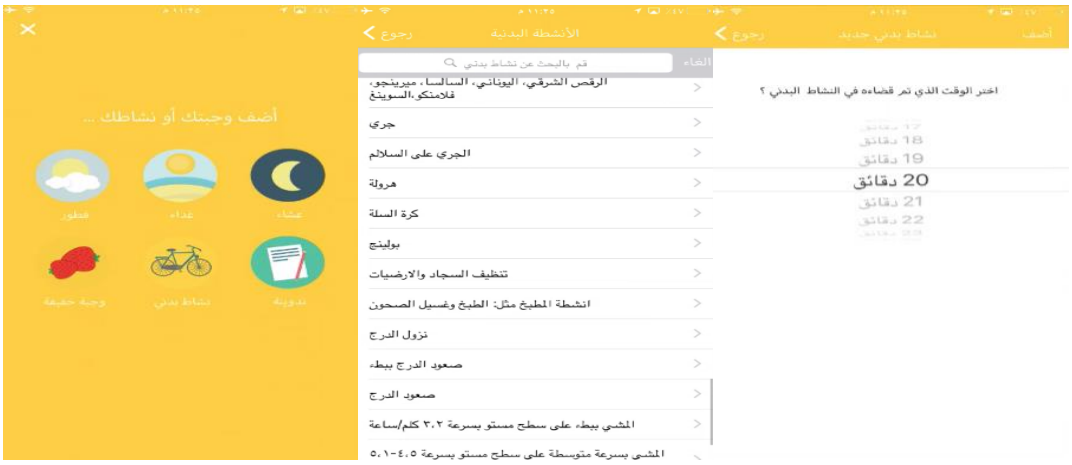

Figure 5.13 Twazon's screens for adding an exercise

After selecting the "add a physical activity option," a screen titled "Physical Activities" appears that contains a variety of exercises. All users through the usability testing succeed in selecting the required exercise, "Running," and found the process easy to perform. User 1 said, "*It was easy to add an exercise*." User 5 reported,

> *I found adding an exercise is an easy task, not like adding the food, and this is because all the exercises are in front of me on the screen and there is no need to type anything. I just select what I want to do*.

After selecting the exercise, users are asked to determine how long they want to do the exercise and for. The requested time was for 20 minutes, which all users were able to select successfully. However, several users criticised the fact that the app does not provide any kind of information regarding the exercise, such as a description of it or the correct way it should be performed. User 4 said, "*There are some exercises that are new for me and when I chose one of them, it just asked me to select how many times I want to do it. How I can perform it without knowing what is it?*" User 9 reported, "*Each kind of exercise available in the app should come with information that explains the benefit of doing it and also I'd like to have video that shows me how to do it*." Moreover, several users did not like the picker function that is used to determine the duration or the counts for doing an exercise and a few of them suggested a typing function be used instead of the picker one.

Twazon recommends its users take a daily walk. The app sets a goal of walking 10,000 steps per day and provides a pedometer which counts the daily number of steps. The majority of users liked this feature; however, a few of them suggested that it would be

better if the users were able to determine their own daily walking goal and also if adding a tool that convert the number of steps to metres and kilometres. User 2 said, "*I like to walk, and this app motivates me to walk every day as it shows me how many steps I have walked today*." User 6 reported:

> *Counting the steps is great and every time I see myself reach the goal, it encourages me to walk even more. But, while using the app, I couldn't change the daily walking goal and I think it's important to have such a feature because once I reached the default goal, I wanted to challenge myself and walk more and more.*

User 8 said, "*The app tells me how many steps I walked in a day, which is good. What would be even better is if it could tell me how many metres or kilometres these steps equal*."

Aded Surat only allows users to add physical activities and does not count the daily number of steps walked. Figure 5.14 shows the screens for adding an exercise.

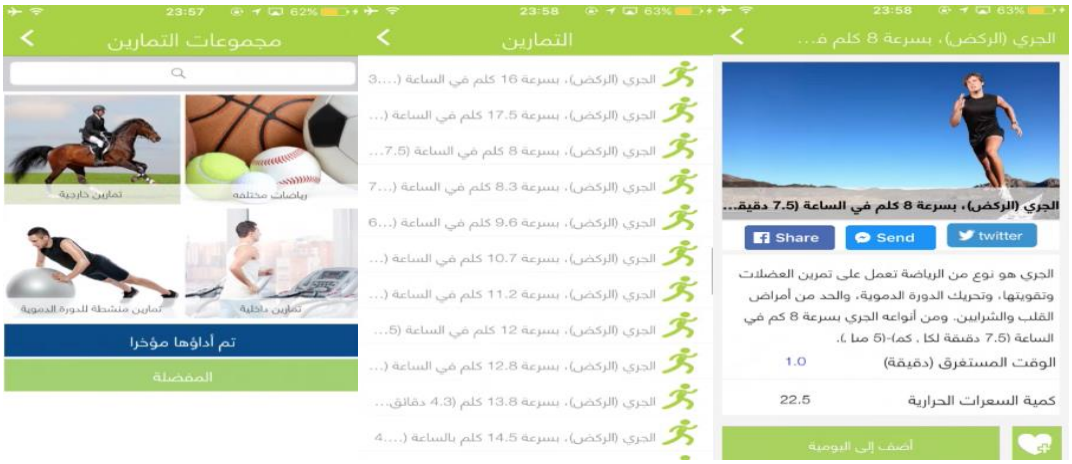

Figure 5.14 Aded Surat's screens for adding an exercise

After selecting the "add a physical activity" option, a screen titled "Groups of Exercises" appears that contains four exercise categories: outdoor exercises, different sports, indoor exercises and exercises to improve the circulation. Each category has a picture that represents the group and includes a variety of exercises. In addition to the four exercise categories, the screen has two other options: recently completed exercises and favourite exercises.

Users were asked to add "Running at the slowest speed" as an exercise and set the duration as 20 minutes. 14 users were not able to locate the requested exercise. Based on the observation and think aloud approaches, the reason for this is because there are too many kinds of running exercises that have similar names and the pictures for the classification of exercises are misleading. For example, User 2 said, "*It is not easy to choose the exercise, there are many options for the same exercise*," while User 17 said, "*I found more than 10 running exercises and I'm not sure which one is the correct one among them*." User 23 reported, "*When the groups of exercises screen appeared, I saw a picture of man running on the treadmill machine and therefore I thought the running exercise will be in this group, but I couldn't find it*."

After selecting the requested exercise, a screen that is titled the exercise name appeared and shows information regarding the benefit of doing the selected exercise. Through this screen, users can share information regarding the exercise via Facebook and Twitter, determine the duration of doing the exercise and add it to the favourites list. Several users appreciated the information that explains the benefit of doing the exercise. However, the majority of users disliked that there is no suggested workout plan or instructions on how to do exercises. User 10 said, "*With such a large number of exercises provided by the app, the app should provide many workout plans*." User 24 said, "*I want to have a guide or plan to follow. I never tried to exercise, so I want to know which exercise I should do first and how many times or for how long should I try to do it*."

After adding the requested exercise, users were asked to do two extra tasks. The first one was to find the option that shows users the exercises that they have done in a day. Seven users were not able to locate the option. The second task was to add the "Running at the slowest speed for 20 minutes" exercise to the favourites list. Four users were not able to add the exercise to the favourite list. In order to add the exercise to the favourite list, users need to select the exercise again, determine the duration and then added to the favourite list. What happened with the four users is that they clicked on the favourite option from the "Groups of Exercises" screen and the favourite list was empty and there was no option to add an exercise to it (Figure 5.15)

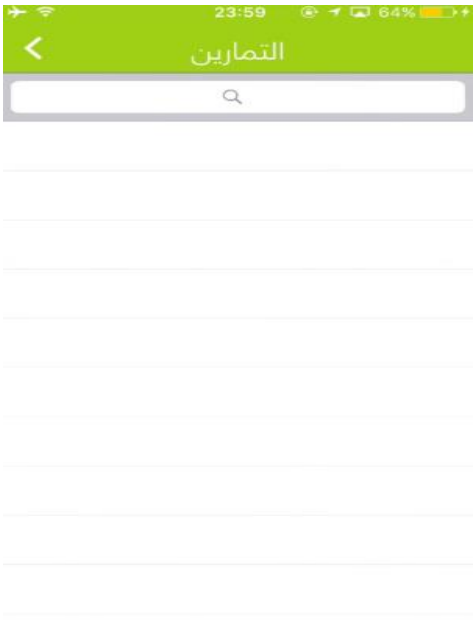

Figure 5.15 Aded Surat's favourite exercises screen

One user recommended that the app should allow users to add an exercise to the favourites list from the favourite option. User 4 reported:

> *They must provide an option to add any exercise from the favourites list screen. It doesn't make any sense to only provide one way to do that. They can easily add the words "add an exercise" to the favourites list screen and then users can choose what they want to add on the list.*

5.2.7 Self-Monitoring, Tracking and Feedback

Both apps aim to help users to monitor and track their daily usage. They do this by asking the user to self-monitor their daily intake of energy, for example, food (kCal), drinks and water consumption (in), the number of burned calories by physical exercise (out) and weight-progress tracking. However, the way of presenting these kinds of information is different in the two apps. Figure 5.16 shows Twazon's screen for self-monitoring, tracking and feedback.

Figure 5.16 Twazon's screen for self-monitoring and tracking

The majority of participants appreciated the four circles that helps users to monitor and track their usage of the app. However, one user complained that the circles were small and hard to read. User 2 said:

> *I loved the circles idea. It is an easy way to track myself. But I found it by the end of the day hard to read as all of the circles are full of information and there is no option that allows me to see each circle individually in a bigger size*.

Several users liked the ability to monitor their weight loss progress. User 6 said, "*The idea of updating your weight and then comparing it with the start weight and the target weight motivates me to keep using the app*." User 7 stated, "*I feel proud of myself when I lose weight and then remember my weight from when I started using the app. The homepage screen presents this kind of information right in front of me, which I like a lot*." However, a few users complained that the app does not allow them to retrieve their previous day's usage of the app. User 1 said, "*I wasn't able to retrieve what I did yesterday. I want to have this feature so I can track my progress over time*." User 8 said, "*For me it's important to compare my performance over time and the app unfortunately doesn't enable me to do that*."

In contrast, Aded Surat has more functions when it comes to self-monitoring and tracking. Figure 5.17 shows its self-monitoring and tracking screens.

Figure 5.17 Aded Surat's screens for self-monitoring and tracking

Aded Surat saves users' daily usage of the app and allows them to retrieve all previous activities. From the homepage screen users can change the date to retrieve a specific day's usage. The majority of users liked the ability to retrieve previous day's usage information. User 11 said, "*It is good that I can see a summary of my previous workouts and diet*." User 18 stated, "*I think it is one of the best features in the app because through it I can see the improvement of myself over time. This will definitely encourage me to use the app*." User 23 noted:

> *The other app that I use just shows me what I've done in my day and in the next day, it starts over, but this app is different. It saves everything and lets me to check all the history since I started using the app*.

In addition to this, users can track their daily and weekly food intake by selecting on the meals option of the chart (Figure 5.17). The daily food intake is represented as a pie chart and the weekly food intake is represented as a bar chart, with both charts divided into three food groups: carbohydrates, protein and fat. However, three users were not able to locate the chart option within the usability testing.

Users can see a summary of their day's activities by clacking on the "Daily" option within the homepage screen. Users were asked to review what they had done in the day and only three users could not locate the "Daily" option. Several users liked the feature and the design of its screen. User 11 said, "*This is a great option that definitely I'll use because it gives me detailed information regarding what exercise I did and for how long*." User 20 said:

> *I always find it difficult to remember what I did, and I believe the "Daily" option will help me to remember. The screen designed in a simple way that shows me all the exercises that I did, what meals I eat and what dishes for each meal and how many glasses of water I drank.*

Users can also update their weight by from the "Progress" screen which can be reached by clinking on the "Weight" option from the homepage. The screen has a line chart with its horizontal x-axis represented by weight and its vertical y-axis by day. The screen also shows the previous weight, the user's current BMI, how many kilograms have been lost and allows users to share their weight loss progress through Facebook and Twitter. The majority of users liked the aspect and the design of the screen. User 1 said "*It is important to have such feature; I think Twazon doesn't have such one*." User 15 stated, "*The tracking feature for weight loss progress is important for me because it helps me to check whether I was losing the weight as I planned or not*." User 19 reported, "*I liked the use of the line chart to track the weight loss progress*."

However, several users from both apps criticised the calculation of the burned calories as a result of performing physical activities, as they stated that such calculations are not precise. Other users recommended replacing the self-monitoring indicators for physical activities from the number of burned calories to number of exercises. User 3 noted:

> *When I selected the requested exercise in both apps and determined the duration, they indicated that I would be burning a specific number of calories. In my second trial, I inputted a different weight and age and after selecting the same exercise and duration and the number of burned calories was the same. My question is why these results are the same? They should be different when the weight and age is changed.*

User 26 said:

> *I found it difficult to set up a goal to burn a specific number of calories in a day. I mean when I do an exercise, I don't know how many calories I burned. I just do the exercise for some time. I'll prefer to have a daily goal to do specific number of exercises.*

5.2.8 Social Communication

Both apps enable users to connect with social media platforms to seek social support from other users. However, the way to do so varies between apps. Twazon allows its users to chat with each other via the built-in chat feature. Figure 5.18 shows Twazon's social media screens.

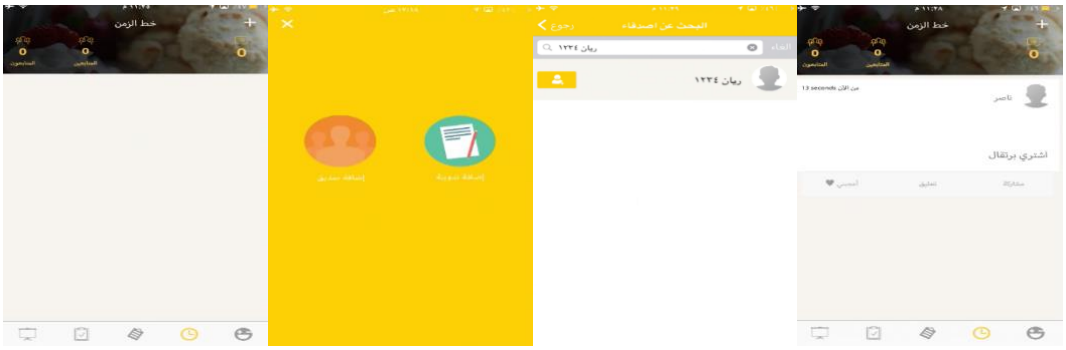

Figure 5.18 Twazon's social media screens

After selecting the social media option from the homepage screen, a screen tilted "Timeline" appears that shows users how many messages they have as well as how many people they are following and who is following them. It also enables users to add a new friend. In the usability testing, one specific user name was given to all users who were asked to add this user as a friend. To do this, users clicked on the "plus" icon and a new screen appeared that has two options, "add a friend" or "add a note." After selecting the "add friend" option, users typed the name of the friend that they wanted to add and the app started searching and showed the result. Only two users were not able to add the request user as the app did not show any results. User 4 said, "*I typed the exact user name and the app didn't find him. I tried many times but had no success.*" While all users liked the built-in chat feature, the majority of them did not like the design of the screens and recommended implementing a design similar the one is used in popular chatting apps, for example WhatsApp. User 2 said, "*Why they didn't make the chatting like WhatsApp? Everyone uses WhatsApp and familiar with its interfaces*." User 6 said, "*The design of the chatting is bad. I'll never use it*."

Aded Surat has more functions in relation to social media support. Figure 5.19 shows its social media screens.

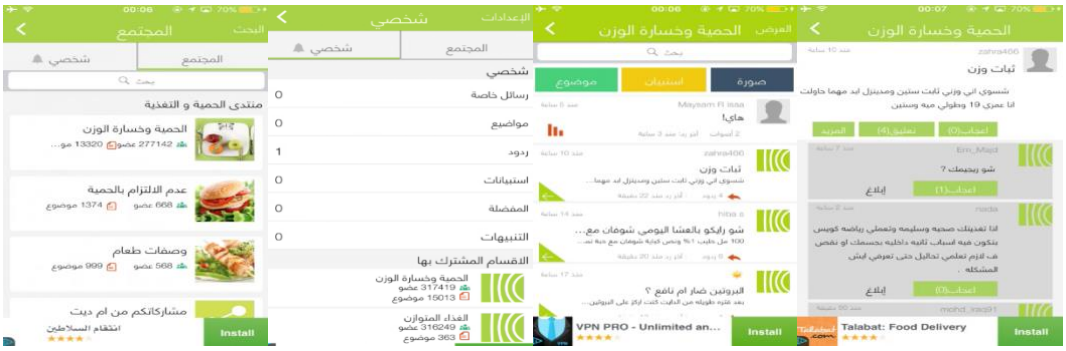

Figure 5.19 Aded Surat's social media screens

After selecting the social media option from the homepage screen, a screen that titled "Community" appears that has two main options, "community" and "personal". The community option has several discussion groups that are related to diet and food and each group has many related topics. Each group has a unique picture and the app indicates how many followers and topics are within it. The personal option shows users how many messages they have received, the number of topics they have created, the number of responses they get and the groups they follow. After selecting a discussion group, a screen that is titled as the name of the group appears, which shows the topics and the subject, name of the user who created it, when it was created and how many responses it has.

Users were asked to read the newest topic within the weight loss discussion group and only one user was not able to access the topic. During the observation, User 26 clicked on the weight loss discussion group several times but the app did not respond and after a while, the user gave up the task.

After users selected the requested topic, a screen that shows the topic appears and users can like the topic, write a comment and click on the extra option to share it via Facebook and/or Twitter. Users were asked to write a comment "Thank you" after reading the topic. However, four users faced some technical issues that did not allow them to submit their comment. User 16 said, "*There is something wrong with the app*," while User 21 said, "*It doesn't respond when I touched the option. I kept trying and trying but nothing happened*." User 22 said, "*I think the app needs to have an update to fix this problem*."

The majority of users did not like the social communication and they recommended to the app should instead have a chatting feature like Facebook Messenger or WhatsApp. User 14 said, "*I don't think users will take it seriously. I read several comments within a topic that prove my point*." User 21 stated, "*I prefer to chat with someone I have added, not with all users*."

5.2.9 Reminders

Only Aded Surat includes a feature that allows users to set a reminder. Figure 5.20 shows the app's reminder screens.

Figure 5.20 Aded Surat's reminder screens

Users need to click on the reminder option that is located on the top right corner within the meal option. Four users within the usability testing failed to locate the reminder option and, after trying unsuccessfully, they gave up. They stated that the reminder option should not be within the meal option and they recommended it instead be located within the main options on the homepage. User 16 said, "*I gave up, I don't know how to set the reminder*." User 21 said, "*For me it doesn't seem right to locate the reminder option inside the meal option. I mean, I can set a reminder for exercising or drinking water, not just for eating*." User 22 noted, "*I was expecting to see the reminder option on the main screen or at least a better location than the current one*."

After users clicked on the reminder option, a screen appeared titled "Reminders." It has five reminders by default: reminders for breakfast, lunch, snacks, dinner and weight. Users can set a time for the existing reminders and can add a new reminder. When users add a new reminder, they can type a reminder text, determine a date to start, and select the time and repeating patterns (for example, every hour, daily, weekly or monthly). The majority of users liked the reminder feature, yet several did not like the design of its screens and recommended they should be designed similar to the ones included on

mobile phones. They also wanted to be allowed to pick the ringtones. User 9 said, "*Reminders are important to me*." User 13 stated, "*The reminder is great, it helps me to remember the time for exercises*." User 17, however, noted, "*I will not set a reminder through this app because it is complicated. Why don't they design it to by the same as the iPhone reminder*?" User 26 remarked, "*I want to be able to set a specific ringtone for specific reminder because I want it to be different than a text message or call ringtones*."

5.2.10 Educational Features

5.2.10.1 Read Food Label

Twazon helps users to learn the correct way to read food labels through providing information on food labels (Figure 5.21).

Figure 5.21 Twazon's read food's label screens

After users click on the food label option from the homepage, a screen that is titled "Food Card" appears and shows a food label example. The food label is divided into six sections and when users click in any section, a pop-up message appears that includes extra information regarding the selected section. Only one user in the usability testing did not click on the sections to learn how to read a food label. User 5 said, "*It wasn't clear for me that the sections within the food label are in fact buttons*." Despite that negative feedback regarding the design and colours, some users found this feature very

beneficial. User 4 said, "*I never tried to read any food label before, but now I'll start to do that to know the nutritional value*." Also, User 7 said, "*I thought it is hard to understand such kind of information, but after trying it, I was wrong, and this is because of the app*."

5.2.10.2 Correct Unhealthy Meals

Twazon helps users to learn how to plan healthy meals. It asks them to "correct" a meal by replacing unhealthy foods with healthy options (Figure 5.22).

Figure 5.22 Twazon's learn how to plan a healthy meal screens

After users click on the "correct a meal" option from the homepage, a screen that is titled "Practical Example" appears and asks users to correct breakfast, lunch, dinner and snack meals so that they have 4021.6 calories in total. When users click on a meal, another screen appears named "extra choices" and, through it, users can modify the meal. The screen has several kinds of food items and each of them has its own nutritional value information. Foods items, which are added in a meal have a '√' next to them.

In the usability testing, users were asked to remove the "McChicken" from the lunch meal and replace it with "potato wedges." Two users did not succeed with the task and stated that they did not understand how they could replace the food items. User 8 said, "*I didn't know how I could remove the burger and add the potato*." The majority of users did not like the feature. User 1 said, "*There is nothing new with it, everyone knows fast food are unhealthy food*." User 5 stated:

> *I noted that the app focuses on encouraging users to eat a specific number of calories in a day. However, it didn't advise them to eat a different kind of healthy food, such as fruits or vegetables. I was able to meet the targeted number of calories in the example by adding unhealthy food items and removing healthy food items. This is not an education tool in my opinion*.

