‘Smartphone Medical Applications: Technology Acceptance and Usage by Medical Students’ in Irish Universities.’

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A dissertation submitted to the University of Dublin

in partial fulfilment of the requirements for the degree of

MSc in Management of Information Systems

1st September 2015

Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work, and has not been submitted as an exercise for a degree at this or any other university. I further declare that this research has been carried out in full compliance with the ethical research requirements of the School of Computer Science and Statistics.

Signed: _____

Kenneth Waters

1st September 2015

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Abstract

With the increasing rise worldwide of smartphones and subsequent ownership, smartphone medical applications' are increasing in popularity. In this study the technology acceptance and usage of smartphone medical applications by students' in Irish medical universities is examined. The theoretical model of the extended unified theory of acceptance and use of technology (UTUAT2) of Venkatesh, Thong, and Xu (2012) was applied.

The research was conducted in three medical universities in Ireland using a probability sampling methodology. Data was collected from 310 respondents using an online survey from the 4th of May to the 9th of June, 2015. The results highlighted high levels of usage of smartphones medical applications. The constructs of performance expectancy, social influence, hedonic motivation, habit and facilitating conditions had a significant effect on behavioural intention in the model but the price value construct was found not significant.

The findings of this research indicate that universities' should focus on incorporating smartphone medical applications into their syllabi and support the information retrieval by sponsoring smartphone medical applications or simply creating them from scratch to provide a quality product that medical students' can utilize throughout their professional career. In conclusion the technology providers should consider the usage and acceptance patterns emerging from this empirical research.

Keywords: Smartphones, Smartphone Medical Applications, Unified Theory of Acceptance and Usage of Technology, (UTAUT2).

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Abbreviations

ACGME	Accreditation Council for Graduate Medical Education
ANOVA	Analysis of Variance
BI	Behavioural Intention
EE	Effort Expectancy
FC	Facilitating Conditions
HB	Habit
HM	Hedonic Motivation
ICT	Information and Communications Technology
IDT	Innovation Diffusion Theory
iOS	iPhone Operating System
MHRA	Medicines and Healthcare Products Regulatory Agency
MPCU	Model of PC Utilisation
NUIG	National University of Ireland Galway
PE	Performance Expectancy
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
PV	Price Value
RCSI	Royal College of Surgeons in Ireland
SCT	Social Cognitive Theory
SI	Social Influence
SMA	Smartphone Medical Applications
SPSS	Statistical Package for the Social Sciences
TAM	Technology Acceptance Model
TAM2	Extended Technology Acceptance Model
TCD	Trinity College Dublin

TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UB	Use Behaviour
UCC	University College Cork
UCD	University College Dublin
UK	United Kingdom
UTAUT	Unified Theory Acceptance and Use of Technology
UTAUT2	Extended Theory of Acceptance and Use of Technology

1.0 Introduction

Smartphone application usage has become widespread in the past several years, with each iteration of smartphone offering increased computing power and operating systems that facilitate application downloads. The increase in smartphone usage is according to (Baheti, et al., 2014, p.60) facilitating the connectivity of medical students' to smartphone medical applications. The possibility of regularly updateable applications is changing the information systems retrieval of medical students' and healthcare professionals. Robinson, et al., (2013), state that smartphone medical applications are used as a supplement to usual learning methods.

The objective of this study is to determine the factors influencing medical students' usage and acceptance of smartphone medical applications in Irish Universities.

1.1 Context and Background

The purpose of the study is to analyse and determine factors that influence the technology acceptance and usage of smartphone medical applications by undergraduate medical students enrolled in university medical schools' in Ireland. The justification for this academic research is to identify whether or not smartphone medical applications are being used as part of the everyday information systems retrieval of medical students' in Ireland. Robinson, et al., (2013, p.5) recommend that research should be carried out to evaluate the use of the latest smartphone devices. Franko & Tirrell, (2012) report that Apple in 2008 created a specific medical applications category in their App Store, they reports a trend of usage across the medical community in the United States. The screenshot in (Figure 1), highlights a smartphone medical application which is used by students and professionals in Galway University Hospitals, which can be found in the iTunes App store.