5.2.11 Editing Users' Information

Both apps allow users to edit their personal information. All users with within the usability testing found it easy to locate the edit option for both apps. Figure 5.23 shows Twazon's screen for editing personal information.

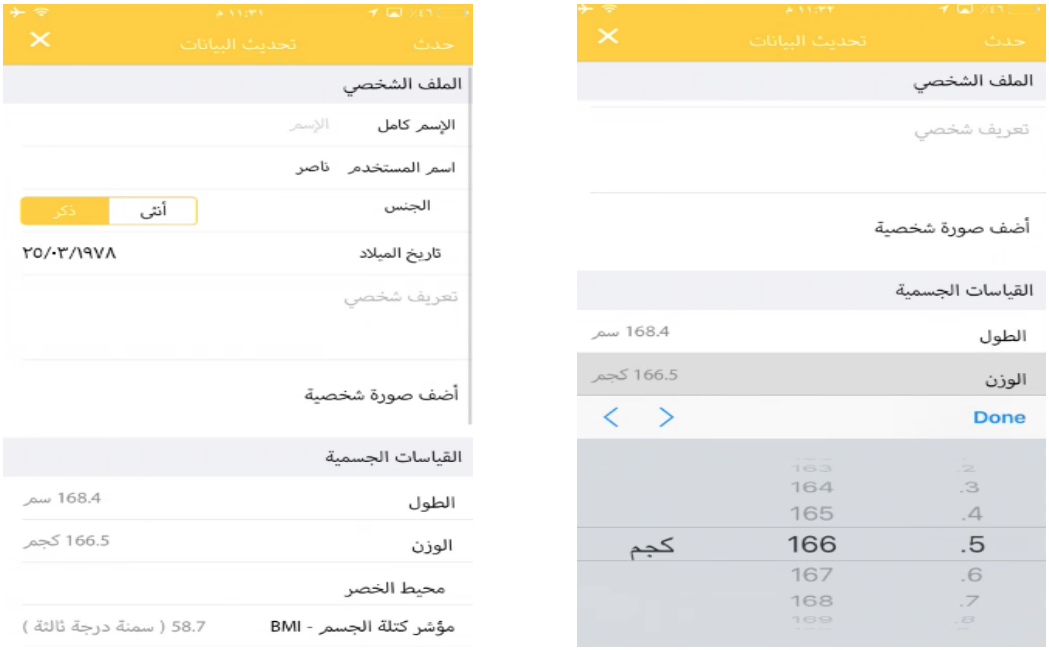

Figure 5.23 Twazon's editing users' information screens

After users clicked on the setting option from the homepage, a screen tiled "Update Data" appears that enables users to edit their personal information. In the usability testing, users were asked to update their weight to 80.5 kilograms. Three users were not able to update their current weight to the requested weight because of issues with the picker function. User 8 said, "*Every time I tried to select 80.5kg, I failed. When I selected 80 and then try to select 0.5, the 80 change to another number because I touched it by mistake. They are too close to each other*."

Aded Surat has more screens than Twazon for editing users' information (Figure 5.24)

Figure 5.24 Aded Surat's editing users' information screens

After users click on the extra option from the homepage, a screen titled "Extra" appears and then users select the setting option. The setting screen allows users to edit their personal information. It divides users' information into the following sections: country, occupation, personal information, allergies, body measurements and goals. In the usability testing, users were asked to update their weight to 70.5 kilograms, which all users were successfully able to do. Several users liked the edit information categorisation. User 4 said, "*I liked it in this way, not like Twazon where all the information in one screen*." User 18 said:

> *It's easy to use. If I want to change my email address, I choose the personal information section, and if I want to update my weight, I choose the body section. I prefer this type of categorisation because it is logical*.

5.2.12 Effect of Advertisements

Aded Surat has an advertisement box that is located at the bottom of its interfaces. It advertises different kinds of products, for example mobile apps and flight and hotel booking websites. If a user clicks on the advertisement box, a browser will opened which directs them to the product. Figure 5.25 shows Aded Surat's advertisement box screens.

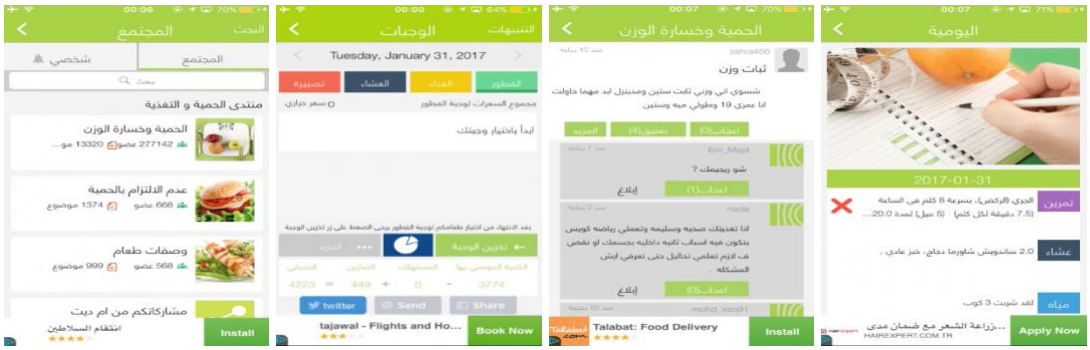

Figure 5.25 Aded Surat's advertisement box screens

During the usability testing, several users clicked on the advertisement box by mistake and were taken to a website or the app store to install apps. The majority of users did not like the advertisement box and asked to be removed. User 4 said:

> *Twazon is much better than Aded Surat in regard to advertisements. I haven't seen a single advertisement box while I'm using Twazon. Not like Aded Surat, all the time there are advertisements in the bottom section of the screen, which is annoying for me.*

User 15 said, "*I touched the advertisement box several times by mistake. I'll never use an app with such an aspect*." User 21 said, "*The app shouldn't have a space for advertisements on its screens*."

5.3 Graphic/Visual Design

A hand-held device has its own special characteristics which can cause several challenges for app developers in providing effective user interfaces. There are many mobile apps users who might only have a little knowledge in regards to using apps. The needs of such users should be addressed and they may require specific design elements. According to Welinske (2014), users can be guided to use apps and do desired tasks through graphics and texts. However, the small screen size of mobile phones makes the interaction between app and its users not easy (Budiu 2015). This section provides feedback and recommendation regarding five key aspect within the graphics and visual design of mobile phone apps: colours, font, icons, language and buttons. Each of the aspects is discussed in detail and supported by quotations from the participants who completed the usability testing.

5.3.1 Colours

Colours are one of the most important design aspects that strongly influence users' evaluations specifically and the overall view of an app in general. The majority of users did not like the colours scheme of either app and especially Twazon. They noted that Twazon uses only the one colour – yellow – across its screens. User 1 said, "*The screen is all in yellow, I don't like that. It is not easy to read through."* User 4 stated, "*I think it is better to have more a simple colours scheme instead of only one colour."* User 9 said, "*For me, it wasn't comfortable to look at the screen at the beginning. I prefer different colours, like blue, in comparison to this one."*

In contrast, users noted that Aded Surat uses several colours, such as green, red, blue and purple; however, this was not appreciated by the users. User 16 said, "*I don't think I'll use the app ever because of its colours. I don't like them*." User 21 said, "*I know that there are many tasks I didn't perform correctly and the app's colours is one of the reasons for that. Because there are so many colours, I couldn't read carefully through the options within a screen*." User 24 said, "*With too many colours in front of me, it's confusing to use the app*."

Several users recommended a feature be added that allows them to change the colours of the app. User 4 said, "*I'd like to be able to change the colours of the app between a while*," while user 16 agreed, "*It would be great if I could select the colours or themes of the app*."

Colours are of vital importance in an app and giving users the option to select themes or colours for a weight loss app will allow the app to avoid many of the problems associated with colour. The usage of colours in a weight loss app is a critical aspect because users use the app in outdoor environments and a poor choice of colours scheme may then result in limiting their visibility. The implementing of a good contrast of colours amongst both the background and foreground as well as the usage of a brighter colour scheme might also have a positive impact on the interaction between users and the app's interfaces. Therefore, giving the users the chance to select from a variety of consistent colour schemes will result in a comfortable experience for an app's users (Cuello & Vittone 2013; Fling 2009).

However, the meaning of a colour can differ from one culture to another and thus can affect people differently. Therefore, it is important to choose a colour scheme that has a positive meaning within the targeted culture. For example, green represents nature, spring and wealth in Western cultures whereas it represents Islamic religion and peace in the Middle Eastern culture (COUSINS 2012; Fling 2009; Helal 2017).

5.3.2 Font

Text within a mobile app has three significant properties: font type, size and colour. Font can be defined as group of characters displayed in a specified style. Clear font types, size and colour play an important role in helping users reading information easily via fitness apps. The aim of the text within fitness apps is to assist users in better understanding the information that they can use to have a healthier lifestyle. Therefore, app developers should avoid using fonts that lead users to frown and think when they read the text provided in apps. In the usability testing, three users criticised the font of both Twazon and Aded Surat, stating that it was difficult to read. User 1 said, "*The Twazon app uses a white font colour, which I found difficult to read through*." User 21 stated, "*The texts within Aded Surat were hard for me to read because of the font size. I'm using an iPhone 7 and its screen is not that big and many times I needed to look closely to the screen to read*."

The main goal of a font is to make sure that users can easily read texts within an app. San Francisco (SF) font style is the default font within iOS. Apple recommends using it within iOS apps and suggests various font sizes based on the type of style, for example, for large titles, it is recommended to use 34-point text and 17-point size for body text (Apple 2019). However, the font style, size and colour should be tested with the targeted users/groups to ensure legibility.

5.3.3 Icons

Commonly used icons in mobile apps are easily and quickly recognised by users. Fitness and weight loss apps should use icons which explain what an icon does so the user can avoid taking a long time thinking before clicking. For example, when users were asked to add an exercise in Twazon, they did not spend much time trying to figure out which icon should they click on as the "plus" icon refers to adding. Similarly, when they were asked to update their weight, they clicked on the "settings" icon as it refers to edit or

update. However, based on the observation and the think aloud techniques, several users found the five icons on the tab bar within the homepage are confusing as they do not refer clearly to what they lead to or do (Figure 5.26)

Figure 5.26 Twazon's tab bar icons

User 1 said, "*I found a smiley face icon, and every time I clicked on it nothing happed. Then I realised that it is the option to back to the homepage screen*." User 5 reported:

> *Once I saw the plus icon I knew that I can add something through it. But there is a clock and, I don't know, a paper icon, I think, and I had no idea what they refer to and when I tried the clock one, I found that it is for chatting. How is clock is related to chatting?!*

However, Aded Surat uses both icons and words at the same time (Figure 5.27), which a few users were not happy about.

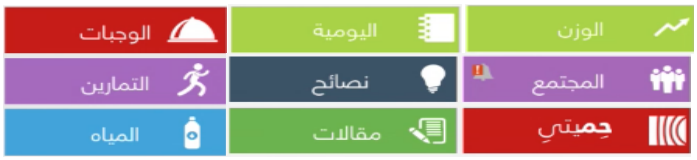

Figure 5.27 Aded Surat's icons and words

Users 5 said, "*I think the icons used in the Aded Surat app refer to what it supposed to navigate users to. So, I don't see the point of adding a word next each icon*." User 12 said, "*All the apps that I use regularly, such as Twitter and Instagram, don't use words in an option. They just use an easily recognised icon*."

5.3.4 Language

Interacting with an app's users in language that they understand is one of the main factors which affects its success. In addition to this, the usage of simple language plays an important role in helping users to understand and get the maximum benefits from fitness and weight loss apps. Some users criticised both apps' language and highlighted several issues. One of these issues is the use of English. For example, Twazon shows the date of birth in English language when users create a new profile (Figure 5.28 left) and Aded Surat uses English to indicate the date (Figure 5.28 right).

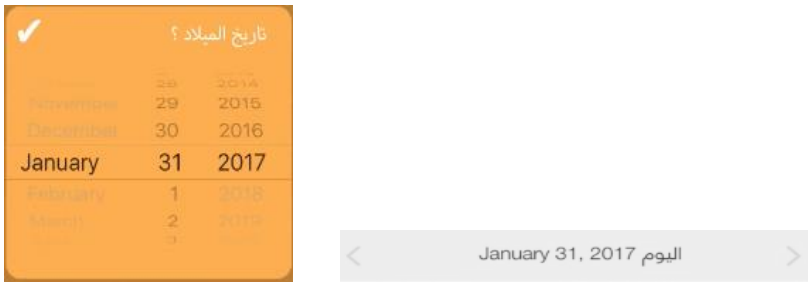

Figure 5.28 Twazon and Aded Surat's use of English

During the observation, two users did not understand what was meant by the "Daily" option in Aded Surat, which led to them giving up doing one of the tasks. Also, the Arabic language is written from the right to the left and therefore all Arabic texts always are presented from the very beginning of the right of a screen. Twazon's screens for selecting foods and exercises place the Arabic text on the left-hand side of the screen, which is not the correct way to present them, as the texts should be placed on the right-hand side (Figure 5.29).

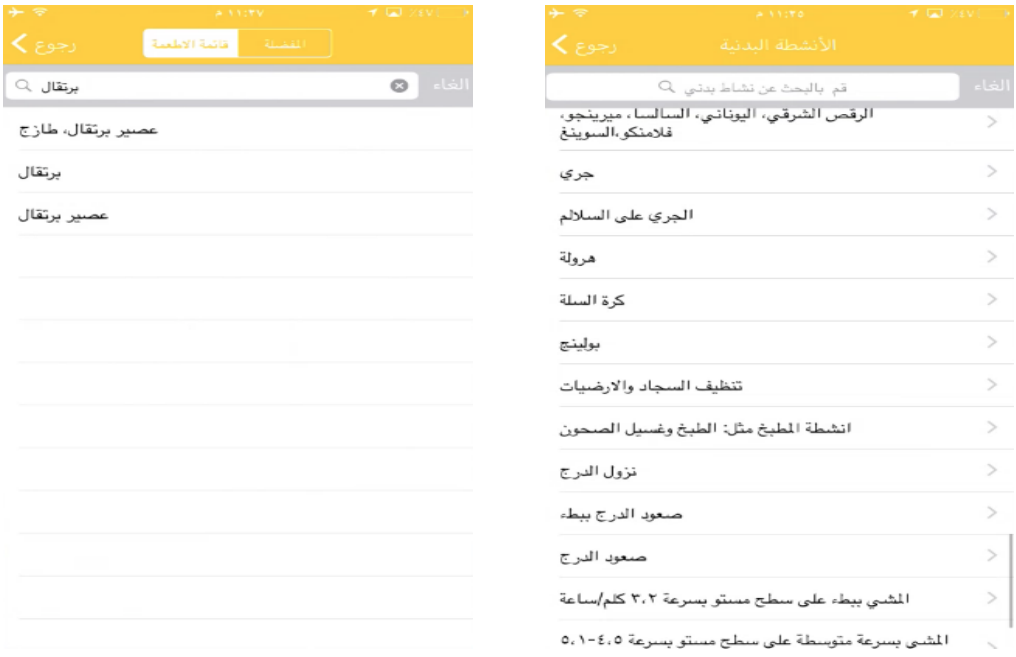

Figure 5.29 Twazon's screen for opposite direction in Arabic language

User 5 said, "*Why there is a big space in the food name field from the right-hand side? This is written in Arabic not in English*." User 9 stated, "*All of the physical activities' names are presented in the wrong direction. It should be from right to left*."

The usage of simple language is vital because it helps users to easily understand what each option or button does. The selection of words is considered as important as the

visual design because it is through these words that users are provided with information. This information can be displayed in several ways, for example notifications, buttons and titles (Cuello & Vittone 2013). The way that phrases are integrated within a weight loss app might have a direct impact on the way that users use the app. For instance, Cuello and Vittone (2013) point out that buttons that are incorrectly labelled might result in confusion and hence frustration amongst an app's users. Easy-to-understand terminology for all app's users and a tone that is both informal and friendly must be implemented within apps. In addition to this, concisely identifying and expressing the app's most important information is very important, as it helps users to quickly read them (Welinske 2014).

5.3.5 Buttons

Buttons can be defined as objects which users use in order to begin activities in apps. The text on the buttons is called titles (Welinske 2014). Different kinds of images and icons are used as buttons to help users when using apps. Based on the observation, several clicked on different buttons by mistake while using both apps. There reason for this is due to the small size of some buttons or the small amount of space between buttons.

5.4 Health Professionals' Analysis

In this research, I interviewed seven health professionals: five dietitians (three women and two men) and two male physical activity professionals. These professionals were asked to evaluate both apps regarding their nutritionist and physical activity options. The evaluation involved individual interviews that were audio-recorded. This was done in collaboration with the Department of Food Services Contracts Operations at King AbdulAziz Medical City, Ministry of National Guard Health Affairs in Jeddah, Saudi Arabia, where the dieticians work.

The results from the individual interviews can be divided into four sections. The first section is about users' information and health history. The second section is regarding the daily calories need. The third section is regarding the foods' portion size. The fourth section is regarding the physical activities.

5.4.1 Users' Information and Health History

There are different kinds of information that dieticians need to have in order to help obese individuals live a better and more healthy lifestyle. All of the dieticians agreed that it is important to ask users for their waist circumferences, which only Twazon does. However, they added that it also important to ask users for their buttock and hip measurements in order to determine whether users suffer from central obesity. A female dietitian reported:

> *We should ask for the circumferences of buttocks and the waist to know if the patient has a central obesity or not. Some patients might suffer from central obesity where all the fat is in waist. This might result in some dangers diseases in the heart and bones*.

In addition to this, they stated that both apps do not obtain enough of the users' health information as they do not ask users whether or not they suffer from chronic diseases. A female dietitian stated:

> *It is a must to ask users whether or not they suffer from chronic diseases, for example, thyroid gland diseases. The thyroid gland has a strong association with obesity and it is really important to know if the thyroid gland is active or not because it affects the way that the diet is designed*.

Knowing the users' vitamin D levels is another key factor in overcoming obesity. A male dietitian noted:

> *There is an important need to know about the level of vitamin D. If a user has a low level of vitamin D, their weight loss process will be slow, and we will need to increase the level of the vitamin to normal*.

Asking users if they use any specific kinds of medications regularly is also important. A female dietitian said:

> *Other important information we need to know is if they use certain medications. Some medications like breathing medications have cortisone. Almost 40 per cent of our medications have cortisone. Using cortisone has a side effect, that is making fat in the body*.

In addition to these, all the dietitians agreed that it is important to ask users about whether or not they are allergic to certain foods, which only Aded Surat does.

5.4.2 Daily Calorie Needs

Both apps advise users to consume a specific number of calories that is calculated based on the information that they provided while creating an account. However, the dietitians stated several common disadvantages in both apps. These are:

- Neither app determined the recommended number of calories per meal, instead providing users with their daily calories needs and giving them the choice of when to consume them over the course of the day;
- Neither app determined the recommended food portions for meals;
- Both apps allow users to keep adding food to their meals even when the recommended number of daily calories is consumed;
- The apps do not encourage users to eat in a healthy way, as there is no feature that motivates users to eat from all the food groups;
- Neither app provides a personalised recommendation regarding the recommended level of water that a user is advised to drink per day. Instead, Twazon recommends all users to drink six cups whereas Aded Surat recommends drinking 12 cups.

A male dietitian reported:

> *Apps provide daily recommendations to eat a specific number of calories. These recommendations are too general and not good for obese users because they just focus on the number of calories rather than advising users how to eat in a healthy way. I'll give an example. When I planned my meals based on the apps' recommendation for the daily number of calories, I can eat unhealthy food or even just focus on eating food that contains only protein or carbohydrates. Eating in such a pattern is unhealthy for users and they might get sick. So, both apps follow the counting calories strategy and for me they are just food trackers*.

Moreover, the health professionals indicated that there is an incorrect association between the food calories and physical activities burned calories.

A male dietitian said,

> *In both apps, when users do physical activities, the number of daily calories that users are advised to eat will increase. Let's say that an app advised users to eat 1,600 calories in a day. When users stated that they had done physical activities, for example walking, both apps increase the advised number of the daily calories to be eaten from 1,600 to more. In this case, users will not lose any weight because the daily number of calories to eat will increase as users reported doing physical activities*.

5.4.3 Food Portion Size

Three dietitians believe that both apps lack a portion control guide that would help users to determine the correct serving size for their food. A female dietitian said:

> *Giving an explanation and examples of how to measure or determine the serving size of foods is important. Some people don't have a scale to measure food's weight or don't know how to determine 30 grams of something. We use the four fingers as a measurement scale for 30 grams. The advantages from using such a technique is to make it easier for users to be aware of how to measure the daily serving size of foods*.

5.4.4 Physical Activities

The physical activity professionals commended the counting steps feature in Twazon and stated that walking was the exercise that they recommended for obese individuals. However, they pointed out that both apps recommend several exercises that obese users might not able to do. They also stated that neither app shows users the correct way to do an exercise. A physical activity professional said:

> *There are many exercises that not suitable for obese users within both apps. And what is more important than including the right exercises is to include a description or a video that explains how to do an exercise. People usually at the beginning are excited and motivated to lose weight but once they don't*

know how to practice or do an exercise in the wrong way and harm themselves, they stop.

5.5 User Interviews

After the usability testing, semi-structured interviews that were audio-recorded were held with each of the potential users to gain their feedback and to respond to any enquiries. The testers were asked to provide feedback about what they liked, disliked and suggestions.

Visual aids such as word clouds were generated based on the data collected through extensive interviews (Alturki & Gay 2019b; Feinberg 2014). Word clouds gather the amount and frequency of words and phrases used and display this through the size of the font (Prochaska et al. 2013). Generally, word clouds are utilised in social and commercial settings; however, they also have practical use in analysis because they provide a rapid means to analyse textual data and reduce bias (Gill & Griffin 2010). In the case of the interview data, three groups were formed with the answers (liked, disliked and suggestions) and three word clouds were generated showing common themes for each group.