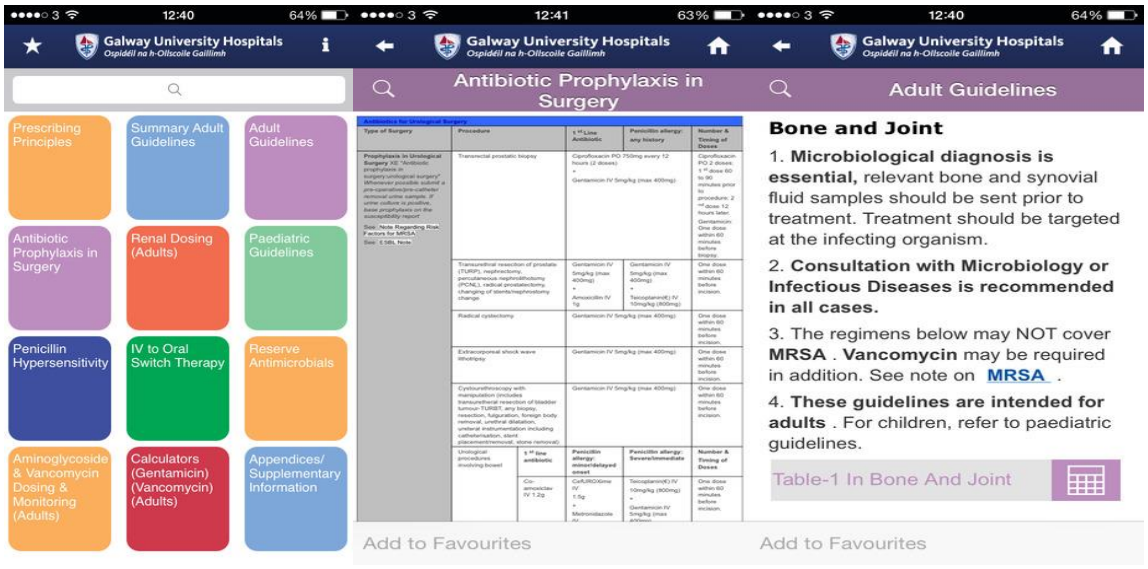

Figure 1.1 - GAPP Guidelines Galway University Hospitals (GUH) Antimicrobial Prescribing Guidelines Application Screenshots, (Apple Inc., 2015).

1.2 Research Question

The primary research question being asked in this study is;

"What is the technology acceptance and usage of smartphone medical applications by medical students' in Irish Universities?"

A secondary question that arises is;

"How are smartphone medical applications being used by medical students' in Irish Universities?"

The research question is: What is the technology acceptance and use of smartphone medical applications by medical students in Irish Universities?

The research question of this study has been prompted by the study of (Franko & Tirrell, 2012). In their study they evaluated the use of smartphones and smartphone apps by providers at medical centres. This research will focus on medical undergraduate students' studying in Irish universities.

1.3 Research Interest and Beneficiaries

This dissertation may be of interest to medical university schools, medical students', medical application providers and software manufacturers. The findings of this research could be useful to medical professionals in the course of their everyday information systems retrieval. The survey responses could direct smartphone medical application providers to provide medical applications developed in conjunction with university medical schools' and publish more frequently updated medical information content.

1.4 Scope of the Study

This work focuses on medical students', 18 years of age and over currently studying in the Schools of Medicine in Irish Universities. The study specifically focuses on the technology acceptance and usage of smartphone medical applications as part of their Information Systems retrieval.

A probabilistic survey approach was considered as it provides a representative sample of the student population in medical Universities in Ireland. The study is limited to the University Medical schools' in Ireland. The research is explanatory in nature.

1.5 Timeframe of Study

The timeframe of this study is from December 2014 to September 2015. The literature review was conducted from December 2014 through to March 2015. The literature review was also revisited throughout the duration of the study. Ethical approval for the online survey was sought and granted in April, 2015 by the School of Computer Science and Statistics Research Ethics Committee, Trinity College Dublin. The online survey was issued for a period of ten weeks from May to July, 2015. The analysis of the data was conducted in July and August, 2015.

1.6 Chapter Structure

The structure of this dissertation is divided into the following chapters.

Chapter 1 - Introduction

This chapter outlines the background, context and rationale for the research. It will provide an overview of the research question and state why and to whom the research question is important. It will state the scope of the study and the research timeline.