5.5.1 What Users Liked About the Apps

Figure 5.30 What users liked about apps

Several users liked the registration process screens' design in Aded Surat and the ability to sign into the app by using social media accounts, such as Facebook. Users also appreciated that both apps calculate their BMI value. Many of Aded Surat's users liked

the food nutrient information that was provided to them when they went to add a food item. Moreover, all Twazon users liked the self-assessment feature and the majority of them also liked the pedometer which counts their daily number of steps. Several users liked that each physical activity within Aded Surat has information regarding the benefit obtained from doing it. The majority of both apps' users liked the ability to self-monitor and track their daily usage and their weight loss progress. In addition to this, the ability to retrieve previous days' usage and see a summary of each day's usage was appreciated by the many of Aded Surat's users. All Twazon users liked the built-in chat feature which they could use to communicate with other app users. Aded Surat users liked the reminder function and being able to set several reminders for different purposes. Furthermore, several Twazon's users liked the feature that helped them to understand and read labels on food products and one user liked Twazon's example of how to correct unhealthy meals.

5.5.2 What Users Disliked About the Apps

Figure 5.31 What users disliked about apps

Many of Aded Surat's users disliked the tour option within the first screen. Two Twazon users were disappointed that the app was not supposed to be used by people who have chronic diseases. Twazon's users criticised that the app does not identify mandatory fields within the registration process, while Aded Surat users disliked that the app does not determine their ideal weight. Twazon's users disliked the use of the picker function to input data, such as their date of birth and food serving size, while the majority of Aded Surat's users disliked the design of the homepage. In addition to this, all of Twazon's

users were not happy with the need to type the name of the food and then select from the search results when they want to add a meal. Aded Surat's users also disliked the large number of food items that the app provides. The design of the self-assessment as a palm tree was criticised by the majority of Twazon's users. All users were disappointed that neither app explained to users the correct way to perform exercises and do not provide any workout plans or instructions. One user disliked the small size of the monitoring and tracking circles within Twazon and a few disliked the fact that the app does not allow them to retrieve previous days' usage. Moreover, both apps' users criticised the calculation of the burned calories as a result of performing physical activities because of imprecise results and the majority of users disliked the design screen for the chatting feature within Twazon. The way that the social communication was applied in Aded Surat was criticised and users were not happy with the app's reminder feature's screen design. Several users disliked the advertisement box within Aded Surat and users of both apps disliked the colour schemes that were used in the apps. A few users were not happy with the font size and colour that was used in both apps. The use of an uncommon icon in Twazon and the use of both words and icons within a button in Aded Surat were criticised by users and users from both apps disliked the usage of the English language within some options. Some users were disappointed that the apps did not use the Islamic calendar and, finally, Twazon users noted that the app placed Arabic text in the wrong direction within screens.

5.4.2.1 Data Privacy and Security

Both apps collect a wealth of private and sensitive information about users, for example name, email, gender, age and weight. Such information is considered as a personal data, which is defined as information regarding an identified or identifiable natural person (Alturki & Gay 2019b). Several users as the word cloud (Figure 5.31) had concerns regarding the privacy and security of their data, in particular that neither app specified how they will provide privacy and security protection for users' data. User 7 asked, "*Before I start using the apps, how can I be sure that my personal information is secured?*" User 16 said, "*The apps didn't have any kind of information regarding the security procedures implemented to protect my data. Other apps mention such information to their users, for example WhatsApp*." Moreover, Twazon's users stated that the app asks them to provide their personal data, such as gender and weight, without explaining to them the purpose of collecting such data. User 1 said, "*When I was creating*

an account, the app asked me for some personal sensitive information, for example my age and weight, but it doesn't inform me why they needed to collect such information." It was also noted that neither app provides their privacy policy within the app and the Twazon app does not have a privacy policy at all. Aded Surat's privacy policy indicates that they have the right to share users' personal information with a third party, which several users disliked. User 22 said, "*I'll not use the app as it might share my personal information with other parties*." Based on these concerns, several users decided that they would not use either app.

5.5.3 Suggestions for Future Apps

Figure 5.32 Users' suggestions for future apps

Several users suggested allowing users to sign in to the app by using other social media app accounts, for example Twitter and Instagram. Users also recommended that the apps should add local/traditional food dishes within the diet as well as use common sizes of water bottles, such as 350 ml and 600 ml, as a serving size for reporting daily water consumption. In addition to this, users wanted to be able to set their own goal of walking a specific number of steps daily and they requested having the ability to convert the number of walked steps to metres or kilometres. Users thought it would be better to replace the self-monitoring indicator for physical activity from the number of burned calories to number of exercises completed. In regard to the screen design of the chatting feature, users prefer to have a design that is similar to popular chatting apps, such as WhatsApp and Facebook Messenger. Users also suggested designing the reminder screen to be similar to that of reminders in mobile phones and wanted to be able to

specify their own ringtones for reminders. In terms of the apps' colour schemes and/or themes, users suggested the apps should have a variety of themes and colours that they can choose from. A few users also recommended to add AR and VR feature to motivate users to do physical activities and improve their eating behaviour.

5.6 Recommendations

Based on the results of the usability testing, users' feedback and health professionals' analysis, it is believed that the tested fitness and weight loss apps and future one can be improved in the following main sections:

5.6.1 Interactive Design

5.6.1.1 Sign-Up Process

1. Start the order of the options/buttons within the first screen with "new user";
2. Design the options/buttons within the first screen with the same size and shape and different colours;
3. Avoid asking users to retype information, such as email;
4. Ask users to provide as little information as possible to make the signing up process easier and faster;
5. Identify mandatory and optional fields to complete during the sign-up process;
6. Ask users to provide their waist, buttocks and hip circumferences as an optional field;
7. Allow users to provide optional information regarding their health history that covers the usage of any medication, if they have a chronic disease and/or vitamin D deficiency and if they are allergic to certain foods; and
8. Allow users to sign in by using other social media accounts, for example Twitter, Facebook and Instagram.

5.6.1.2 Homepage

1. Avoid having too many options and selections in the homepage.

5.6.1.3 Assessing and Reaching Ideal Weight

1. Explain to users how the app determines the recommended daily calories and water intake by providing the equations that are used;
2. Clarify to users the equation used to calculate their ideal weight;
3. Explain to users how their BMI value is calculated;

4. Allow users to set up a goal to lose either 0.5 kilogram or 1 kilograms per week; and
5. Provide users with the duration (in days or weeks) it is estimated it will take to reach their ideal weight based on the goals they set.

5.6.1.4 The Diet

1. Allow users to plan six meals in a day, which are breakfast, morning snack, lunch, afternoon snack, dinner and bedtime snack;
2. Provide users with the recommended time for each meal;
3. Divide the foods based on their groups, such as vegetables, fruits, milk, grains, protein and oil;
4. Show the food items within each food group without the need from users to type what they want to add;
5. Indicate the total number of calories for each meal;
6. Determine the food portions from each group of food for each meal;
7. Use more common measurement units such as spoons, cups or hands instead of grams to make it easier for users to determine the quantity of food ingredients;
8. Prevent users from exceeding the determined food portion from food groups and the total number of calories for each meal;
9. Avoid providing users with unhealthy food items and drinks;
10. Allow users to suggest new food items to be added to the app;
11. Provide a variety of Saudi Arabian food varieties;
12. Use the common sizes of water bottles, for example 350 ml and 600 ml, as serving sizes for reporting water intake; and
13. Send notifications to users if the calorie consumption differs from the recommended level.

5.6.1.5 Self-Assessment

1. Provide a weekly self-assessment;
2. Design the self-assessment in an easy to understand shape, such as graphs;
3. Include a question regarding water consumption in the self-assessment;
4. Send a notification to users to remind them about the self-assessment;
5. Address the self-assessment results by sending a notification that contains customised advice to users whose results do not meet the suggested levels.

5.6.1.6 Physical Activities

1. Only suggest exercises that obese users can do;

2. State the benefit obtained from each kind of exercise;
3. Provide users with written instructions or a video that shows them the correct way to do each exercise;
4. Avoid the categorisation of exercises into groups such as “outdoor exercises” or “exercises to improve circulation”;
5. Suggest different workout plans;
6. Motivate users to walk daily;
7. Count the steps for daily walking;
8. Allow users to adjust the daily walking goal;
9. Allow users to convert the number of walked steps to metres or kilometres;
10. Send notifications to users if the burned calorie or number of performed exercises differs from the recommended level.

5.6.1.7 Self-Monitoring, Tracking and Feedback

1. Allow users to choose to monitor and track physical activities by number of performed exercises or number of burned calories;
2. Avoid the interference between calories that are gained from eating and calories that are burned from doing physical activities by separating them from each other;
3. Monitor and track users’ daily number of steps walked steps, performed exercises, food and water consumption;
4. Use shapes, such as circles, to show users the tracked information for their daily usage/activities;
5. Do not group all of the tracking information in one screen;
6. Allow users to monitor and track their weight loss progress by providing a line chart that shows their weight loss over time;
7. Enable users to see their started, current and ideal weights;
8. Save users’ daily usage and allow them to retrieve previous usage information;
9. Provide users with a daily summary for their usage/activities.

5.6.1.8 Social Communication

1. Provide users with a built-in chat feature;
2. Design the chat screens to be similar to popular messaging apps such as WhatsApp or Facebook Messenger;
3. Allow users to share their weight loss development via social media platforms, for example, Path, Facebook and Twitter; and
4. Enable users to have a one-to-one conversation with a qualified physical activity professional and dieticians via the app.

5.6.1.9 Reminders

1. Allow users the ability to set up reminders;
2. Give users the flexibility to determine the repetition pattern;
3. Allow users to specify the reminder tone;
4. Design reminder screens to look similar to the ones included in mobile phones.

5.6.1.10 Educational Features

1. Provide an option that helps users to understand and read food labels;
2. Provide a portion control guide to help users determining appropriate food serving sizes;
3. Provide users with an educational tool that shows users how to improve nutritionally poor meals; and
4. Send daily notifications that include general health advice.

5.6.1.11 Advertisements

1. Try to avoid advertisements within the app;
2. If the app has advertisements, avoid providing a clickable advertisement box.

5.6.2 Graphic/Visual design

5.6.2.1 Colours

1. Avoid using only one colour or too many colours;
2. Use traditional colour schemes/patterns;
3. Provide users with several themes that they can choose from;
4. Allow users to customise the colour scheme as well as the app's themes.

5.6.2.2 Font

1. Avoid using complex font types;
2. Avoid using a small font size;
3. Use different font sizes for different text styles, for example headings and body text.

5.6.2.3 Icons

1. Use common icons that users can easily identify;
2. If uncommon icons are used, provide an information screen that explains what each icon refer to and does.

5.6.2.4 Buttons

1. Avoid using icons and words within a button, use only icons or words;
2. Avoid using a small size button;
3. Give enough amount of space between buttons.

5.6.2.5 Language

1. Only use the Arabic language;
2. Avoid using jargon;
3. Use simple language that easily can be understood by users;
4. Allow users to use both Islamic and Gregorian calendar;
5. Present Arabic text from the right to the left-hand side of a screen.

5.7 Conclusion

In this chapter, a comprehensive qualitative analysis of the Twazon and Aded Surat apps was presented. The analysis aimed to investigate the reasons and factors that resulted in the low level of usability which was determined in Chapter 4. The qualitative analysis was divided into four parts: interaction design, graphic and visual design, health professionals' analysis and users' interview. Each part provided findings and recommendations that are based on a combination of the usability testing for the apps, health professional evaluation of the content and the level of accuracy and research techniques from Chapter 3. Figures and quotations are used to explain the various kinds of functions, content, screens and visual design in both apps. Following this, usability guidelines based on the results and recommendations of the analysis were outlined.

The next chapter presents the developed and proposed weight loss app Akser Waznk. This app is based on the results and recommendations from Chapters 4 and 5. Chapter 6 explains in detail the full functions and content of Akser Waznk.

CHAPTER 6
PROPOSED SOLUTION

6.1 Introduction

This chapter presents and explains the development of the Arabic weight loss app Akser Waznk. The chapter starts by explaining the methodology that is used for the app's development and justifying its choice. Then, the chapter provides information regarding the initial focus group that tested the app while it was under development. Following this, it provides a detailed explanation of the app that is illustrated by using figures regarding the unique features, contents and design element of Akser Waznk.

6.2 Development Methodology

There are two popular methodologies for software development: waterfall and agile. Each of these approaches has its advantages and disadvantages; however, both methods have proven to be effective and usable when it comes to developing a mobile app (Srivastav 2017). The waterfall methodology is the most traditional methodology for software development, as it was developed in the '80s (Royce 1987). This style is a strict and linear frame that contains from six stages which should be implemented as follows: planning, analysis, design, development, testing and deployment (Figure 6.1) (Srivastav 2017).

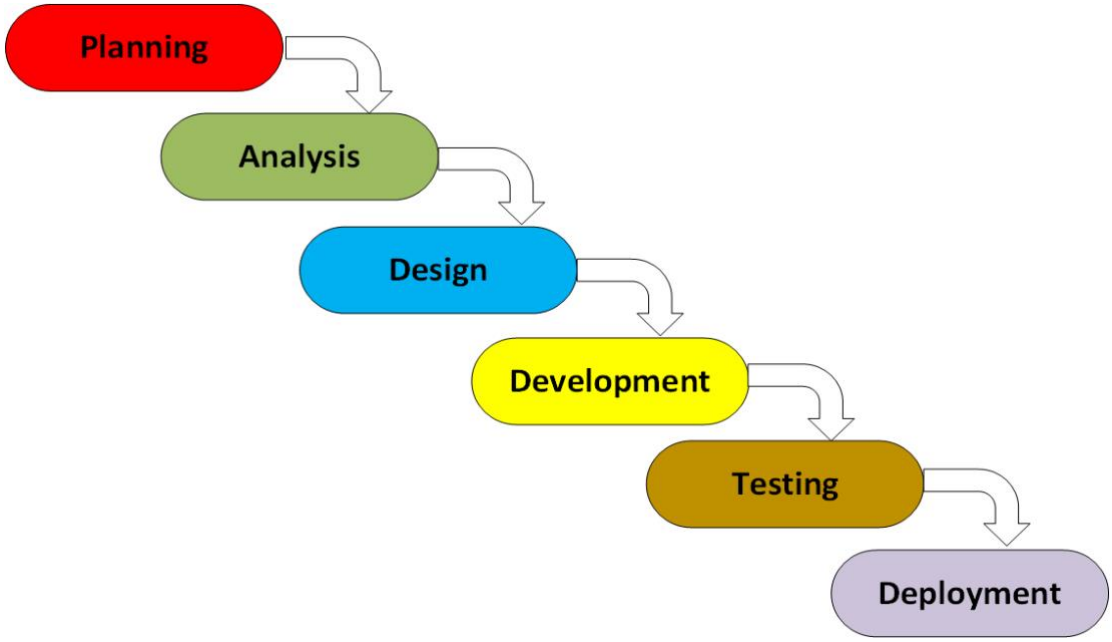

Figure 6.1 Waterfall methodology stages

The agile method was developed by Beck et al. (2001) and many researchers recommend it be implemented when developing mobile apps (Almuraikhi 2017; Guest Contributor 2018; Rahimian & Ramsin 2008). This approach is based on the idea of a sprint action style, where each sprint represents a cycle in the app development process. App development stages within this methodology can be done in parallel, where each person or team is responsible for a specific aspect of the app. This approach contains five stages as follows: plan, design, build, test and review (Figure 6.2) (Guest Contributor 2018). This approach has an important advantage, which is the high involvement of apps' potential users during the developing process. When an app cycle that might include a specific feature or a design is developed, it can be shared with the app's potential users to gain their feedback and recommendations, thus improving the quality of the app before the actual release (Brandall 2018). As this research aims to consider the opinions of the app's potential users regarding their use, requirements, feedback and recommendations in terms of each aspect of the app, the agile methodology was used while developing Akser Waznk. Akser Waznk is developed for iPhones because 84.61% of the participants within the usability testing in this study (22 out of 26 participants) used mobile phones that were operated under the iOS operating system.

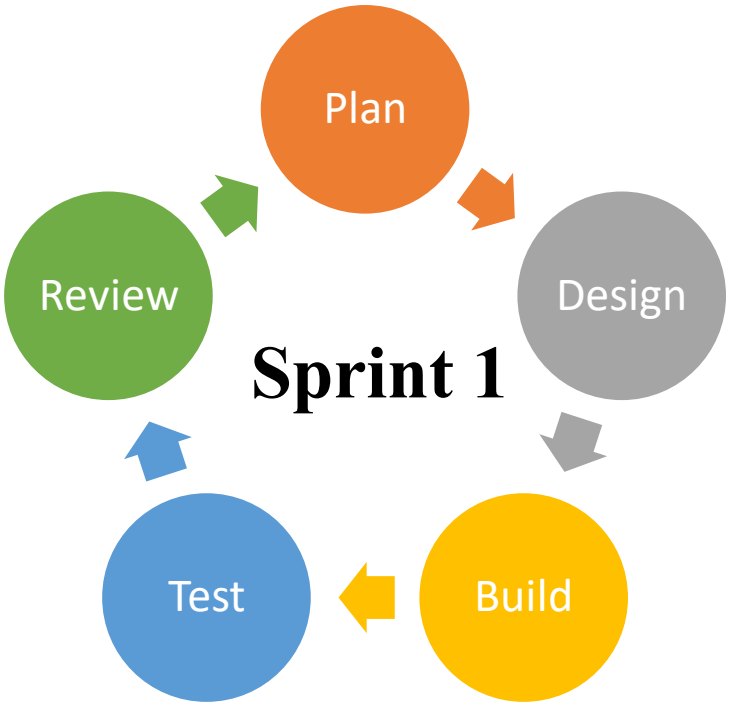

Figure 6.2 Agile methodology stages

6.3 Focus Group

A focus group is a method that involves a group of people from the target audience for a product or topic participating in a group interview that is run and guided by a moderator (Rabiee 2004). According to Nielsen (1997), a focus group is an informal technique which helps developers gain users' feedback, needs and recommendations regarding the interface or performance of a software. It is recommended to have five to 10 participants who differ regarding their age group, occupation and experience within a focus group (Usability.gov 2019). Thus, five participants, all of whom are Saudi citizens who experience obesity but who differ in age, occupation and experience, participated within the initial focus group while developing Akser Waznk. Their information is presented in Table 6.1.

Table 6.1 participants in focus group information

Gender	Age group	Occupation
Male	18 to 24	Student at university
Male	35 to 44	Teacher at a primary school
Male	Preferred not to say	Preferred not to say
Female	25 to 34	Unemployed

Female	Preferred not to say	Preferred not to say

When design elements or app features were developed, they were shared with the participants within the focus group via TestFlight, which is an app that allows iOS developers to invite users to beta test the app that is under development. After testing it, a group discussion was conducted via Skype to gain the focus group participants' feedback and recommendations. Implementing this technique played an important role in improving the quality of the app.

6.4 Akser Waznk

The Arabic term 'Akser Waznk' means 'lose your weight.' This term was selected as the name for the designed app as it refers to the app's main goal. The app aims to assist and motivate users to overcome obesity in a healthy way by helping individuals who are experiencing obesity to change their lifestyle. The initial focus group from the local community were consulted in order to develop the app's name, logo and slogan.

Figure 6.3 Akser Waznk app's logo and slogan

6.4.1 Sign Up Process

Users begin using the app with membership and social networking features as shown in (Figure 6.4). They have the option to create a new account by completing a two-step registration process involving creating a user profile and inputting their information and body measurements or to sign in via their Facebook, Twitter or Instagram account and then complete a one-step registration process of inputting their information and body measurements. Creating a user profile requires users to input basic information such as their name and email address and to select a password. The information and body

measurements step requires users to input their gender, age, height in centimetres, weight in kilograms and, if known, the circumferences of their waist, buttocks and hips.

Figure 6.4 Membership and social network feature

In addition to these compulsory steps, an optional step – 'health information' – can be completed which requires users to provide information regarding four aspects: whether they use any medication permanently; if they have a chronic disease; whether they experience vitamin D deficiency; and if they are allergic to certain foods. Diet specialists will contact users in the case that one or more of the reported answers means the user requires a specific diet. Initially, they will provide users with a customised diet based on their needs and then help users to plan their future diets. This step was added based on recommendations from diet specialists as such factors affect users' diet and weight loss progress. After submitting the required information, users' ideal weight and current BMI is displayed in the app screen.

6.4.2 Health Promotion

There are a variety of different approaches that can be used to guide health promotion interventions. Social cognitive theory forms the theoretical base of the Akser Waznk app because this theory addresses the importance of social systems relative to an individual's behaviour and considers the value of both self-efficacy and regulation. Moreover, this theory considers the dynamic interaction amongst personal, behavioural and

environmental factors and the importance of observational learning that is established on observing others' consequences and experience is confirmed (Bandura 1998).

6.4.3 Evidence Informed Practice

The app contains numerous tools and features to address all the 13 evidence-informed practices for weight-loss interventions (Breton, Fuemmeler & Abroms 2011) (Table 6.2). The development of the app considers the results and recommendations from chapter 4 and 5 and the study that determines the motivational features to overcome obesity (Alturki & Gay 2016).

Table 6.2 The tools used in Akser Waznk to address evidence-informed practice for weight-loss management

Practice	App information
Assessing and reaching an ideal weight	The waist circumference and BMI is calculated to assess each individual's weight.
	The app provides a target weight and a date for individuals to use as their objective.
Healthy diet	Based on users' target weight, a daily calorie count required is calculated.
	Provides the recommended daily portions of food items and beverages.
	Provides the recommended daily amount of water.
	Generates and distinguishes recommendations based on the score of the weekly self-assessment.
	Helps users to understand and read labels on food products.
	Suggests substitutions of healthy foods for unhealthy food options.
	As an educational tool, the app shows users examples of nutritionally poor meals and diets to improve them to plan their healthy meals.
	Users can plan healthy meals via a specific tool.
	The app will send notices if the calorie consumption and exercise deviate from the recommended level as it is stated based on the score of the weekly self-assessment.
	The user's consumption report helps to create a tailored healthy lifestyle circle.

Physical activity	The app suggests a minimum of six exercises from a list of physical exercises for the individual to do for a minimum of 45 minutes at least five times per week.
	The users are able to analyse their physical activity at the end of every week.
	The app provides videos and detailed information regarding all physical exercises in the app list for the users so that they execute the exercises in the proper manner.
	If physical activity is not achieved or the recommended level is not met, the app will send a reminder to the users.
	The 'Lets Walk' feature encourages the users to walk together every week.
	There is an added feature that provides directions so that users can walk to their nearest Mosque (place of worship).
	Gamification features encourage users to reach/achieve the daily count of steps goal, with the app donating money to charity every time the goal is met.
	Set an initial aim of 5,000 steps, with this number gradually rising over time. A pedometer is offered to users so they can count the steps taken.
Self-monitoring and assessment	The app tracks the daily consumption of water, food (calories), performed exercise and counts the daily steps taken.
	The users can perform the self-assessment regarding their physical exercise, food and water consumption at the end of the week.
	The weight-loss tracker allows users to keep track of their weight-loss progress, offers their current weight in kilograms and shows how they are meeting their weight-loss goal.
Social support	The users can use the built-in social network feature to communicate with other users, share their experiences and provide useful tips and support.
	The users can have a one-to one-conversation with a qualified fitness trainer and diet specialists so that the users can raise any queries with professionals.
	The app can merge with social media platforms including Facebook.

6.4.4 Assessing and Reaching Ideal Weight

The app assesses users' current weight based on the information that they input while creating their user profile. Lemmens, Brodsky and Bernstein (2005) equations were used to determine users' current BMI and ideal weight. The app allows users to set up a goal to lose either 0.5 or 1 kilogram per week and users will be encouraged to have at least a moderate loss of their original weight (between 5% and 10%) because this amount of weight loss is significantly associated with significant changes in chronic disease risk (Centre for Public Health Excellence at NICE & National Collaborating Centre for Primary Care 2006; Wing et al. 2011). The duration (in days or weeks) that is required to reach the ideal weight is calculated, allowing users to set realistic and appropriate goals. The Mifflin et al. (1990) equation for men and women is used to determine the daily calorie intake, as it was the most accurate and reliable calorie calculator equation available at the time of conducting this research (Frankenfield, Roth-Yousey & Compher 2005). All the equations that were used in the app are provided and explained to the users.

6.4.5 The Diet

The app uses a diet template developed by the Clinical Nutrition Department at the Ministry of National Guard Health Affairs, Saudi Arabia to help users to plan their daily meals (Figure 6.5). The template recommends users have six meals a day: breakfast, morning snack, lunch, afternoon snack, dinner and bedtime snack. The template contains six food groups: vegetables, fruits, milk, grains, protein and oil. The food portions for meals are determined according to the individual's daily calorie needs. The app suggests meal times based on the recommendation of diet specialists.

Figure 6.5 Clinical Nutrition Department's diet templet

The app requires users to add the exact amount of their food portions from each food groups for each meal. Users cannot exceed the daily requirement of calories or the calories recommended for each meal. The app has an interactive screen that makes planning or adding a meal easy for users (Figure 6.6). In the top part of the screen, users can see a number of circles that represents the different kinds of food groups that are displayed on the bottom of the screen. When users add a food item, its related food group circle turns on and, once users add all of the required amount from a particular food group, the food group icon turns as well. If the user does not do this, a notification appears that asks users to follow the diet requirements in order to add a meal. In the case that users consumed a food that is not on the app's food list, they can suggest their food items and the app's supporting team will address these foods to determine whether they would be added or not (Figure 6.7).

Figure 6.6 App implementing diet templet

Figure 6.7 User suggests food item

The app also determines the recommend daily amount of water based on a specific equation and allow users to add water consumption (Gupta 2018). The app uses the common size of water bottles, 220ml, 350ml, 600ml and 1liter as a serving size for reporting water intake.

Figure 6.8 Adding water

6.4.5.1 Customised Saudi Food Database

It was important to create a food composition caloric information database that included Saudi Arabian food varieties. The database uses the Clinical Nutrition Services Diet Manual from King AbdulAziz Medical City and Saudi food composition tables as a base to offer both caloric information and serving size for more than 100 food items (Musaiger 2006). However, as the caloric count of many traditional food items were not available, so I had to use common recipes from local restaurants and then calculate the nutrient values of different ingredients in order to determine the caloric count. The existing Saudi food databases use grams for measurement, yet considering the traditional social norms, it was required to convert the quantity of food ingredients from measuring in grams to measuring with spoons, cups or hands so that users could easily understand the quantities required. Furthermore, the app allows users to suggest new food items to be added to a specific database, with the app support team evaluating items before adding them to the official food database.

6.4.6 Self-Assessment

There is a self-assessment feature in the app that allows users to keep track of their activities, performances and progress during the week. Numerous studies have shown that eating a Mediterranean diet is helpful for reducing the obesity ratio (Esposito et al. 2011; Mendez et al. 2006). Therefore, the app's self-assessment technique is developed based on the Mediterranean diet assessment instruction (Martínez-González et al. 2012). However, as alcohol consumption is prohibited in the religion and culture of Saudi Arabia, alcohol was excluded. Based on both the Saudi Healthy Food Palm Guide (El Bcheraoui et al. 2015) and Clinical Nutrition Department, Ministry of National Guard Health Affairs guide, five extra questions were added, which cover an additional four aspects: the consumption of dairy, wholegrains and water, and physical activity. The total score of the self-assessment is 18, with each question holding a value of one point (Table 6.3). These questions help to analyse the level of consumption of different food items and users' responses are calculated to determine if their consumption is meeting the advised level or not.

Table 6.3 Lifestyle self-assessment questions

Aspect	Question
Vegetables	Are you eating two or more servings (of 200g each) of vegetables every day?
	Are you eating pasta, vegetable or rice dishes with garlic, tomato, leek or onion two or more times per week?
Fruits	Are you eating three or more servings of fruit (of 80g each) every day?
Oils	Do you use olive oil as the main culinary fat?
	Do you use four or more tablespoons of olive oil every day?
	Are you eating less than one serving (12g) of butter, margarine, or cream every day?
Sugar	Are you consuming less than one serving (330ml) of sweet or sugar-sweetened carbonated beverages every day?
	Are you eating less than three servings of commercial sweets/pastries every week?
Meat and beans	Are you eating less than one serving (100–150g) of red meat/hamburgers/other meat products every day?
	Are you consuming three or more servings (of 150g) of legumes every week?
	Are you eating three or more servings of fish (100–150g) or seafood (200g) every week?
	Are you consuming less than one serving (30g) of nuts every week?
	Are you eating chicken, turkey or rabbit routinely instead of veal, hamburger or sausage?
Dairy	Are you eating two or less servings of dairy products every day? (One serving is one cup of milk or yogurt, three slices of processed cheese slices)
	Are you consuming low fat or skimmed milk products in place of full fat?
Bread and cereal	Did you eat wholegrains in place of refined grains?
Water	Did you consume the recommended water quantity per day?
Physical activities	Did you do any kind of physical activity for 45 minutes five or more times per week or more?

To make the results easy for users to understand, the results of the assessment will be presented in a graphic user-friendly interface (Figure 6.9). When answers meet the recommended level, the graphic format will change from the grey to a unique colour in each aspect.

Figure 6.9 Graphic display regarding self-assessment's results

Users' responses that do not meet the suggested level are addressed by sending a notification to them that provides customised advice obtained from the Saudi Healthy Food Palm Guide and international government health sources (Eat For Health 2015; El Bcheraoui et al. 2015; National Health Service 2018; Oldways n.d.). The app will also send a notification in the event that the performed activities, food and water consumption rates did not meet with the recommended level according to the weekly self-assessment score.

6.4.7 Physical Activities

The app's physical exercise section was developed keeping in mind exercises that obese Saudi Arabians will be able to do. Exercises that are not available or possible for some users, for example swimming, is substituted with different exercises that can be performed easily at home. This is a great benefit, especially for female app users, who are not permitted to go outside like men. Each of the physical activities has information

that describes the goal of the activity as well as a video to show the correct way it should be performed.

Figure 6.10 Physical exercises example

A qualified trainer will contact users once a month through the app's chat feature to discuss the daily exercises. Users will also be able to talk to the trainer if they have an enquiry. The app will recommend the user do six physical exercises from the provided exercises list for approximately 45 minutes at least five times a week.

The Akser Waznk app has three unique features that will inspire users to walk more. The first one is named Let's Walk. With this feature, users can vote between two footpaths locations to determine a place to gather with other users and walk as groups (Figure 6.11). The vote takes place weekly. Currently, this feature works in two cities in Saudi Arabia (Makkah and Jeddah). The nominated places to be as a starting point will be determined according to the footpath availability. The administration team will send a notification to users regarding the footpath that has been chosen each week based on the voting results.

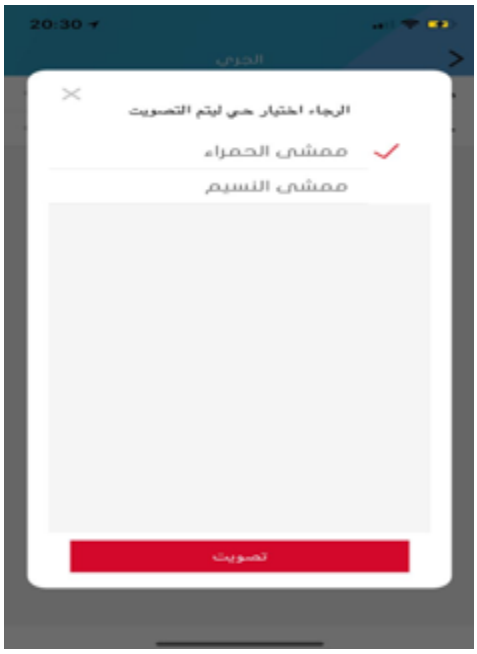

Figure 6.11 Voting screen for let's walk

Saudi Arabia is a nation where more than 92% of the population believe and follow the Islamic religion (FAHMY 2018). In Islam, believers are required to pray five times in day and most men go to mosques to practice their prayers daily. Therefore, a second unique feature was developed, called Walk to Mosque. The app gives users the option to turn on notifications or alerts when it is a time of prayer that show the mosques nearest to the user's location (Figure 6.12). If the users choose this option, the app will guide them. The app will give the users a choice of mosques, so the user can walk to a more distant mosque if they want to increase their walking distance.

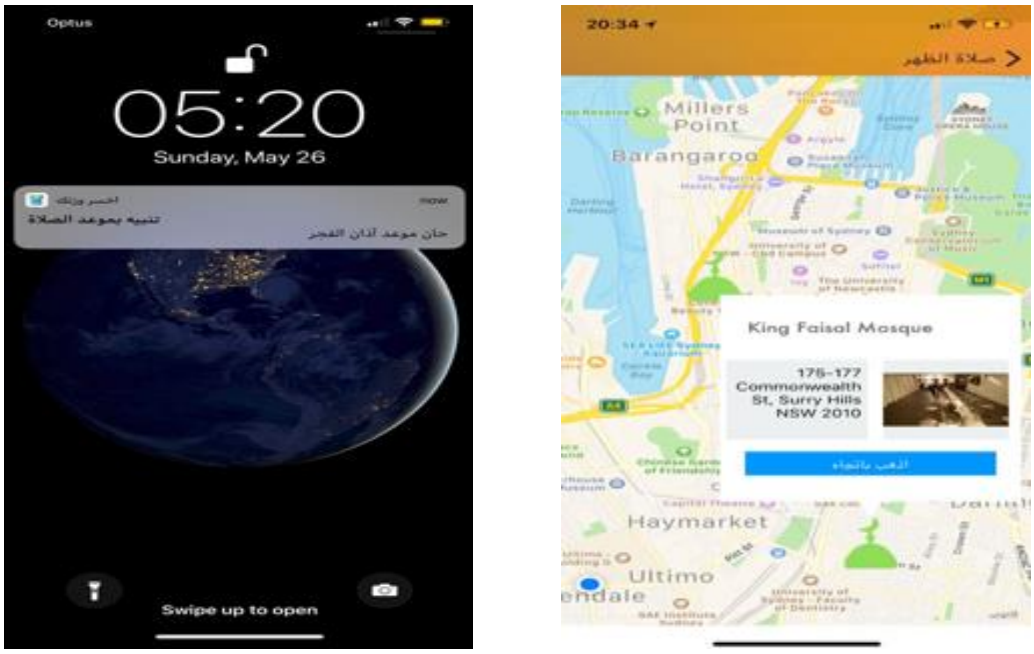

Figure 6.12 Notification for a pray and mosques nearest location

Several studies state that adding rewards to goal-setting features is a very useful way of increasing motivation and task performance because they give sense of achievement and satisfaction to the user and that leads to improved motivation and the achievement of fitness goals (Alturki & Gay 2016). Therefore, the gamification feature was implemented on this app. The app provides a pedometer that allows users to track their daily number of steps (Figure 6.13). Users have a daily goal of a certain number of steps to achieve and when it is achieved they can donate a small amount to a charity. All the new users will have a credit of few cents at the beginning that can be used for the donation. Over time, the daily goal then will increase to the next level in increments of 500 steps until they reach a total of 10,000 steps.

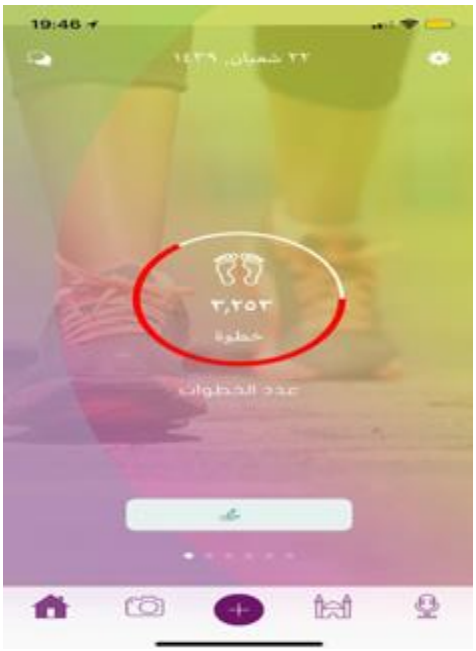

Figure 6.13 Tracking daily number of steps

6.4.8 Self-Monitoring, Tracking and Feedback

Self-monitoring is an essential part of the app because of the strong association between both physical exercises and a healthy diet with weight loss (Burke, Wang & Sevick 2011; Carter, Burley & Cade 2017). Thus, users will be able to self-monitor their daily intake of energy, for example, food (kCal), drinks and water consumption (in), the amount of physical exercise (out) and weight-progress tracking.

As it is important for the users to track and monitor their daily balance in form of calories (in) versus exercise (out), the Akser Waznk app provides a customisable database for that purpose. Through using this database, users have the ability to store their daily food intake and physical exercise performed and view their previous day's history.

The homepage has six horizontally scrolling sliding screens that provide information regarding the step count, exercise, meals, water consumption, weight loss progress and the summary of the day to allow easy access for tracking and goals. In addition to this, the app enables users to report their daily consumption of food and drinks and then calculates the number of calories eaten, so that it can inform users about the calories left to consume before the end of the day. Thus, the Akser Waznk app tracks the daily calorie consumption, steps taken, water consumption and performed physical exercises.

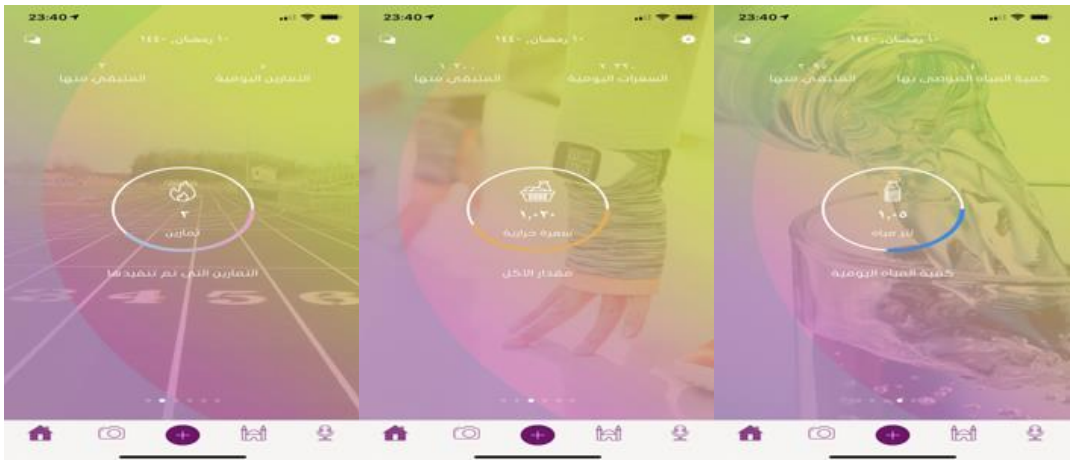

Figure 6.14 Tracking exercise, meals and water consumption

Users cannot exceed the required amount of daily food and drink consumption (kCal) for weight loss, but if they do not consume the daily required amount of calories, drink enough water or perform the recommend amount of physical exercise, the app will send a notification to remind them to engage more. Table 6.4 shows the full list of the Akser Waznk app's feedback and prompts.

Table 6.4 Full list of the Akser Waznk app's feedback and prompts

Category		**Kind of feedback**
Physical activity	Daily gauge	Visual feedback Homepage: The 'physical activity' circle gauge completes itself and turns purple when users perform the required amount of daily exercises.
	User did not perform the required amount of exercise	Visual feedback Homepage: The physical activity's circle gauge remains partially completed and part of it remains grey.
Step counter	Daily gauge	Visual feedback Homepage: The 'step counter' circle gauge completes itself and turns red when users walk the required number of daily steps. In the beginning, it will be 5,000 steps and then it gradually increases by 500 steps until it reaches 10,000 steps.
	A user walked 1,500 steps or fewer	Popup message: "It is not easy to reach 5,000 steps for the first time. Try to walk more tomorrow."

	A user walked between 1,501 and 2,499 steps	Popup message: "You did great, you almost reached halfway. Keep it up!"
	A user walked between 2,500 and 3,500 steps	Popup message: "Good! You walked more than halfway. You can make it tomorrow."
	A user walked between 3,501 and 4,999 steps	Popup message: "Amazing! You almost reached your goal. Tomorrow is the day."
	A user walked between 5,000 and 7,499 steps	Popup message: "Congratulations! You reached your goal."
	A user walked between 7,500 and 9,999 steps	Popup message: "Excellent! You can do this every day."
	A user walked 10,000 steps or more	Popup message: "Unbelievable! You must be proud."
Food consumption	Daily gauge	Visual feedback Homepage: The user's daily calorie consumption and the calories remaining are calculated and showed as numbers. The food intake's circle gauge completes itself and turns yellow when users consume the required amount of daily calories. Food's database: The user's daily calorie consumption and the calories remaining are calculated and showed as numbers.
	User did not consume the required amount of calories	Visual feedback Homepage: The food intake's circle gauge remains partially completed and part of it remains grey.
Water consumption	Daily gauge	Visual and spoken feedback Homepage: The user's daily water consumption and the amount remaining are calculated and showed as numbers. The water consumption's circle gauge completes itself and turns blue when users drink the required amount of daily water.

		Homepage: The app displays the user's water consumption so far and the remaining amount to be drunk that day.
	User did not drink the required amount of water	Visual feedback Homepage: The water consumption's circle gauge remains partially completed and part of it remains grey.
Donate to charity	After a donation is achieved	Popup messages: "You are helping to make a better world" "You have made a difference" "We are grateful for your generosity" "We appreciate it" "Thank you so much"
Self-assessment	When the self-assessment is done	Visual feedback Self-assessment page: Each section in the circle turns to a different colour when users answer correctly; otherwise, sections will remain grey.
	When users complete the self-assessment successfully	Popup message: "Well done! You are following a healthy lifestyle."
	When users complete the self-assessment unsuccessfully	Popup message: "Oh! We encourage you to avoid unhealthy habits."
	Remind users to do the self-assessment	Popup message: The apps send a notification to remind users saying "Please do the self-assessment"
Goal setting	Duration to reach ideal weight	Visual feedback Homepage: The duration to reach the ideal weight is showed in days or weeks. Homepage: BMI value is displayed and it is updated when users update their weight.
	Information about updated user's BMI	Visual feedback Settings page: Information on how to calculate the user's BMI

	User's ideal weight information	Visual feedback Settings page: Information on how to calculate the ideal weight value for male and female.
Self-monitoring and tracking	Reminds user to update weight every week	Popup message: The app send a reminder notification to users saying "Please update your weight"
Social notifications	New message	Visual feedback Chatting page: Users see messages Popup message: "New message from (name)"
Alarm notification	Reminder	Popup message: The app notifies users when the alarm goes off (the user names the alarm themselves).
Advice for a healthier lifestyle	Daily general health advice	Popup message: The supporting team sends daily general health advice. For example: "Avoid consuming soft drinks" "Eat fruits and vegetables every day"
	Advice based on the weekly self-assessment score	Popup message: A tailored notification is sent to the user from an archive of advice regarding the eight topics of the self-assessment. For example: "Use low or fat free dairy products instead of full fat" "Use olives oil with the green salad"

The app also allows users to monitor and track their weight development (Figure 6.15) by providing their starting weight, current weight, ideal weight, current BMI and remaining duration (days or week) to reach their ideal weight. The app allows users to update their weight weekly and provides a graph that shows users their progress towards overcoming obesity.