Chapter 2 - Literature Review

This chapter reviews the literature relating to technology acceptance and usage theory and theoretical models. It also describes smartphone medical applications, their growth and acceptance.

Chapter 3 - Methodology and Fieldwork

This chapter investigates the methodological approaches that were considered. It will provide a justification as to why the approach chosen was appropriate in comparison to other methodologies. A brief discussion is detailed as to shortcomings of the research methodology employed. An explanation of how the research was conducted and the type of research used is also provided. Explanations of the data gathering mechanism, population, sampling frame, access, analysis of data, problems which arose and lessons learned are also discussed.

Chapter 4 - Findings and Analysis

This chapter states the findings of the research and analyses and interprets these findings. It also reports what these findings disclosed.

Chapter 5 - Conclusions and Future Work

This chapter will show that the research question has been answered and highlight new outcomes. It will discuss the universality of the findings and how the research advances theoretical and practical knowledge. It will also highlight limitations of the research findings and possible future research directions.

Chapter 6 – References

Chapter 7 – Appendices

This chapter will contain the research ethical approval letters, research indemnity letter and online survey questionnaire.

2.0 Literature Review

2.1 Introduction

The literature review examines smartphone medical applications, technology acceptance and usage theories and then proposes an appropriate model of acceptance and usage theory that will guide the future direction of this study.

2.2 Smartphone Medical Applications

Smartphone medical applications are the software applications that can be run on a smartphone with or without a wireless connection to the internet, (U.S. Food and Drug Administration, 2015). These medical application categories were created by the Apple iTunes App Store in 2008. According to (PocketGamer, 2015), 38,376 medical applications are available to download in the Apple iTunes App Store. This is 2% of the overall total of applications available in their marketplace. In the Google Play App Store as reported by (AppBrain, 2015), there are 25,568 medical applications, representing 1% of their overall total of applications. According to Statista Statistics Portal, (2015), the approximate number of apps that are expected to be downloaded worldwide in 2017 is 268.69 billion. This is also the figure quoted by Gartner, (2015) in (Table 2.1).

Table 2.1 - Mobile App Store Downloads, Worldwide, 2010-2016 (Millions of Downloads), Source, Gartner, (2015).

Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
Free Downloads	57,331	92,876	127,704	167,054	211,313	253,914
Paid-for Downloads	6,654	9,186	11,105	12,574	13,488	14,778
Total Downloads	**63,985**	**102,062**	**138,809**	**179,628**	**224,801**	**268,692**
Free Downloads %	*89.6*	*91.0*	*92.0*	*93.0*	*94.0*	*94.5*

2.3 Smartphones

Smartphones are becoming ubiquitous and developments in processing speeds and capabilities ever increasing. Smartphone medical applications from an information systems perspective are becoming increasingly commonplace among medical students' and healthcare professionals. Although smartphone medical applications usage is increasing, there is a paucity of literature on the subject. According to (Robinson, et al., 2013), in a study of 361, clinical medical students at the University of Birmingham, UK, 37% reported using a smartphone to support their learning. Furthermore, at the University of Leeds, UK, it has a programme that issues iPhones to medical students in their fourth and fifth years. Boyce, (2012, p.209), states that students are given electronic handbooks and Formularies on these iPhones and there is a "dedicated application" that allows the possibility of uploading information to an "online portfolio" while they are on work placement. The support of this research by (Payne, et al., 2012) suggests that smartphone medical applications usage among medical students and doctors is worthy of further research. Smartphone medical applications allow medical students and clinicians to access and transfer data instantly. There is a gap in the literature in Ireland as to the technology usage and acceptance of smartphone medical applications by medical students'. Baheti, et al., (2014) highlight some smartphone medical applications in their review and propose their technological integration into medical education and clinical practice.

In Ireland, smartphone penetration has reached 59%, (Commission for Communications Regulation, 2014). The leading smartphone operating system is Apple (54%), Samsung (26%), Sony (4%), HTC (4%) and Asus (1%). The reported usage of Windows operating systems on smartphones was (1%) with Blackberry (0%), (Kennedy, 2015).