Figure 6.15 Weight loss progress

6.4.9 Social Communication

The app allows users to connect to online social media platforms and has a built-in chat feature (Figure 6.16) so that the users can share their experiences and tips with each other, which positively affects users' health behaviour (Ahmadi 2016). This also enables users to get to know each other and then view each other's progress, chat and post photos and share them on several social media platforms, for example, Facebook and Twitter. This real-time communication allows users to get answers to various questions instantly and users can answer queries by talking to each other. Many other weight loss apps in both English and Arabic lack this feature and the ability to do this will motivate the users of Akser Waznk (Alnasser et al. 2015; Breton, Fuemmeler & Abroms 2011; Pagoto et al. 2013). The decision to include this feature was based on the users' recommendations to design the chat interface to be similar to other widely used messenger apps such as WhatsApp.

Figure 6.16 Chat between users

6.4.10 Augmented Reality

There are serval technologies that have emerged recently that have been used widely in mobile apps as motivational tools, for example AR (Alturki & Gay 2019a). In AR, physical reality can become improved via the extra information which computers can produce in real time (Carmigniani et al. 2011). AR technology has been used in several mobile apps. In addition to this, it has been used in different fields, for example education (Hahn 2012). Such technology can even enable the better use of mobile devices for those with declining cognitive ability, such as people affected by Alzheimer's disease (Zhou et al. 2011). As AR technology has proven that it can be used successfully in different fields by a various group of people and based on the users' recommendations, the AR feature was implemented in the Akser Waznk app. The app allows users to scan fitness equipment to identify it and then the app will provide information regarding the benefit of using that type of equipment and the correct way for it to be used (Figure 6.17). The app identifies several fruits and vegetables common in Saudi Arabia and provides information regarding their average energy (kCal). For that purpose, a specific database was created to offer information for fitness equipment and food items.

Figure 6.17 Scan fitness equipment

6.4.11 App Themes

After the app's functionality and features, an app's colours are arguably its most vital aspect. They assist an app's users to see and interact with its contents, elements and better understand actions (Babich 2017). Thus, they are seen as one of the most significant design features that strongly affects users' evaluation and the perception of apps in general. Selecting the colour schema is a challenge, however, because it affects the level of usability for an app (Adoriasoft 2017; Babich 2017).

In this app, the traditional colour scheme patterns (monochromatic, analogous and complementary) were implemented. The app currently has five different themes that users can choose from. These themes were developed and tested with participants from the initial focus group and it was reported that they facilitate interaction with the app's contents. According to the results from chapter 4 and 5, an interactive design is seen as a vital tool that motivates users to keep using an app and hence improve the usability of an app. Therefore, the variety of app themes was presented.

Figure 6.18 Different theme

6.4.12 Voice Recognition

To ensure a user-friendly experience, the app supports voice commands for easy interaction (Whitenton 2017). This function allows users to add tasks or submit enquires using verbal commands (Figure 6.19). The app translates the verbal command into written text on the screen and then performs what is asked to do or answer the enquires by either providing information on the screen or speaking to the user. Currently the app can:

- Navigate users to the ‘add meal’ option
- Add the consumed amount of water
- Say the remaining amount of daily water consumption
- Say the consumed amount of water
- Say the remaining amount of daily calories consumption
- Say the consumed amount of calories

Figure 6.19 Voice commands

6.4.13 Reminders

Many researchers have examined the effect of reminders on health in different settings and found that reminders are an effective motivational intervention (Alturki & Gay 2016). Research by Turner-McGrievy and Tate (2011) measures the impact of reminder features in apps as weight-loss intervention among obese individuals. The study explored the six-month efficacy of a weight-loss intervention by mobile apps and found that intervention through reminders can produce modest weight loss. Therefore, the Akser Waznk app allows users to set a reminder, with users able to determine the date, time, repetition, name and the ringtone for a reminder.

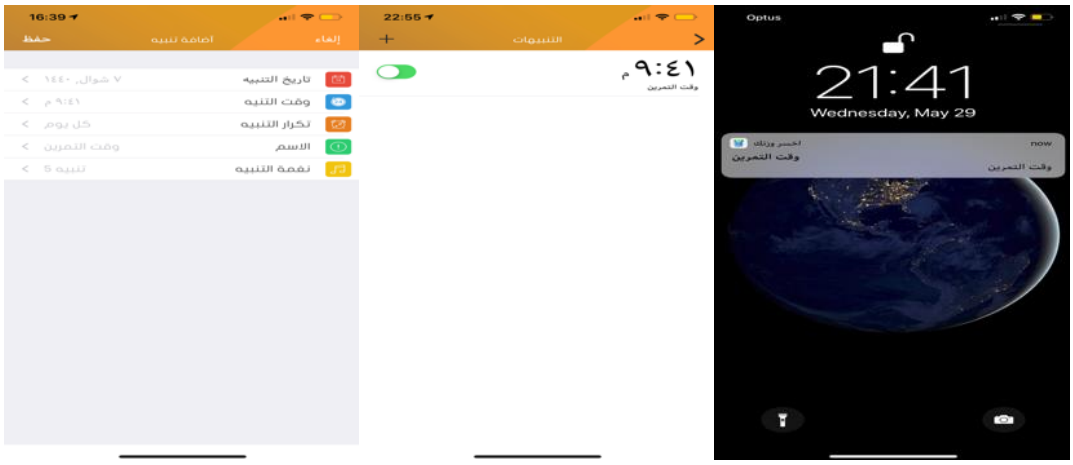

Figure 6.20 Reminder

6.4.14 Educational Features

6.4.14.1 Read food Label

The app describes to the users the right way to read food labels. It dose that by categorising a food label into 5 sections and each has a unique colour.

Figure 6.21 Description of how to read a food label

6.4.14.2 Portion Control

The app aims to help users to be able to easily determine food serving size. As the app use the traditional serving measurement, such as spoons, cups and hands instead of grams, it provides users with a portion control guide that uses hand as a measurement.

Figure 6.22 Determining food serving size by using hand

6.4.15 Behaviour Change Techniques

The requirements and suggested features for an effective weight-loss app were based on the results of (Alturki & Gay 2016); recommendations gained from chapter 4 and 5 as well as all aspects of evidence-informed practices (Breton, Fuemmeler & Abroms 2011; Pagoto et al. 2013). Number of existing weight-loss apps implement behaviour change techniques (BCT), and it is believed that BCT can be helpful in rising activities and healthy behaviours (Sullivan & Lachman 2016). Therefore, these techniques are implemented in this app by using Michie's taxonomy (Michie et al. 2013). Thirty BCTs were incorporated into the following related goals: identity (one code), goals and planning (four codes), antecedents (three codes), feedback and monitoring (four codes), regulation (one code), social support (three codes), rewards and threats (three codes), shaping knowledge (one code), repetition and substitution (three codes), natural consequences (two codes), comparison of outcome (one code), comparison of behaviour (two codes) and associations (two codes). A reflection of the system prerequisites, BCTs and relevant Akser Waznk app features are presented in the table below:

Table 6.5 A reflection of the system prerequisites, BCTs and relevant Akser Waznk app features

System requirements	BCT	Associated features in the app
Arabic language and culturally sensitive.	Shaping knowledge (4.1): Advise or suggest how to execute the behaviour.	Offers all information in the Arabic language including numbers and texts in a dialect with an easy, traditional and sensitive approach. This permits users to comprehend the app's advice and lose weight.
Improving motivation tools via delivering qualified guidance and optimistic strengthening.	Information about other users' approval (6.3): Deliver information about other users' perception about the behaviour.	Other users' view of the posts on the social network will help to deliver inspiration and advice to users. For instance, receiving "likes" for what you have for dinner.
	Identification of self as role model (13.1): Show how one's own behaviour can set a strong example for one's followers.	The users are encouraged to think of themselves as a role model for their friends and family members.
	Credible source (9.1): Offer a visible or oral mode of communication from a reliable source against or in favour of the behaviour.	Professional guidance and optimistic strengthening is achieved through the app by informing the users about their progress, objectives and encouraging them to keep working via sending messages. Because this is an evidence-based app, the messages and sources are deemed as reliable.
	Instruction on how to perform a behaviour (4.1): Advice or suggest about how to execute the behaviour.	Expert guidance for users to apply evidence-informed practices is provided via the app's

		notifications and tips. The users are also given valuable information regarding the impacts of unhealthy food choices and abdominal obesity.
	Information about health consequences (5.1): Deliver valuable information regarding the impact on health as a result of the behaviour.	Guidance is provided to users with the aim of encouraging them to eating healthy food and prevent them from consuming high calorie foods regularly. For instance, instead of eating a cake as a snack at work, instead eat fruit such as a banana or apple.
	Remove access to the reward (7.4): Guidance is provided to users so that they avoid the undesired behaviour.	Guidance is provided to substitute a behaviour that contributes to overweight and obesity, such as eating unhealthy foods, with healthy food products.
	Behaviour substitution (8.2): Rapid replacement of undesired behaviour with a neutral or wanted one.	Expert guidance to reshape living circumstances and move towards making more healthy decisions through the app.
	Restructuring the physical environment (12.1): Suggest changes in the physical environment with the purpose of preventing undesired behaviour and enhancing the performance of the desired behaviour.	Guidance is provided to the users to reshape their social conditions by participating in weight-loss programs, communicating with others and being involved in physical activity, for example playing football with friends or family members or other activities that can contribute to weight loss.

	Restructuring the social environment (12.2): Suggest changes in the social environment with the purpose of preventing undesired behaviour and enhancing the performance of the desired behaviour.	Guidance to replace unhealthy eating habits with new healthy eating habits and behaviour.
	Habit reversal (8.4): Rapid recurrence and rehearsal of substitute behaviour in place of an undesired habitual conduct.	Built-in chat platform where users can exchange their success and failures and get inspiration from those who have achieved results in order to reach their goals.
Physical activity and dietary tools	Goal-setting behaviour (1.1): Resolve or decide on a goal with regard to the behaviour to be attained.	The users' BMI and weight loss goals are calculated after users provide their information. The app then determines users' ideal weight and sets consumption strategies and target dates for the users to achieve it.
	Goal-setting outcome (1.3): Resolve or decide on a goal with regard to the positive result of desired behaviour.	The app sets a target to reduce 0.5 to 1 kilogram every week as a consequence of following the app's instructions and recommendations.
	Action planning (1.4): Rapid detailed planning of behaviour's performance.	The app sends regular notifications to users so they do not forget to exercise, walk and consume water and food as recommended. The app also sets a calorie target for each day and notifies the users when they reach the limit.
	Discrepancy between current behaviour and goal (1.6): Draw attention to	Graphical features are added in the app that reminds the users if

	inconsistencies between the formerly set action plans, conclusion goals or behavioural goals with the present behaviour.	they are deviating from their weight-loss guidelines.
	Graded tasks (8.7): The tasks should begin at an easy level and then slowly become more difficult but also achievable at the same time.	The app increases the number of steps and the amount of exercise over time through the graded weight-loss goals.
	Conserving mental resources (11.3): Suggestions to assist in behaviour change by reducing pressure on mental resources.	The app teaches users to understand nutritional labels to reduce the need to search for the calorie count every time. The food calorie guide in the app also helps users by providing different calorie counters. The app also promotes doing exercise and uses a step counter to enhance physical activities.
	Body changes (12.6): Facilitating behaviour change via altering body structure, functioning or support directly.	When behaviours are performed, the messages are automatically reduced and the prompt settings are set accordingly.
	Reduce prompts/cues (7.3): To perform the behaviour, the gradual removal of prompts is implemented.	
Tailored feedback and information	Feedback on behaviour (2.2): Fulfil and supervise evaluative or informative feedback on users' performance.	The feedback is given to users with regard to their daily or weekly data archives.
	Self-monitoring of behaviour (2.3): Create a technique for the user to record and observe their behaviours as a segment of behavioural change tactics.	The saved data is used to evaluate and observe users' behaviour.

	Self-monitoring of outcomes of behaviour (2.4): Create a process for the user to observe and record the results of their behaviours as a segment of behavioural change tactics.	The app suggests users record their weight once a week and then advices users to track via an updated app setting.
	Feedback on outcomes of behaviour (2.7): The users should be updated about their weight-loss reduction status when they have completed their exercises and updated their weight.	The app provides information to users about the duration in days or weeks they have spent doing physical exercise and updated their weight.
	Reduce prompts/cues (7.3): To perform the behaviour, the gradual removal of the prompts is implemented.	After every weekend assessment, the feedback messages are adjusted. The messages are reduced when the conduct is achieved and are tailored according to the users.
	Awareness (2.5): The app provides detailed information regarding particular points and helps users with awareness.	There are videos and tutorials in the app that show the proper ways to do different exercises.
User-friendly interface	Shaping knowledge (4.1): Provide advice or suggestions as to how to execute the behaviour.	The app's user-friendly interfaces comes with a designed built-in BCTs to help them understand the goals they must achieve for weight loss.
Social networking and support	Social competition (6.2): Highlight the performance of other users and allow users to compare it with their own performance	Social networking helps users to motivate themselves and improve their own performance. The users would be able to see the percentage of users achieving their goals.
	Social support - unspecified (3.1): Deliver social support when conduct is achieved.	The built-in social feature allows different users to share their

		stories and suggestions and to improve their performances via the app's social network or other social networks, for example Facebook and Twitter.
	Social support - practical (3.2): Deliver practical help to achieve the desired conduct.	Users can share their experiences in private windows by sharing their photos, weight-loss data and other valuable information to help them to provide and get emotional and practical support.
	Social support - emotional (3.3): Deliver emotional support to achieve the conduct.	
Metafictional toll rewards	Non-specific reward (10.3): The reward should only be provided if progress is seen in achieving the behaviour.	As the users attain their goals, the app congratulates the users through notifications which help to boost their motivation. The app also shows a coloured circle when all the goals are met over a week.
	Social reward (10.4): If the daily step count is achieved then a social reward is provided.	The users have the option of donating a small amount of money to charity when they achieve their goal.
	Self-reward (10.9): If the daily step count is achieved then a self-reward is provided.	The app generates a thank-you message each time a user donates to a charity.
Self-assessment	Self-assessment of affective consequences (5.4): Create a procedure for the users to self-assess themselves regularly.	The app encourages the users to complete their weekly self-assessment option and also provides the results.

6.4.16 Data Privacy and Security

The Akser Waznk app provides accurate and personalised advice for weight loss through collection of users' personal data. Personal data can be defined as information regarding an identified or identifiable natural person (General Data Protection Regulation 2016). Due to the nature of the app, and its use of private and personal information, the Akser Waznk app utilises number of the guidelines that were included in the European Commission's Code of Conduct on privacy for mHealth apps (European Commission 2018) and the EU's General Data Protection Regulation (2016) to guarantee users security. These guidelines include purpose limitation, data minimisation and user's consent. Upon signing up to the app users are given a set of questions and an explanation of the purposes and method of the app before they consent to provide the necessary personal information including their age, gender and weight. This forms an important data set utilised to measure the user's BMI, establish the target weight for the user's and provide the accurate diet plan. The app also requires user's consent after creating an account and before the actual using the app in order to access users' health data via iPhone Health option to retrieve data regarding steps and walking + running distance. These data will be used to measure the daily walking steps and distance for users. In simple Arabic language the app provides a detailed privacy policy outlining the purposes behind the data collected, permissions and privacy statements as well as provision of necessary details of the app developer. This privacy policy for the Akser Waznk app can be found through either the Apple Store or through the app in setting options.

Moreover, and in order to protect the users' data, an advanced level of security procedure which is recommend by (Martínez-Pérez, De La Torre-Díez & López-Coronado 2015) is performed that is encryption of the data. Encryption uses algorithms turning plain texts to unreadable text or jumbled code to ensure the security of the data and app. To decrypt this ciphertext, an encryption key is needed. Such key is something which only authorised parties have in their possession (Olesenko & Beklemysheva 2018). The encryption protects two types of data; in transit and at rest data. In transit data is data that is moving from one location to another, for example, when users input information on their mobile device and the data is transferred to servers or databases. At rest data refers to data that is not actively transferred and is instead stored, for example, in databases or clouds (Lord 2018). The Akser Waznk app considers both types of data and implements encryption techniques in order to ensure data protection.

6.5 Limitation

The current Akser Waznk app has some limitations. It is not available on smartphone platforms other than iPhone, for example Android and BlackBerry. The app also currently does not support virtual reality features and is not integrated with smartwatches, such as Apple watches, or fitness trackers, for example, Fitbit. It does not support the barcode-scanning feature for food items, and the app cannot work offline. There is no sponsor for the gamification feature, and the app does not allow users to donate to charities directly. In addition to this, the response time for the health information step might take up to a week as there are just 5 diet specialists participating as consultants. However, finding possible solutions to these limitations in the near future and updating the app regularly will further help to motivate and keep users engaged.

6.6 Strength

The Akser Waznk app is different from its counterparts in a number of ways. It is built on all of the 13 evidence-informed practices for weight-loss management, and it addresses the initial focus group's feedback and recommendations, which allows the app to meet the specific requirements of obese Saudi people via a localised and tailored method. The Akser Waznk app is currently the only Arabic app in Saudi Arabia that has gamification, AR, voice command features, and it is the only app which encourages weekly walking groups via the Let's Walk feature and daily walking via Walk to Mosque feature. The app offers local Saudi household measurement units, such as cups and spoons for local and traditional foods, which makes it easier for users to manage their daily portion control. The daily physical exercise suggested by the app meets the social and cultural norms of Saudis and suits users' physical status. The app provides a social media platform especially for the app's users, which allows them to share information and support and motivate each other. Finally, advice and recommendations to avoid specific foods and increase the consumption of others are sent by notification to users based on the results of their weekly self-assessments.

6.7 conclusion

This chapter presented and explained the development of the proposed Arabic weight loss app Akser Waznk. It started by outlining the available methodologies for developing a mobile app, then it explained and justified the use of the selected approach, agile, for developing Akser Waznk. Next, a brief description regarding the focus group technique was presented and the demographic information for the participants within it was provided as well. In addition to this, the chapter identified the method used for inviting potential users within the focus group to beta test Akser Waznk app while it was under development and the way that is used to conduct group discussion. Following this, a detailed explanation regarding the unique features, contents and design element for Akser Waznk app was provided.

The next chapter presents the quantitative and qualitative analysis and results for the usability testing of the Akser Waznk app.

CHAPTER 7
EVALUATION

7.1 Introduction

This chapter presents and discusses the quantitative and qualitative findings regarding the testing of the usability level of the Akser Waznk app. The usability testing was conducted with the same 26 participants who tested the level of usability of the Twazon and Aded Surat apps, as described in Chapter 4. The usability testing environment and analysis procedures for the quantitative data were also the same. Moreover, the chapter presents the qualitative analysis that were done by two different groups: the app's potential users and health professionals. The chapter then concludes with a discussion of the results.

7.2 Usability Testing, Participants and Data Analysis

The usability testing for the Akser Waznk app is performed following the same techniques, procedures, analysis process and environmental settings that were used in the previous usability testing of two Arabic weight loss apps, Twazon and Aded Surat, which were explained in Chapters 4 and 5. Moreover, the participants within the usability testing were the same 26 potential users who performed the previous usability testing for the Twazon and Aded Surat apps. This is because Akser Waznk is developed based on the results of the previous usability testing and, by following the same procedure, I can then compare this result with the previous results and answer the following three questions:

- Does Akser Waznk have a better level of usability compared to the previously tested apps?
- Does Akser Waznk consider the social and cultural norms of the users?
- Does Akser Waznk meet users' expectations?

Within the previous usability testing, users 3, 5, 14 and 16 used a phone that was operated by Android. However, in this usability testing, I found that user 16 updated his

mobile phone to iPhone X. As the Akser Waznk was developed only for iPhones, users 3, 5 and 14 were given an iPhone X to perform the usability testing. Also, I found that user 1 updated his phone from iPhone 7 to iPhone X and user 8 updated her phone from iPhone 6S to iPhone X.

In total, 78 videos for Akser Waznk app were examined as each user tested the app three times.

7.3 Quantitative Results

7.3.1 Effectiveness

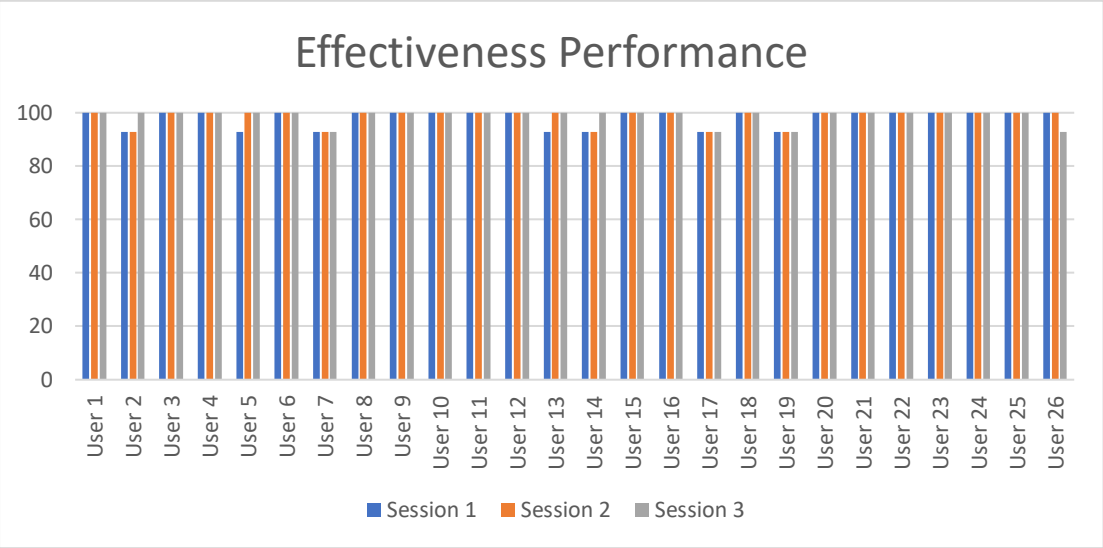

Figure 7.1 Akser Waznk's effectiveness performance

Figure 7.1 demonstrates the effectiveness performance percentage for each potential user for each session. 18 users had 100% correct completion rate over the three sessions. Users 2, 5, 13 and 14 showed positive progress across sessions, as they scored 92.85% at session one and then 100% by the third session. The correct completion rate of users 7, 17 and 19 remained constant over the three sessions at 92.85%. Only user 26 showed negative progress across sessions, scoring 100% at both sessions 1 and 2 and then decreasing to 92.85% by the third session.

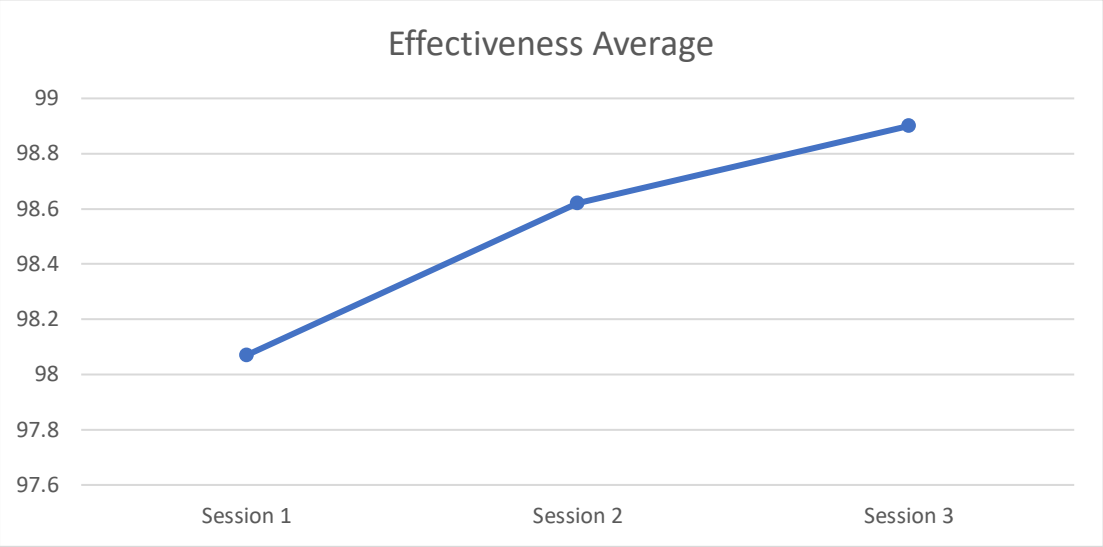

Figure 7.2 Akser Waznk's effectiveness average

Consequently, the effectiveness performance average increased over sessions. It started at 98.07%, then increased to 98.62% and finally reached 98.90%.

7.3.2 Efficiency

7.3.2.1 Overall Relative Efficiency

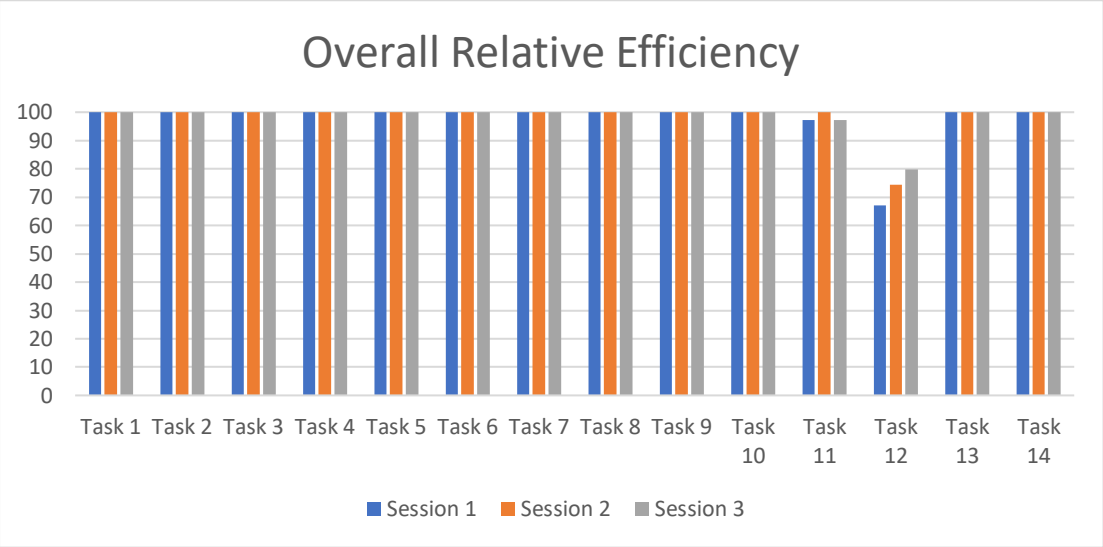

Figure 7.3 Akser Waznk's overall relative efficiency

Figure 7.3 describes each task's overall relative efficiency percentage over the three sessions. All tasks except tasks 11 and 12 scored 100% in all three sessions. The overall relative efficiency percentage of tasks 11 and 12 improved over the sessions. Task 11's overall relative efficiency percentage was 97.15% in session 1, which increased to 100% in session 2 but decreased to 97.23% by the third session. Task 12's overall relative

efficiency percentage started at 67.16% in session 1, then increased to 74.3% in session 2 and slightly rose again to reach 79.8% in session 3.

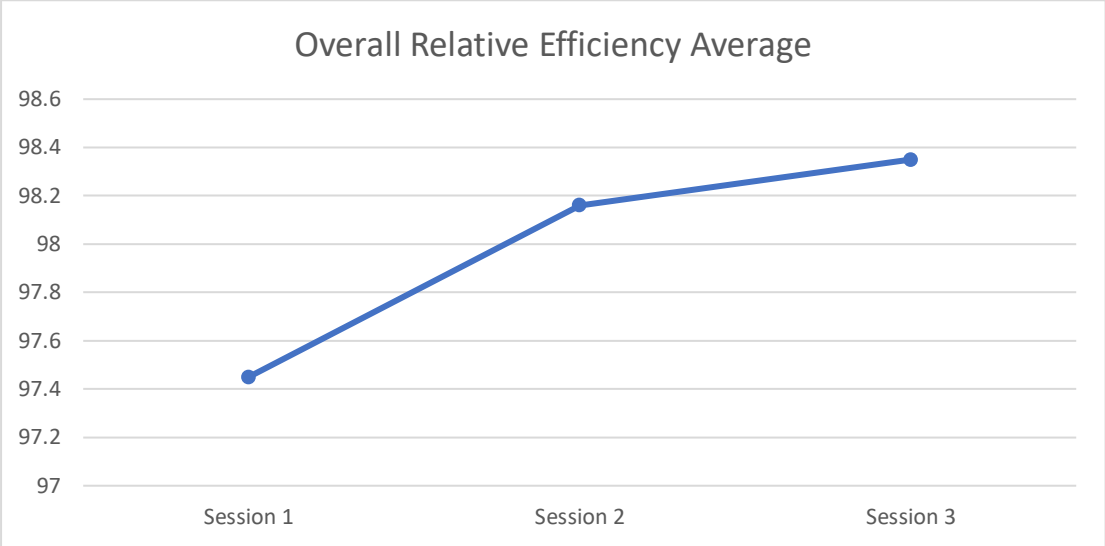

Figure 7.4 Akser Waznk's overall relative efficiency average

The average percentage for the overall relative efficiency improved across the three sessions. It started at 97.45%, then increased to 98.16% and finally reached 98.35%.

7.3.2.2 Time-Based Efficiency

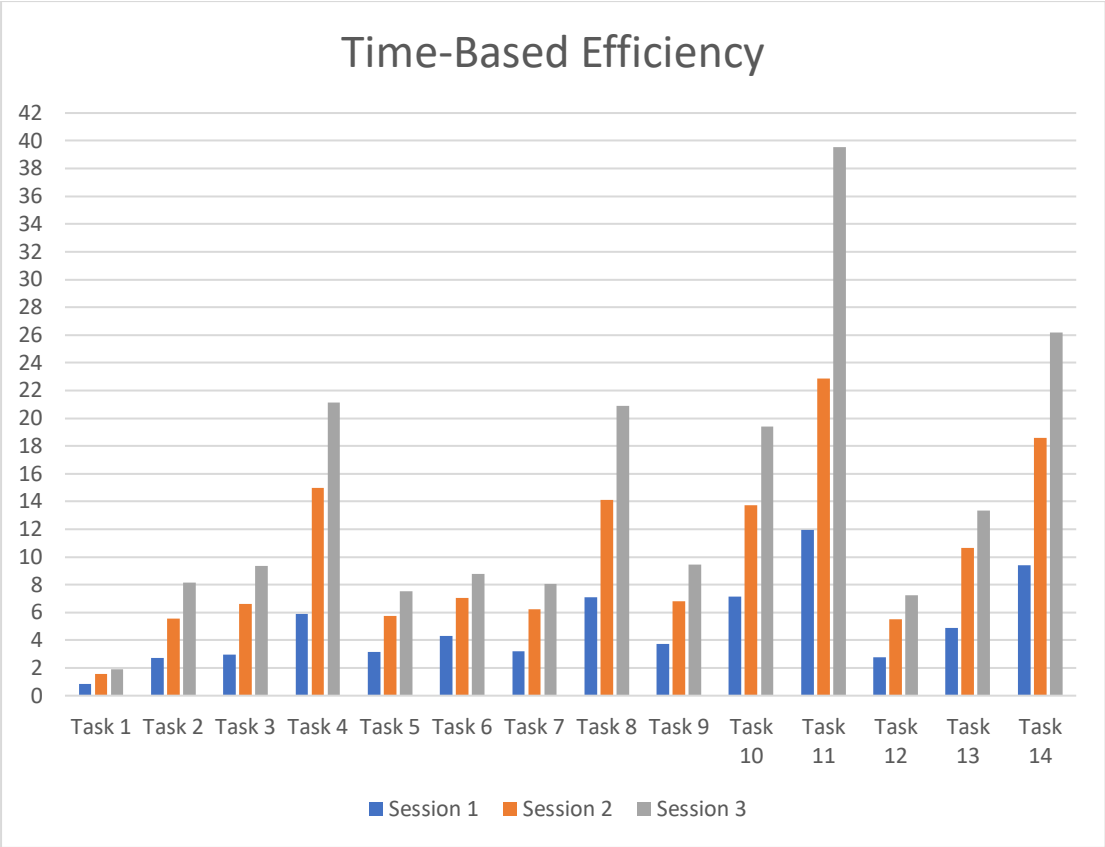

Figure 7.5 Akser Waznk's time-based efficiency

Figure 7.5 shows each task's time-based efficiency score over the three sessions. Task number 11 scored the highest time-based efficiency score out of the tasks. It started at 11.95 goals per second, then rose to 22.87 goals per second and, in the final session, reached 39.56 goals per second. Tasks 14, 8 and 4 scored the second, third and fourth highest time-based efficiency respectively. In contrast, task 1 scored the lowest time-based efficiency followed by tasks 12 and task 5.

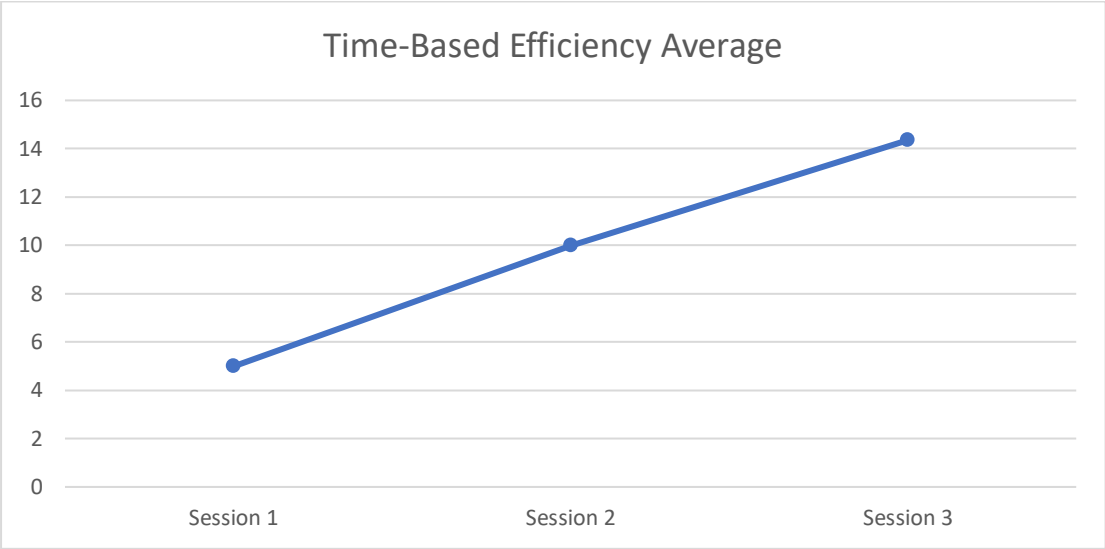

Figure 7.6 Akser Waznk's time-based efficiency average

The average score for the time-based efficiency improved over sessions. It started at 4.99 goals per second, and then rose to 9.99 goals per second and, by session three, it had increased to 14.35 goals per second.

7.3.3 Satisfaction

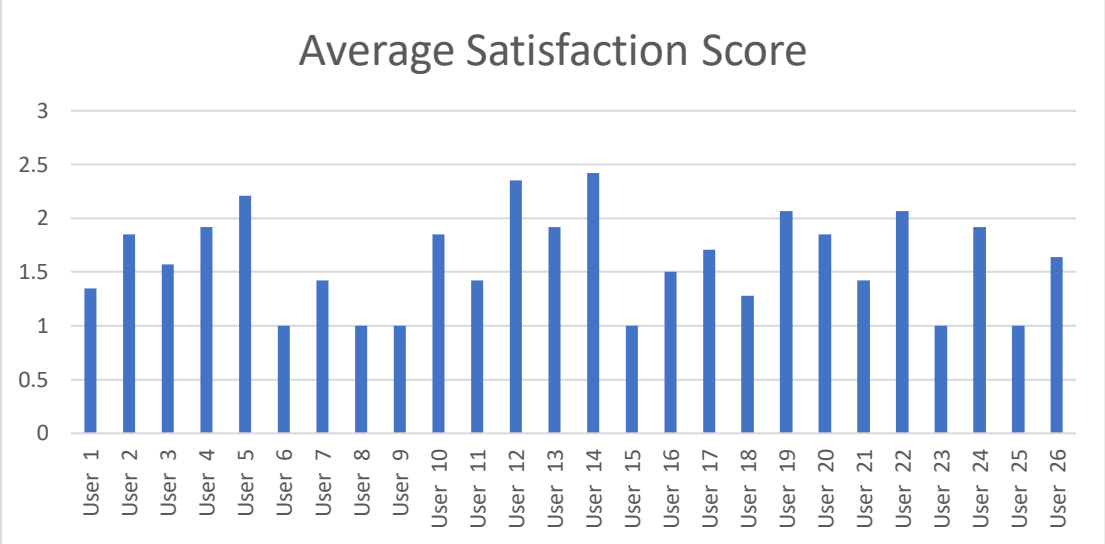

Figure 7.7 Akser Waznk's average satisfaction score

On average, all the potential users found performing and completing the tasks easy. Using a scale where 1 is very easy and 7 is very difficult, user 14 scoured the highest value at 2.42, followed by user 12 at 2.35. However, six users, (users 6, 8, 9, 15, 23 and 25) found performing the tasks really easy as they all scored the lowest value of 1.

7.3.4 Cognitive Load

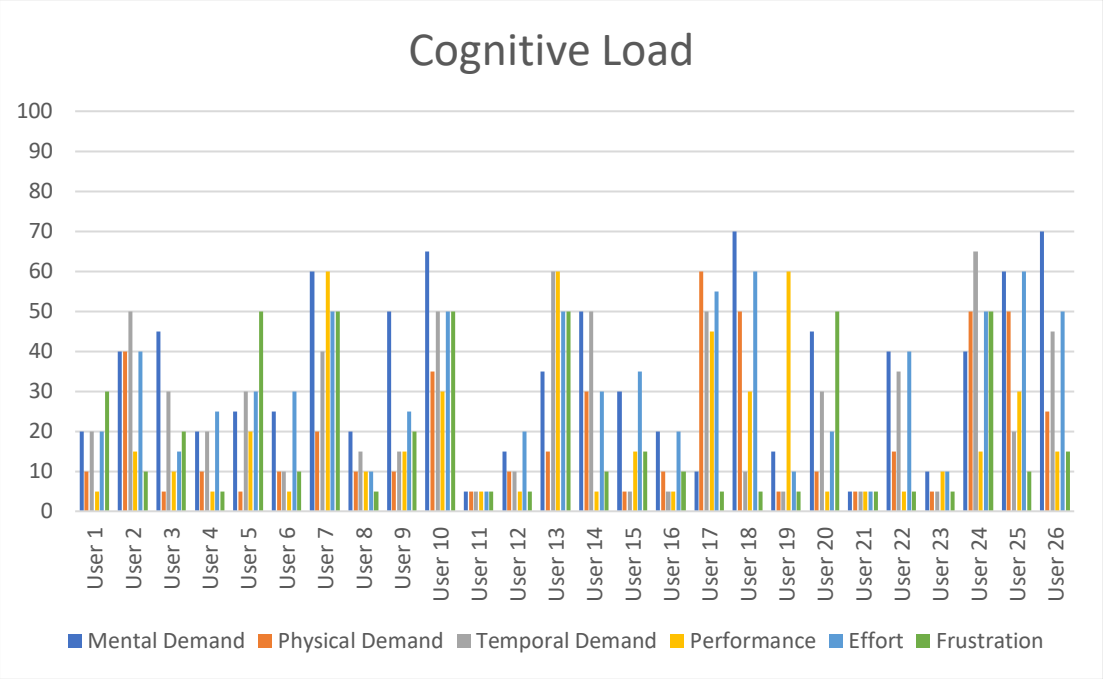

Figure 7.8 Akser Waznk users' rating for each subscale in cognitive load

Figure 7.8 presents each subscale score in the cognitive load for each potential user. The cognitive load of users 11 and 21 was the most consistent, as both users had a score of 5 for all of the subscales. User 23's cognitive loading was the second most consistent, with scores between physical, temporal demand and frustration at 5% and mental demand, performance and effort at 10%. The cognitive loading of users 18 and 20 was not consistent, as the gap between all of the subscales scores was high. The highest score for all potential users was for mental demand and the lowest scores were for performance, frustration and physical demand.

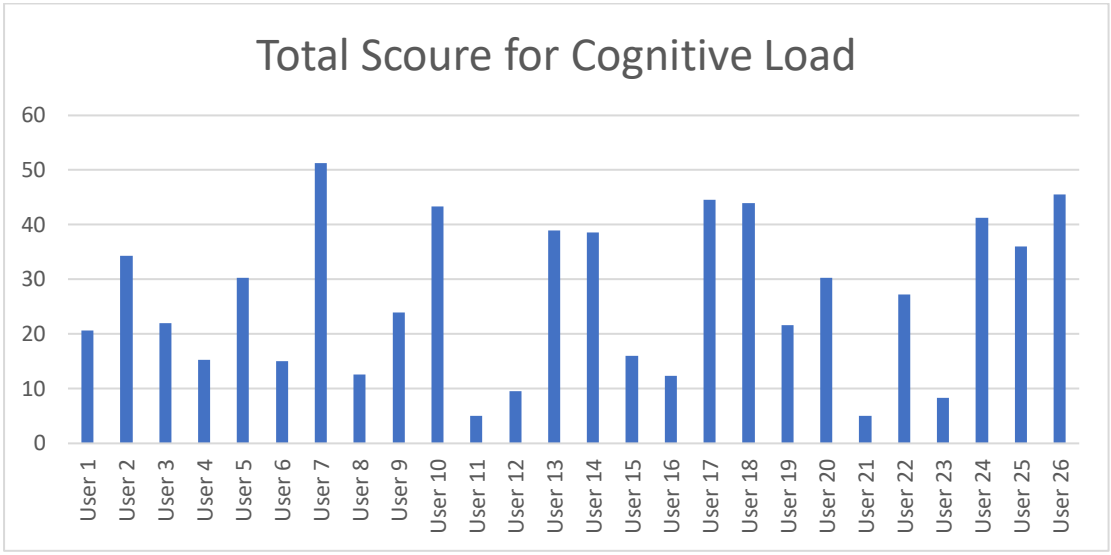

Figure 7.9 Akser Waznk's total score for cognitive load

Figure 7.9 shows the total score for the cognitive load for each user. User 7 had the highest percentage at 51.3%. The lowest percentage was for users 11 and 21 at 5%, followed by user 23 at 8.3%, user 12 at 9.6% and user 16 at 12.3%.