2.4 Smartphone Medical Applications Studies

In a study of smartphone medical applications in the UK by (Payne, et al., 2012), they reported that 79% of medical students'and junior doctors surveyed (n = 203/ 257) owned a smartphone and of these, the iPhone had 56.6% usage, with Google Play supported android smartphones accounting for 18.7% usage. The usage of smartphone medical applications in this study highlights an interesting difference between the student in pre-clinical education, (years 1 – 2) and those in their clinical years , (years 3 – 5). The student respondents' in their pre-clinical years primarily used medical applications for education, citing revision and learning as the

main reason for use, while the students' in their clinical years used applications to supplement their clinical decision making. In a study by Abeynaike (2012,), it reported that researchers using smartphones in a medical research laboratory were more productive but benefits of using smartphone applications were not significant enough to outweigh their concerns of health and safety, security and distraction.

This theme of risk assessment is also reported in a survey undertaken by (Moore & Jayewardene, 2014) with only 24% (n = 82 / 416) of nurses and 23% (n = 334 / 416) of doctors performing a risk assessment of the smartphone medical applications utilised. Carter, et al., (2014) report a 91% smartphone ownership among surgical trainees in a national study in Scotland, the iPhone ownership rate was 80%, (n = 56/ 70), HTC Android platform phone ownership of 6%, (n = 4/ 70) and Blackberry ownership 4%, (n = 3/ 70). The percentage of downloads of smartphone medical applications was 82%.

Franko & Tirrell, (2012), indicate that over 85% of respondents to their survey report using a smartphone, (n = 3,306) with 63.5% using medical applications. These studies highlight smartphone ownership and medical application usage but there is a lack of generalizability outside of the Accreditation Council for Graduate Medical Education (ACGME) in the United States.

2.5 M-learning

In education there is a movement towards the support of digital learning through all devices and platforms, m-learning is according to (UNESCO, 2015), the use of information and communications technology at anytime and in any location.

2.6 Application Regulation

There are some issues with using smartphone medical applications as reported in the literature, these areas include privacy, security and confidentiality, infection and pathogen transmission issues and loss of device containing confidential data. Ethical and medico-legal issues are also concerns that have been flagged, (Carey, et al., 2015). In the UK, the Medicines and Healthcare products Regulatory Agency (MHRA) are the authority that are tasked with the regulation of smartphone medical applications. (MHRA, 2015)

2.7 Technology Acceptance Model

One of the most influential contributions over the last three decades is the Technology Acceptance Model, (Davis, 1989). The Technology Acceptance Model contains two factors which are perceived usefulness (PU) and perceived ease of use (PEOU). In the literature, few studies have been carried out on usage experience and intention to use smartphone medical applications, (Wang, et al., 2014). The factor of perceived usefulness is described as the belief that a technological system would increase job performance within an organisational setting, (Davis, et al., 1989). The factor of perceived ease of use is the belief that using a technological system will be free from effort, (Davis, et al., 1989). The Technology Acceptance Model explains technology acceptance and user behaviour of IT users. A limitation of the TAM model according to (Benbasat & Barki, 2007) is that the scales that are used in the model only measure if the "technology is useful" or "easy to use".

TAM was an advancement of the theory of reasoned action (TRA), Fishbein & Ajzen, (1975). The TRA suggests theorizes that an individual's attitude towards a behaviour and their subjective norms influence their behavioural intention. Their subjective norms according to (Fishbein & Ajzen, 1975), is the individual's belief that people that are important to them think that they should perform the behaviour. The theory was extended to incorporate beliefs of an individual about the user acceptance. The theory of planned behaviour (TPB) contains three beliefs, attitude towards a behaviour, subjective norm and perceived behavioural control.

2.8 Technology Accceptance Model (TAM2)

The extended TAM which included subjective norm, image and voluntariness. Venkatesh & Davis, (2000), included a mandatory effect on perceived usefulness and intention to use a technology. The longitudinal field study carried out was significant in that they predicted from 44% - 57 % variance in perceived usefulness and between 37% - 52% in usage intention (Venkatesh & Davis, 2000, p. 195). Four longitudinal studies involving two mandatory and two voluntary with points in time being measured, after training, one month after implementation, three months after implementation. The sample size was 156 people pooled across the four organisations each period giving a n = 468. In this model of technology acceptance carried out in an organisational setting with mandatory technology usage. This model would not be considered as the conceptual model due to the fact that smartphone

application usage is voluntary and is carried out by the consumer. The use of smartphone medical applications technology is generally speaking voluntary and it is personal.

2.9 UTUAT – Unified Theory of Acceptance and Use of Technology

UTAUT as posited by (Venkatesh, et al., 2003), is the consolidation of eight models of information systems usage behaviour. The UTAUT is used in the acceptance literature to examine technology acceptance and use by employees within organisations. The key constructs in the UTUAT that influence behavioural intention to use a technology are performance expectancy, effort expectancy and social influence while behavioural intention and facilitating conditions influence use behaviour. In their comparison they compared the models of Theory of Reasoned Action (TRA), Technology Acceptance Model (TAM), Motivational Model (MM), Theory of Planned Behaviour (TPB), Combined TAM and TPB (C-TAM-TPB), Model of PC Utilisation (MPCU), Innovation Diffusion Theory (IDT) and Social Cognitive Theory (SCT). After the eight models were compared the UTUAT was formulated leaving the constructs of performance expectancy, effort expectancy, social influence and facilitating conditions. In the UTUAT the moderators are, gender, age, experience and voluntariness. Social influence is defined as the "degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh, et al., 2003, p. 451). Social influence costructs of contains the subjective norm, social factors and image. The subjective norm or "influence of on the user's decision to use or not to use the technology", (Venkatesh, et al., 2003). Social influence in a voluntary context will have an impact on the behavioural intention of the technology thus leading to greater internalisation and identification.

2.10 Research Model and Hypotheses Presentation

The UTAUT2 extended the UTAUT model into the consumer context. Added to the initial four constructs of performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC). The three new constructs of hedonic motivation (HM), price value (PV) and habit (HB) are added into the model to fit the model to a consumer technology usage setting.

2.11 UTAUT2 – Extended Unified Theory of Acceptance and Use of Technology

The unified theory of acceptance and use of technology (UTAUT2) model explains a larger variance in the model constructs of behavioural intention with an increase from 56% to 74% and technology use increasing from 40% to 52%, from the UTUAT model (Venkatesh, et al., 2012). In the UTUAT2 model the addition of hedonic motivation, price value and habit with a link from facilitating conditions to behavioural intention. The moderating relationships of age, gender and experience are also linked to the constructs of hedonic motivation, price value and habit.

Performance expectancy is defined as "the degree to which using a technology will provide benefits to consumers in performing certain activities" (Venkatesh, et al., 2012, p. 159). In this research performance expectancy is defined as the level of usefulness of smartphone medical applications, whether smartphone medical applications are easy to understand and overall more productive for students' in performing their tasks.

Therefore the following hypothesis is proposed;

H 1: Performance expectancy (PE) will influence behavioural intention (BI) positively to use smartphone medical applications.

Effort expectancy is defined as "the degree of ease associated with consumers' use of technology" (Venkatesh, et al., 2012, p. 159). In the context of smartphone medical applications usage, if students' find that the applications are easy to access, easy to use, clear and understandable and that they become familiar with the technology as they are using it. Therefore the following hypothesis is proposed;

H 2: Effort expectancy (EE) will have a positive influence on behavioural intention (BI) to use smartphone medical applications.

Social influence is defined as "the extent to which that consumers perceive that important others believe that they should use a particular technology" (Venkatesh, et al., 2012, p. 159). In the context of smartphone medical applications if students' are influenced by people who are important to them they will be more inclined to use smartphone medical applications. Also, people who influence the usage behaviour of applications and whose opinions that they value are influences on the medical students' usage.

Therefore the following hypothesis is proposed;

H 3: Social influence (SI) impacts positively to behavioural intention (BI) to use smartphone medical applications.

Facilitating conditions are defined as the "consumers' perception of the resources and support available to perform a behaviour", (Venkatesh, et al., 2012, p. 159). In the context of smartphone medical applications having the resources necessary, compatible technologies and knowledge to use the applications will mean that the consumer has a positive set of facilitating conditions and will be more likely to use. Facilitating conditions will influence use behaviour and intention.

Therefore the following hypothesis is proposed;

H 4: Facilitating conditions (FC) impacts positively on behavioural intention (BI) to use smartphone medical applications.

H 9: Facilitating conditions (FC) impacts positively on use behaviour (UB) to use smartphone medical applications.