7.3.5 Errors

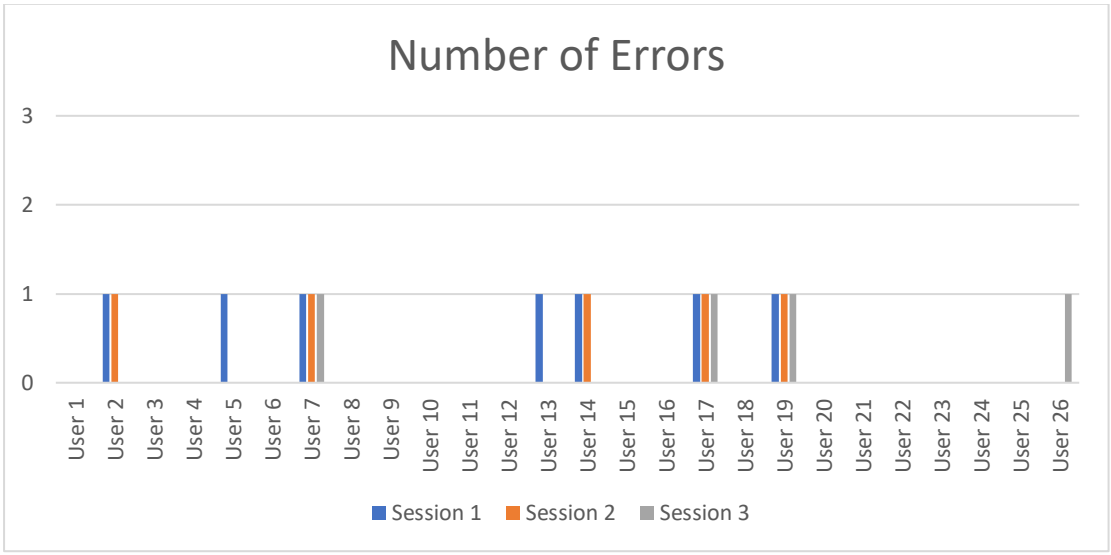

Figure 7.10 Akser Waznk's number of errors

Figure 7.10 demonstrates each user's number of errors made over the sessions. Users 2, 5, 7, 13, 14, 17, 19 and 26 made errors while performing the tasks. The error rates of users 2, 5, 13 and 14 started with one error each in session 1 but had decreased to 0 by the third session. The error rate of users 7, 17 and 19 was 1 in all the three sessions. User 26's error rate was 0 in both sessions 1 and 2 but one in session 3.

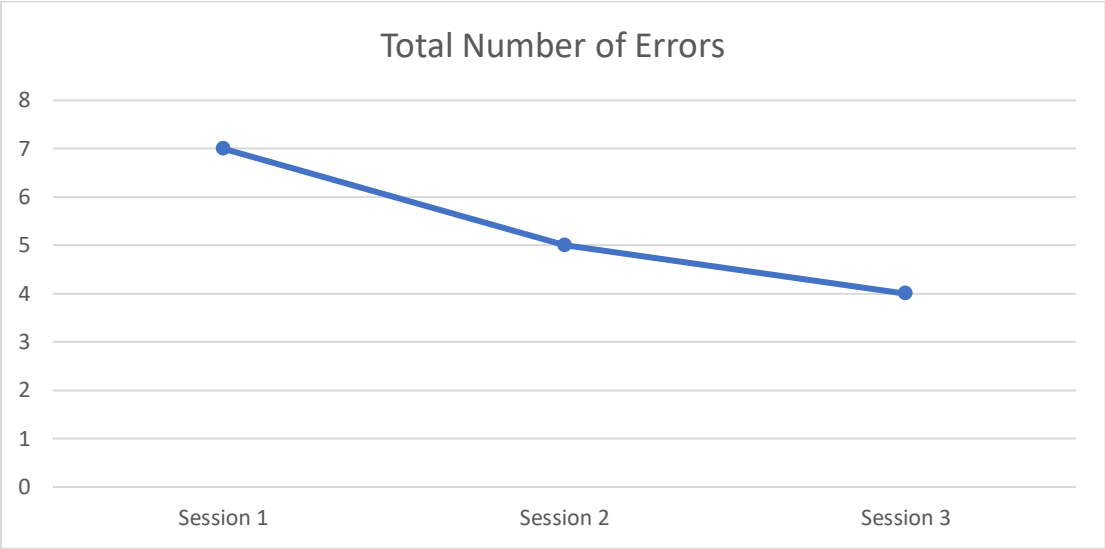

Figure 7.11 Akser Waznk's total number of errors

The total number of errors made by potential users decreased across sessions. It started with seven errors in session 1, decreased to five errors in session 2 and four errors in session 3.

7.4 Qualitative Results

7.4.1 Health professionals' analysis

As it mentioned in Chapter 5, the expert testing group was comprised of seven health professionals in total: five dietitians (three females and two males) and two male physical activity professionals. These testers evaluated the level of the accuracy of the app by analysing the app's information, advice and goals and they confirmed that the information and advice provided by the app was accurate according to their professional experience and knowledge. They had complete access to the app and its documentation. They stated that the Akser Waznk app meets all required criteria and its contents are effective and precise. The dietitians' criteria includes assessing users' current weight, calculating current BMI, determining ideal weight and allowing users to provide information regarding their health history and current status. In addition to this, this formula includes determining the daily caloric intake, suggesting six meals (three meals and three snacks), encouraging users to eat from the six food groups and describing appropriate food portions for meals. The physical activity professionals' criteria includes providing a variety of exercises attainable for people who experience obesity. This section includes showing the correct way for exercises to be done, explaining the

goals of each exercise, guiding users to perform a minimum of six exercises at least five times a week and encouraging daily walking.

Four of the dietitians responded positively to the app's ability to determine the recommended calorie intake and food portions. A female dietitian reported:

> *The app determines the daily calorie intake and the food portions for meals. It does not allow users to add more calories within meals and ensure that users eat from all the different groups of foods. It is important that patients eat fruits, vegetables and all other food groups and not only focus on eating protein and grains. This is what I liked most of all about the app; it helps patients to have a healthy diet.*

All of the dietitians stated that knowing obese patients' health history and current status is an important factor as it affects their diet and weight loss progress. A male dietitian stated:

> *Users can report more information regarding their health status. Patients with a chronic disease, for example diabetes, should not eat some specific kinds of food. As a dietitian, it's important to know our patients' health status and history and the app helps in doing that.*

The physical activity professionals liked the physical exercise section of the app and how the app provides specific information regarding each kind of exercise, such as the correct way to perform it and the reason for doing each exercise. A physical activity professional pointed out:

> *Through the app, people can see how exercises should be performed and know what the benefit is from doing them. I had several cases when people do exercises in the wrong way and then harm themselves and decide to stop practising.*

7.4.2 Users Interviews

7.4.2.1 What Users Liked About the App

Figure 7.12 What users liked about the app

Several users liked the screen design and the clarity of the registration process. User 2 said, "*To register as a new user was really easy. The process has only two screens, which were designed in a simple way*." In addition to this, users appreciated the ability to sign in to use the app using their social media accounts. User 9 said, "*I can use my Facebook account to use the app, it's great*." Moreover, many users liked that the app explain to them how their BMI and ideal weight was determined. User 7 said, "*This is the only app that I have used which explained to me how I can calculate my BMI value. I think it is important to inform app's users about the methods that it uses to know such a thing*." Also, user 12 said, "*Providing the equations that were used is a must step and this app did so*." Additionally, the majority of users liked the diet template and how the app encouraged them to eat in a healthy way. User 1 said, "*The app provided meals in a way that includes many dishes from different food groups, such as fruits, vegetables and protein*." Also, user 14 said, "*It helps me to eat in a healthy way*," User 21 said, "*What I liked most about the diet is that it specifies the serving size for each kind of food*." Furthermore, many users found the self-assessment to be a motivational feature that helped them to follow a heathy lifestyle. User 8 said, "*Each week I'll assess myself to*

see whether or not I was doing as it was recommended, which I believe will motivate me to have a healthy lifestyle."

The majority of users liked the physical activities section within the app. User 9 said, "*All the exercises have videos that show me how to perform them correctly*." Also, user 22 said,

> *The app has a variety of physical activities that I can do at home and each physical activity comes with information regarding the benefit from doing it and how can it be done. This is one of the greatest aspects of the app*.

Users also liked the gamification features and how they were contributing socially while walking towards the daily counting steps goal. User 7 stated that, *"Every time I walk, I remember that there are other people who will benefit from such walking. It is a good feeling and even encourages me to walk more and more."* User 15 said, "*The feature of the rewarding will motivate me to walk every day*." Also, the "Walk to the Mosque" function was appreciated by many users. User 14 said, "*I usually go to the mosque next to me. But, when I started using the app, I enabled the notification for the time of prayer and started to walk to faraway mosques as the app guides me toward them*."

The ability to self-monitor weight-loss progress and the ease of tracking daily activity and the consumption of both food and water were appreciated by the majority of users. User 1 reported:

> *All the tracking screens are in the main screen, I just scroll right and left, and all the information is there. It is great to know how many calories I had and how much is left. The same thing for the water consumption as well. What I liked most is the weight progress screen. When I updated my weight, I can see a chart that shows me the exact date of updating my weight and even in the screen there is my start, current and goal weight*

Users also liked the built-in chat feature and its screen design. User 14 said, "*I like to chat with other people and especially people who have the same interests*." Also, user 26 said, "*I don't go out much and was happy to know that through the app, I can chat and share my experience about losing weight and diet with other users*." The AR feature and how it can help to provide information regarding fitness equipment was also appreciated. User 6 pointed out that *"It is great and easy to use. This is the first app I*

used that has such a feature." Also, user 20 said, "*When I scanned the fitness equipment, the app showed me a video how to use it. That's great*."

The majority of the users liked the app's colour scheme and the variety of themes that they can choose from. User 8 said, *"I like the colours of the app but what I liked more is the ability to change the whole theme."* Also, 12 said, "*The app uses simple colour schemes which look nice.*" User 25 said, "*I loved the colours of the app*." In addition to this, the voice recognition function was appreciated as well. User 19 said, "*It was easy to use it. I just talk, and the app does the rest*."

7.4.2.2 What Users Disliked About the App

Regarding what potential users disliked about the app, while none of them stated any specific points, four potential users highlighted two usability issues. Two potential users believed that the app does not allow users to update their personal information, for example, current weight. User 7 reported, *"One of the questions asked me to change my weight and I wasn't able to do that. I used the app three times, and every time I failed. I don't think I can update my weight."* Also, user 19 said, *"I can't change my weight."* Another potential user claimed that the app does not help users to understand how to read labels on a food product. User 17 pointed out that *"I gave up, I don't think this app helps in reading food products' label."*

7.4.2.3 Suggestions for Future Version of the App

Figure 7.13 Users suggestions for future version of the app

Figure 7.13 shows potential users' most mentioned words regarding their suggestions to improve the app. Several users suggested that it would be good for users to be able to customise the colour scheme as well as the app's themes. In addition to this, some users wanted to receive notifications to remind them about meal times. One user mentioned that it would be good to have a tutorial on how to use the app. Another suggestion by the majority of users was to make the app integrate with fitness and watch trackers, such as Apple Watches. Also, several users suggested that this app should have sponsors or that users should have the ability to donate to charities when they have achieved their daily steps goal. In addition to this, three users recommended that an Android version of the app be provided, while a few users suggested that it would be better for future users to have the option to use the app without the need to go through the registration process at the beginning. A few users also suggested adding a VR feature in order to motivate users to do physical activities.

7.5 Usability Level Between Users

The results found that app's level of usability is different amongst potential users as users have diverse learning styles and technological literacy. Users 5 and 13 made mistakes only in the first session whereas users 2 and 14 made mistakes in both the first

and second session. User 26 made her only mistake in the third session. Users 7, 17 and 19 are only the users who made mistakes in all the three sessions. Moreover, user 14's average satisfaction score was the highest comparing to other users at 2.42 out of 7. The total score of the cognitive load for user 7 was the highest amongst users at 51.3%. Such differences between users is investigated by examining their video records from the usability testing and identifying the specific tasks in which they were not able to either perform correctly or complete. Considering their feedback from the recorded interviews, especially what they did not like about the app and their suggestions for improvement, is another compulsory step in the app development process.

7.6 Current Usability Issues and Solutions

7.6.1 Deep Navigation

One potential user faced difficulty when asked to locate the option for learning how to correctly read and understand labels on food products. Such an issue affects the app's usability, as users might need to keep navigating to find what they are looking for and thus increasing both the time and steps taken to locate it. The food label option in the beta version of the app is four levels below the Homescreen and users need to navigate the following levels to reach it:

- Homescreen
- Setting
- Useful information
- Food
- Read food label

This issue is addressed by enhancing the navigation for the food label option. Now, it is located just two levels below the Homescreen, as follows:

- Homescreen
- Food
- Read food label.

Due to this change, users will be required to perform fewer steps to find the food label option, thus decreasing the time needed compared to the previous design.

7.6.2 Option Location

The second usability issue is the location for updating users' information option compared to other options' location within the same screen. Figure 7.14 shows the old design for the settings screen where the option for the personal information is located on the top left corner of the screen. While analysing the video records for the usability testing, we found that six users did not recognise this option the first time they used the app and they were trying other options within the same screen.

Figure 7.14 Original design for the setting screen

This issue was addressed by changing the location of the personal information option so that it is located with the other options. Through this change, it is much easier to recognise the option as users only now need to look at one place.

Figure 7.15 New design for the setting screen

7.7 Discussion on the Results

Previous usability testing for two Arabic weight loss apps (Twazon and Aded Surat) showed that both apps' level of usability is low and users reported that they had difficulty using the apps. However, this is not the case with the usability testing of the Akser Waznk app. Overall, the app's usability level improved over the three sessions. The percentage score for potential users' effectiveness and efficiency (overall relative and time-based) performance was enhanced between session 1 and session 2 and again from session 2 to session 3. Furthermore, the total number of errors decreased across the three sessions. Based on the observed increase of scores, it is easy to learn how to use the Akser Waznk app and also easy to remember how to use it, which means that the app positively considers learnability and memorability attributes.

Moreover, the majority of potential users recorded a low ratio in the satisfaction questionnaire. This is positive because a low value means that the app is very easy to use. The average score for satisfaction for all the users is improved comparing to their results when they tested the Twazon and Aded Surat apps, as only one potential user assessed the Akser Waznk app difficulty, at 2.42 out of 7 as an average which was the highest whereas it was 3.86 and 3.85 out of 7 for the Twazon and Aded Surat apps respectively. Moreover, six users rated the whole task in Akser Waznk app as very easy and scored 1 as an average whereas only one user rated the whole task in Twazon app

as very easy and scored 1 as an average and none of the users rated the whole task in Aded Surat app as very easy and scored 1 as an average.

The total score for cognitive load for all the users except user 7 is better than their results when they tested Twazon and Aded Surat apps. Their recent total score for cognitive load was not that high; only user 7 scored 51.3%, which was the highest. This shows that the majority of potential users had the ability to complete tasks correctly when performing other actions, such as speaking to the examiners.

The 26 potential users (13 men and 13 women) also tested the Akser Waznk app to evaluate the app's performance and motivational features. The testing found that the app assisted numerous potential users to understand their weight-loss goals and techniques. Moreover, the testers reported that the app's design is aesthetically pleasing and that the majority of motivational features are user-friendly. In addition to this, a group of seven experts (five dietitians and two physical activity professionals) evaluated the app in terms of how accurate the information it provides is. According to their professional experience and knowledge, Akser Waznk app's information, advice and goals are accurate.

7.8 Conclusion

In this chapter, a quantitative and qualitative analysis for Akser Waznk app was presented. The analysis had the aim of determining the usability level for the app. The same 26 participants from the usability testing of Twazon and Aded Surat participated in the Akser Waznk usability testing. In addition to this, the same testing environment, techniques, procedures and analysis process that were explained in Chapter 3 and 4 were applied within the usability testing for Akser Waznk app. Moreover, the same health professionals who evaluated the contents of the tested apps in Chapter 5 evaluated Akser Waznk app's contents. Based on the quantitative and qualitative results, two usability issues were identified. However, proper solutions were presented and applied to address them. The chapter then ended with a discussion on the results which showed that Akser Waznk app has a high level of usability.

The next chapter concludes the thesis.

CHAPTER 8
CONCLUSION AND FUTURE WORK

Obesity refers to the process of storing extra energy in the body in the form of fat. It is estimated that 39% of adults globally are overweight and a total of 13% of the entire world's population are obese. Obesity is increasing at a rapid pace in Saudi Arabia, and it is believed that more than one-third (40%) of the population experiences this problem. Obesity causes health problems and raises the risks of hypertension, cancer and diabetes as well as cardiovascular and other diseases.

Some critical local factors have been identified that have caused the growth of the obesity problem in Saudi Arabia. These include the increase in wealth and greater development in the country that has brought with it changes in lifestyle, with easier access to cars and the increased acceptance of processed food leading to a change in diet. Other significant factors are a lack of exercise and the country's climate, which forces people to limit outdoor activities and stay indoors. Furthermore, cultural aspects, beliefs and restrictions, especially for women, could contribute to increasing the rate of being overweight and obese. Despite the widespread occurrence of obesity and overweight in Saudi Arabia, there is little treatment currently available. One of the most popular ways to decrease weight in the country is doing gastric and bariatric surgery because Saudis consider this to be the fastest and most effortless method, despite the side effects and risks associated with it.

Due to the health issues and illnesses which result from obesity, numerous experts have been encouraged to find effective solutions that overcome and then prevent obesity. The majority of research investigations conclude that performing physical activities and improving eating habits are the most efficient ways to lose weight and overcome obesity. However, several researchers believe that motivating people who suffer from obesity to positively change their lifestyle by doing more physical activities is not easy and, actually, is often very difficult. While there is a variety of research that discusses ways to motivate obese people to lose weight, one of the best methods is through behavioural change techniques. Moreover, several studies point out that behaviour interventions are

considered as one of the most effective techniques to change behaviour related to health and weigh loss. In addition to this, fitness and weight loss apps have been proven to be an effective intervention method that contribute to increasing the performance of physical activity levels due to their unique features.

The use of smartphones and apps is common in Saudi Arabia and the country is ranked as having the third largest global smartphone usage penetration at 73% as well as the largest global Twitter usage. The usage of smartphones and apps can assist Saudi citizens, specifically women, to interact publicly and socially in a virtual way when they cannot do that otherwise due to cultural restrictions. However, the success of any mobile app can be affected by its level of usability as this factor motivates users to use apps.

Usability is a multi-dimensional term that defines the extent to which a mobile app or device can help users to achieve specific goals in an efficient and effective way and how well it provides customer satisfaction. Therefore, a high level of usability in fitness and weight loss apps improves UX and affect the apps' success.

Despite the possibilities available with fitness and weight loss apps, at the time of conducting this research, the available Arabic fitness and weight loss apps do not consider the unique features that play an important role in motivating obese users to be active, improve their lifestyle and help them to lose weight and overcome obesity. They also do not adhere to the 13 evidence-informed practices for weight-loss management. Moreover, the current fitness and weight loss apps were not designed to provide a high level of usability by considering usability attributes and its factors. In addition to this, the available fitness and weight loss apps were developed without considering the effect of social and cultural norms of Saudi obese users (males and females), as potential users were not consulting during the development process to identify their use and requirements. Therefore, based on the major shortcomings in the exciting Arabic fitness and weight loss apps and the growing ubiquity of the use of smartphones and apps, developing an Arabic app that can be used as a tool to treat and stop obesity in Saudi society is vital.

This thesis presents validated and evaluated usability guidelines for designing a fitness and weight loss app to help obese users generally and Saudi users specifically to lose weight and overcome obesity. It also provides a technological solution through the

development of an advanced Arabic weight loss app called Akser Waznk, which aims to help obese Saudi users to lose weight and live healthier lifestyles.

This chapter is structured as the follows. First, an overview of the chapter is provided in this section. The next sections will discuss the research issues and the contributions of this thesis to address them. Then the potential impact of the Akser Waznk app among the Saudi users and community is discussed. Finally, I will outline the future work and conclude the chapter.

8.1 Issues Addressed in this Thesis

This thesis has the aim of addressing the critical gaps within the existing literature in regard to mobile fitness and weight loss app usability guidelines and motivational features helping users and specifically Saudis to lose weight and overcome obesity. In Chapter 2, a comprehensive review on the existing literature was provided. Based on this review, the following research issues as summarised below were addressed in this thesis:

1. Proposing the unique features that would motivate obese users and specifically Saudis to lose weight and overcome obesity;
2. Proposing the usability attributes to be considered while testing and developing mobile apps and fitness and weight loss apps specifically;
3. Proposing comprehensive usability guidelines for fitness and weight loss app;
4. Proposing numerous tools and features to address all the 13 evidence-informed practices for weight-loss interventions; and
5. Proposing a technological solution that is an advanced Arabic weight loss app that will contribute to decrease obesity rate in Saudi Arabia.

8.2 Contributions of the Thesis

The main contribution of this research work is to help obese users and specifically Saudis to lose weight and then overcome obesity by improving fitness and weight loss app usability guidelines and features. A brief overview in regard to the thesis' four principal contributions to address the gaps in the existent literature is provided in the following sub-sections.

8.2.1 A Comprehensive Survey on the Existent Literature: State-of-the-Art

An inclusive state-of-the-art survey in the existing literature in regard to fitness and weight loss app usability guidelines and motivational features to overcome obesity is documented within this thesis in Chapter 2. To the best of this researcher's knowledge, the survey of the literature that was conducted within this research work is the most inclusive so far in the existent literature. In order to discuss and evaluate it, the existent literature was split into the following main and secondary aspects:

1. Fitness and weight loss apps
    1.1. Fitness, weight loss apps and behaviour change
2. Mobile app usability and motivation
3. Usability
    3.1. Definition of usability
    3.2. History of usability
    3.3. Main usability models
    3.4. Usability attributes in mobile apps
    3.5. Factors affecting mobile apps usability
4. Obesity
    4.1. Obesity in Saudi Arabia
    4.2. Factors contributing to the increase of obesity in Saudi Arabia

After conducting the survey, a comprehensive analysis was performed to identify research gaps.

8.2.2 A Comprehensive Framework Methodology for Mobile App Usability Testing

Within this thesis and in Chapter 3, a comprehensive framework methodology for mobile app usability testing is documented. An inclusive illustration that is supported by the literature in regard to each layer within the framework and appropriate components from each layer for mobile app usability testing is provided and justified.

In addition to this, a detailed explanation in regard to the appropriate techniques and procedures for collecting data while conducting usability testing for mobile apps is also

documented and justified. To the best of this researcher's knowledge, this is the first research that used the specified multiple methods together to conduct usability testing for mobile apps. The methods used as described here:

1. Interview
2. Think aloud
3. Observation
4. Usability metrics
    4.1. Effectiveness
    4.2. Efficiency
    4.3. Satisfaction
    4.4. Cognitive load
    4.5. Errors
    4.6. Learnability
    4.7. Memorability

The usage of the above-mentioned methods helped in collecting quantitative and qualitative data that allows the research to determine the usability level of the tested Arabic fitness and weight loss apps, as presented in Chapter 4, and identified the reasons and factors for such levels, as presented in Chapter 5.

8.2.3 Usability Guidelines for Fitness and Weight loss Apps

Comprehensive usability guidelines for fitness and weight loss apps is documented in Chapter 5. To the best of this researcher's knowledge, this research provides the first detailed usability guidelines for fitness and weight loss apps. In order to discuss and evaluate the fitness and weight loss apps, the usability guidelines were divided into the following main five aspects:

1. Interactive design;
2. Graphic/visual design;
3. Health professionals' analysis;
4. User interviews; and
5. Recommendations.

The guidelines are unique as they were developed based on the outcomes of end-users (obese users) and health professionals (dietitians and physical activity professionals) as well as the literature investigation. The guidelines were illustrated by using figures and quotations from participants within the usability testing as well as the health professionals and the literature. The guidelines and the recommendations from this research work will be valuable for researchers and developers to help them to design effective and usable fitness and weight loss apps in the future.

8.2.4 Advanced Weight Loss App 'Akser Waznk'

An extensive explanation in regard to the Akser Waznk app's development process, motivation unique features, contents and design elements is documented in Chapter 6. The app was developed considering the results from Chapter 4 and 5. The Akser Waznk app is different from other Arabic fitness and weight loss apps in the following ways:

1. End-users and experts in the field of exercise and diets helped design the app and their requirements, feedback and recommendations were incorporated into the beta version;
2. The app is in line with all 13 evidence-informed practices for weight loss management;
3. Social network access for interacting with other app users is provided;
4. The app contains calorie counts of common Saudi foods;
5. The app's design considers usability attributes;
6. The app considers the social and cultural norms of Saudi citizens;
7. Users can view the history of their calorie consumption and exertion via a customised database;
8. The app has a gamification feature to encourage users to walk more;
9. The app provides information regarding the correct use of a fitness equipment via an AR feature;
10. The app supports voice commands;
11. The app encourages group-walking via the Let's Walk feature;
12. The app can guide users to mosques near their location via Walk to Mosque feature;

13. The app utilises several guidelines based on the European Commission's Code of Conduct on privacy for mobile health apps and EU's General Data Protection Regulation to guarantee users' security; and
14. The app applies an advanced level of security procedure encryption to protect users' data.

Based on the results from Chapter 7, the Akser Waznk app is determined to have a high level of usability, unique motivational features and accurate contents. To the best of this researcher's knowledge, this is the first Arabic weight loss app that was developed with the aim of to helping users to overcome obesity by including all the aforementioned aspects.

8.3 Akser Waznk app Potential Impact

Lacking nutritional knowledge, exercise, limitation for outdoor activities owing to Saudi Arabia's climate and restrictions especially for women are some of the critical local factors that contribute to increasing rates of obesity. Smartphones are becoming very popular in the country, and this is changing many dynamics of the conservative society. The Akser Waznk app aims to help people who suffer from obesity to lose weight and improve their overall lifestyle. The app is a low-cost alternative to traditional personal behavioral weight-loss programs as it considers the needs of Saudi obese users, unique living habits of the country, and provides several unique features that motivate users to monitor and track their food consumption and increase their physical activity. On the basis of the results of the experts' evaluation, potential users' usability testing, and feedback, it is believed that the usage of Akser Waznk app will decrease the obesity rate in the country.

Motivational features such as Let's Walk will encourage people to gather together to walk. As more than 92% of the Saudi population believe and follow the Islamic religion, the majority of people go to mosques 5 times a day. The Walk to Mosque feature will, therefore, contribute, providing attainable exercise with the potential to make it communal. It will encourage and guide users by giving them a choice of mosques near their location, and users will have the ability to choose to walk to a more distant mosque if they want to increase their walking distance. The app also provides a pedometer, allowing users to track their daily steps and when users reach their daily goal of walking,

they can donate a small amount to a charity. Users will be able to share their achievement with their peers within the built-in chat feature or with their friends on other social media platforms which will positively affect users' health behavior. The app will also encourage users to set up a goal to lose either 0.5 or 1 kilogram per week and will determine the daily calorie intake and the duration (in days or weeks) to reach their ideal weight. Including local food varieties and providing their ingredients and measurement in an easy way to be understood, such as spoons, cups, or hands, is another aspect that can motivate users to follow their diets. All of these and other features with the ease of use of the app will positively contribute in the acceptance of the app among the target group and help to decrease the rate of obesity in Saudi Arabia.

8.4 Conclusion and Future Work

The research which was described within this thesis has been published widely as a part of proceedings within peer-reviewed journals, book chapters and international conferences. Six publications in total have been published at the time of writing this thesis: three journal articles, two book chapters and one conference paper. In addition to this, two conference papers have been submitted and they are under review at this stage. The full list of publications that emerged as a result of conducting this research can be found in the front matter of this thesis. This research has also been nominated twice to be presented at the School of Electrical and Data Engineering Showcase and won the second award within the poster presentation category.

There are open issues and future directions which would play an important role in strengthening the proposed usability guidelines and the Akser Waznk app. This research can be continued in the following areas:

1. To develop Akser Waznk app on other popular mobile phone platforms, such as Android;
2. To integrate the developed app with smartwatch and fitness trackers to better collect physical activity data and analyse them;
3. To develop a VR feature within the proposed weight loss app to motivate users to lose weight; for example, as users walk on a treadmill or ride on a stationary bike, they can see themselves doing that in a virtual place, like foreign cities or woods;

4. To take advantage of the next generation of smartphones, folding phones, by conducting usability testing on them and keep updating the usability guidelines; and
5. To perform a one year pre- and post-intervention study with obese Saudis to better determine the effectiveness of the app on weight loss management. Users who lose at least 10% of their body weight will be the main endpoint for this study.

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APPENDICES

Appendix A: Research Ethics Approval

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Human Research Ethics Committee
Ethics Secretariat
C/O Research and Innovation Office
15 Broadway, Ultimo NSW 2007

T: +61 2 9514 9681
Research.Ethics@uts.edu.au

PO Box 123
Broadway
NSW 2007 Australia
www.uts.edu.au

UTS CRICOS PROVIDER CODE 00099F

21st September 2016

Associate Professor Valerie Carole Jeanne Gay
School of Electrical and Data Engineering
UNIVERSITY OF TECHNOLOGY SYDNEY

Dear Valerie,

UTS HREC ETH16-0833 – Associate Professor Valerie Carole Jeanne Gay; Mr Ryan Mansor A Alturki; – "Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia"

Thank you for your response to the Committee's comments. Your response satisfactorily addresses the concerns and questions raised by the Committee who agreed that the application now meets the requirements of the NHMRC National Statement on Ethical Conduct in Human Research (2007). I am pleased to inform you that ethics approval is now granted.

Your approval number is UTS HREC REF NO. ETH16-0833.
Approval will be for a period of five (5) years from the date of this correspondence subject to the provision of annual reports. Your approval number must be included in all participant material and advertisements. Any advertisements on the UTS Staff Connect without an approval number will be removed.

Please note that the ethical conduct of research is an on-going process. The *National Statement on Ethical Conduct in Research Involving Humans* requires us to obtain a report about the progress of the research, and in particular about any changes to the research which may have ethical implications. This report form must be completed at least annually, and at the end of the project (if it takes more than a year). The Ethics Secretariat will contact you when it is time to complete your first report.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

If you have any queries about your ethics clearance, or require any amendments to your research in the future, please do not hesitate to contact the Ethics Secretariat at the Research and Innovation Office, on 02 9514 9772.

Yours sincerely,

Professor Marion Haas
Chairperson
UTS Human Research Ethics Committee
C/- Research & Innovation Office
University of Technology, Sydney
E: Research.Ethics@uts.edu.au

Appendix B: Invitation Letter

INVITATION LETTER (Stage 1)

Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia

Dear ……..

My name is Ryan Alturki and I am a student at the University of Technology, Sydney.

I am conducting research on fitness mobile application usability and would welcome your assistance. The research will involve filling out a brief questioner, test two different fitness mobile applications and a semi-structured interview and should not take more than 1 hour and 15 minutes of your time. I have asked you to participate because you are in a position to provide informed opinions regarding the two fitness mobile applications.

If you are interested in participating, I would be glad if you would contact me, my supervisor Dr.Valerie Gay or the local independent contact person, Dr. Abdulrahamn Alaryni.

You are under no obligation to participate in this research.

Yours sincerely,

Email: Ryan.M.Alturki@student.uts.edu.au
Phone number: +61
Phone number: +966

Email: Valerie.Gay@uts.edu.au
Phone number: + 61 2 9514 4645

Email: dr.alaryni@hotmail.com
Phone number: +966

NOTE:
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 2478 Research.Ethics@uts.edu.au), and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

INVITATION LETTER (Stage 2)

Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia

Dear …….

My name is Ryan Alturki and I am a student at the University of Technology, Sydney.

I am conducting research on fitness mobile application usability and would welcome your assistance. The research will involve filling out a brief questioner, test a developed fitness mobile application and a semi-structured interview and should not take more than 1 hour and 10 minutes of your time. I have asked you to participate because you are in a position to provide informed opinions regarding the two fitness mobile applications.

If you are interested in participating, I would be glad if you would contact me, my supervisor Dr.Valerie Gay or the local independent contact person, Dr. Abdulrahamn Alaryni.

You are under no obligation to participate in this research.

Yours sincerely,

Email: Ryan.M.Alturki@student.uts.edu.au
Phone number: +61
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Email: Valerie.Gay@uts.edu.au
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Appendix C: Participant Information Sheet

PARTICIPANT INFORMATION SHEET (Stage 1)
Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia
Education UTS HREC Approval No. ETH16-0833

WHO IS DOING THE RESEARCH?

My name is Ryan Alturki and I am a student at UTS. My supervisor is Dr. Valerie Gay
Email: Valerie.Gay@uts.edu.au
Phone number: +61 2 9514 4645

WHAT IS THIS RESEARCH ABOUT?

This research aims at identifying how to improve usability and user experience in fitness mobile application. The aim of this research is to make fitness mobile applications more usable and help people who suffer from obesity to lose more weight and to keep them motivated.

IF I SAY YES, WHAT WILL IT INVOLVE?

I will invite you to test two different fitness mobile applications. In the beginning, you will fill out a brief questioner that will take you approximately 5 minutes to complete. Then, you will test two different fitness mobile applications. “Twazon” and “Aded Surat”. This should take you approximately 40 minutes to complete and it will be screen recorded. Finally, you will participate in a 15 minutes semi-structured interview that will be audio recorded.

ARE THERE ANY RISKS/INCONVENIENCE?

While no harm is intended, invasion of privacy, embarrassment or distress may result in unforeseen ways. You will be reporting and discussing your experience, which will require some level of personal disclosure. While the testing is anonymous, there is a small chance that you may feel privately embarrassed if you not managed to perform a task correctly the first time. Please be aware that you won't be judged on your performance we are only seeking your personal opinion on the apps and it’s usability.

Please be aware that participation in this research is voluntary and you are free to withdraw from participating in this research at any time without consequences.

WHY HAVE I BEEN ASKED?

You have been asked to participate because this experiment is designed for people who are suffering from obesity and are motivated to lose weight and you are in a position to provide informed opinions regarding the two fitness mobile applications.

DO I HAVE TO SAY YES?

Participation in this research is voluntary.

WHAT WILL HAPPEN IF I SAY NO?

You are free to withdraw from participating in this research at any time without consequences. I will thank you for your time so far and won’t contact you about this research again.

IF I SAY YES, CAN I CHANGE MY MIND LATER?

You can change your mind at any time. However, changing your mind after data collection may affect analysis and research outcomes. Please advise as soon as possible of any intension to withdraw. I will thank you for your time so far.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I, my supervisor or or the local independent contact person Dr. Abdulrahamn Alaryni can help you with, please feel free to contact us on:

Email: Ryan.M.Alturki@student.uts.edu.au
Phone number: +61

Phone number: +966

Email: Valerie.Gay@uts.edu.au
Phone number: + 61 2 9514 4645

Email: dr.alaryni@hotmail.com
Phone number: +966

NOTE:
This study has been approved by the University of Technology Sydney Human Research Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au), and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

PARTICIPANT INFORMATION SHEET (Stage 2)
Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia
Education UTS HREC Approval No. ETH16-0833

WHO IS DOING THE RESEARCH?

My name is Ryan Alturki and I am a student at UTS. My supervisor is Dr. Valerie Gay
Email: Valerie.Gay@uts.edu.au
Phone number: +61 2 9514 4645

WHAT IS THIS RESEARCH ABOUT?

This research aims at identifying how to improve usability and user experience in fitness mobile application. The aim of this research is to make fitness mobile applications more usable and help people who suffer from obesity to lose more weight and to keep them motivated.

IF I SAY YES, WHAT WILL IT INVOLVE?

I will invite you to test a fitness mobile application. In the beginning, you will fill out a brief questioner that will take you approximately 5 minutes to complete. Then, you will test a developed fitness mobile application. This should take you approximately 30 minutes to complete and it will be screen recorded. Finally, you will participate in a 15 minutes semi-structured interview that will be audio recorded.

ARE THERE ANY RISKS/INCONVENIENCE?

While no harm is intended, invasion of privacy, embarrassment or distress may result in unforeseen ways. You will be reporting and discussing your experience, which will require some level of personal disclosure. While the testing is anonymous, there is a small chance that you may feel privately embarrassed if you not managed to perform a task correctly the first time. Please be aware that you won't be judged on your performance we are only seeking your personal opinion on the apps and it's usability.

Please be aware that participation in this research is voluntary and you are free to withdraw from participating in this research at any time without consequences.

WHY HAVE I BEEN ASKED?

You have been asked to participate because this experiment is designed for people who are suffering from obesity and are motivated to lose weight and you are in a position to provide informed opinions regarding the two fitness mobile applications.

DO I HAVE TO SAY YES?

Participation in this research is voluntary.

WHAT WILL HAPPEN IF I SAY NO?

You are free to withdraw from participating in this research at any time without consequences. I will thank you for your time so far and won't contact you about this research again.

IF I SAY YES, CAN I CHANGE MY MIND LATER?

You can change your mind at any time. However, changing your mind after data collection may affect analysis and research outcomes. Please advise as soon as possible of any intension to withdraw. I will thank you for your time so far.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I, my supervisor or the local independent contact person Dr. Abdulrahamn Alaryni can help you with, please feel free to contact us on:

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NOTE:
This study has been approved by the University of Technology Sydney Human Research Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au), and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix D: Informed Consent Form

INFORMED CONSENT FORM (Stage 1)
Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia
Education UTS HREC Approval No. ETH16-0833

I _____ agree to participate in the research project "Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia" UTS HREC Approval No. ETH16-0833 being conducted by Ryan Alturki C/O PO Box 123 Broadway, NSW 2007; +61 2-9514-7605.

I understand that the purpose of this study is to identifying how to improve "usability" and the user experience while using fitness mobile applications. The aim of this research is to make fitness mobile applications more usable and to help people who suffer from obesity stay motivated.

I understand that I have been asked to participate in this research because I am in a position to provide informed opinions regarding the two fitness mobile applications and that my participation in this research will involve testing two different fitness mobile applications. In the beginning, I will fill out a brief questioner that will take me approximately 5 minutes to complete. Then, I will test two different fitness mobile applications. "Twazon" and "Aded Surat". This should take me approximately 40 minutes to complete and it will be screen recorded. Finally, I will participate in a 15 minutes semi-structured interview that will be audio recorded.

While no harm is intended, invasion of privacy, embarrassment or distress may result in unforeseen ways. You will be reporting and discussing your experience, which will require some level of personal disclosure. While the testing is anonymous, there is a small chance that you may feel privately embarrassed if you not managed to perform a task correctly the first time. Please be aware that you won't be judged on your performance we are only seeking your personal opinion on the apps and it's usability.

Please be aware that participation in this research is voluntary and you are free to withdraw from participating in this research at any time without consequences.

I agree to be:
☐ Audio recorded
☐ Video recorded

I agree to keep confidential all information including all conversations and discussions, materials and methods provided to me by the UTS research team.

I agree that the research data gathered from this project may be published in a form that:
☐ Does not identify me in any way

I am aware that I can contact Ryan Alturki or the local independent contact person, Dr. Abdulrahamn Alaryni via his email: dr.alaryni@hotmail.com or mobile number: +966 [redacted] if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that Ryan Alturki has answered all my questions fully and clearly.

_____ ____/____/____
Name and Signature (participant) Date

_____ ____/____/____
Name and Signature (researcher or delegate) Date

NOTE:
This study has been approved by the University of Technology Sydney Human Research Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

INFORMED CONSENT FORM (Stage 2)
Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia
Education UTS HREC Approval No. ETH16-0833

I _____ agree to participate in the research project "Improving Mobile Fitness Application Usability Guidelines to Help Users Reach Their Health and Fitness Goals, Case Study: Obesity Apps in Saudi Arabia" UTS HREC Approval No. ETH16-0833 being conducted by Ryan Alturki C/O PO Box 123 Broadway, NSW 2007; +61 2-9514-7605.

I understand that the purpose of this study is to identifying how to improve "usability" and the user experience while using fitness mobile applications. The aim of this research is to make fitness mobile applications more usable and to help people who suffer from obesity stay motivated.

I understand that I have been asked to participate in this research because this experiment is designed for people who are suffering from obesity and are motivated to lose weight and I am in a position to provide informed opinions regarding a developed fitness mobile application and that my participation in this research will involve testing the developed fitness mobile application. In the beginning, I will fill out a brief questioner that will take me approximately 5 minutes to complete. Then, I will test a developed fitness mobile applications. This should take me approximately 30 minutes to complete and it will be screen recorded. Finally, I will participate in a 15 minutes semi-structured interview that will be audio recorded.

While no harm is intended, invasion of privacy, embarrassment or distress may result in unforeseen ways. You will be reporting and discussing your experience, which will require some level of personal disclosure. While the testing is anonymous, there is a small chance that you may feel privately embarrassed if you not managed to perform a task correctly the first time. Please be aware that you won't be judged on your performance we are only seeking your personal opinion on the apps and it's usability.

Please be aware that participation in this research is voluntary and you are free to withdraw from participating in this research at any time without consequences.

I agree to be:
☐ Audio recorded
☐ Video recorded

I agree to keep confidential all information including all conversations and discussions, materials and methods provided to me by the UTS research team.

I agree that the research data gathered from this project may be published in a form that:
☐ Does not identify me in any way

I am aware that I can contact Ryan Alturki or the local independent contact person, Dr. Abdulrahamn Alaryni via his email: dr.alaryni@hotmail.com or mobile number: +966 [redacted] if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that Ryan Alturki has answered all my questions fully and clearly.

_____	____/____/____
Name and Signature (participant)	Date
_____	____/____/____
Name and Signature (researcher or delegate)	Date

NOTE:
This study has been approved by the University of Technology Sydney Human Research Ethics Committee (UTS HREC). If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au, and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

Appendix E: Participants' Information Questionnaire

1. What is your gender?
    - Male
    - Female
    - Prefer not to say

2. What is your age?
    - 18 to 24
    - 25 to 34
    - 35 to 44
    - 45 to 54
    - 55 to 64
    - 65 to 74
    - 75 or older
    - Prefer not to say

3. What is your occupation?
    - …….
    - Prefer not to say

4. What is the type of phone that it will be used?
    - ……..

Appendix F: Usability Tasks

Twazon

1- Make an account and fill out all the information.
2- Add the activity, “running for 20 minutes”.
3- Record that you ate an orange in the breakfast meal.
4- Find out how many calories in that orange.
5- Add a note “buy oranges”.
6- Make this comment to the previous note “it works”.
7- Add this friend “Ryan 1234”.
8- Find the dinner example and replace “Mac Chicken” with “Potato wedges”.
9- Read the example of the nutrition label.
10- Add that you “drank 6 cups of water”.
11- Change the notification feature to once in a week.
12- Change your weight to 80.5kg.
13- Answer the oil enquires in the healthy food palm.
14- Sign out from the app.

Aded Surat

1- Make an account and fill out all the information.
2- Add the activity “running in the minimum speed for 20 minutes”.
3- Find the activity that you just added.
4- Add the activity to the favorite list.
5- Add a diner meal that contain “2 Chicken Shawarma Normal Bread “and save it.
6- Add the previous dinner to the next day dinner.
7- Add that you drank 3 cups of water.
8- Read an advice about the hunger.
9- Read the information chart regarding all meals that you have saved “per day and week”.
10- Adds a reminder to a lunch meal at 1.30 pm.
11- Read the newest topic regrading weight lose that is written by the society.
12- Write this comment “Thank You” in the topic.
13- Review what you have done for this day.
14- Change your weight to 70.5 kg.

Akser Waznk

1- Make an account and fill out all the information.
2- Add the activity, “running for 20 minutes”.
3- Add a Bed time snack meal.
4- Find out how many calories in that meal.
5- Send the word “Hi” to Naser.
6- Adds a reminder to the day at 1.30 pm.
7- Adjust the target number of daily steps to 10 steps.
8- Change the theme of the app.
9- Find when “almaghrib” prayer time.
10- Add that you “drank 2 bottles of water that have the size of 350ml”.
11- Read the example of the nutrition label.
12- Change your weight to 80.5kg.
13- Donate to Makkah charity.
14- Review what you have done for this day.