The moderators of age, gender and experience will have an effect on intention to use and actual usage.

Venkatesh, et al., (2012), updated the UTUAT model and incorporated three new constructs, these constructs are hedonic motivation, price value and habit. This model will be utilised as the conceptual model for the research on smartphone medical applications technology acceptance and usage by medical students in Irish universities.

Hedonic motivation can be defined as "the fun or pleasure derived from using a technology", (Venkatesh, et al., 2012, p. 161). In the context of smartphone medical applications the greater the value of return from using smartphone medical applications over other sources of information will lead to greater intention to use the technology. Therefore the following hypothesis is proposed;

H 5: Hedonic Motivation (HM) impacts positively on behavioural intention (BI) to use smartphone medical applications.

Price value can be defined as "consumers' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using them", (Venkatesh, et al., 2012, p. 161). In the context of smartphone medical applications the price value is deemed to be positive when the cost of the application is less than the benefit that is gained by using the technology. Therefore we hypothesize;

H 6: Price value (PV) impacts positively on behavioural intention (BI) to use smartphone medical applications.

Habit is defined as "the extent to which people tend to perform behaviours automatically because of learning", (Limayem, et al., 2007). Previous use of a technology is according to (Kim & Malhotra, 2005), a predictor of future usage. Therefore in the context of smartphone medical applications, previous usage in the downloading of an application and the regular usage of the application in terms of usage is considered to be a determining factor for automaticity to occur. Therefore the following hypotheses is proposed;

H 7: Habit (HB) impacts positively on behavioural intention (BI) to use smartphone medical applications.

H 10: Habit (HB) impacts positively on use behaviour (UB) to use smartphone medical applications.

Behavioural intention has an impact on technology use (Venkatesh, et al., 2012). Therefore in the context of smartphone medical applications the intention to use applications in the future, planning to use them corroborates the behavioural intention on technology use. Therefore the following hypothesis is proposed;

H 8: Behavioural intention (BI) impacts positively on use behaviour (UB) to use smartphone medical applications.

The age construct will be dropped from the model as undergraduate students' in medical universities will be within the same age demographic. The gender and experience constructs will also be dropped from the model but will be tested individually without the interaction facilitating conditions, price value, hedonic motivation, habit or behavioural intention.

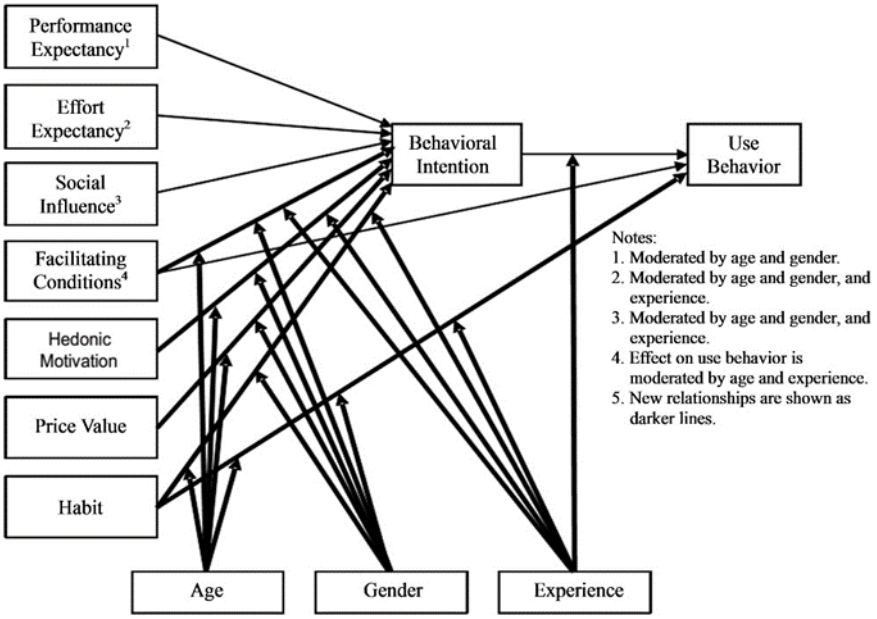

FIGURE 2.1 – Unified Theory of Acceptance and Usage of Technology (UTAUT2), (Venkatesh, et al., 2012, p. 160).

Updated UTAUT2 Model

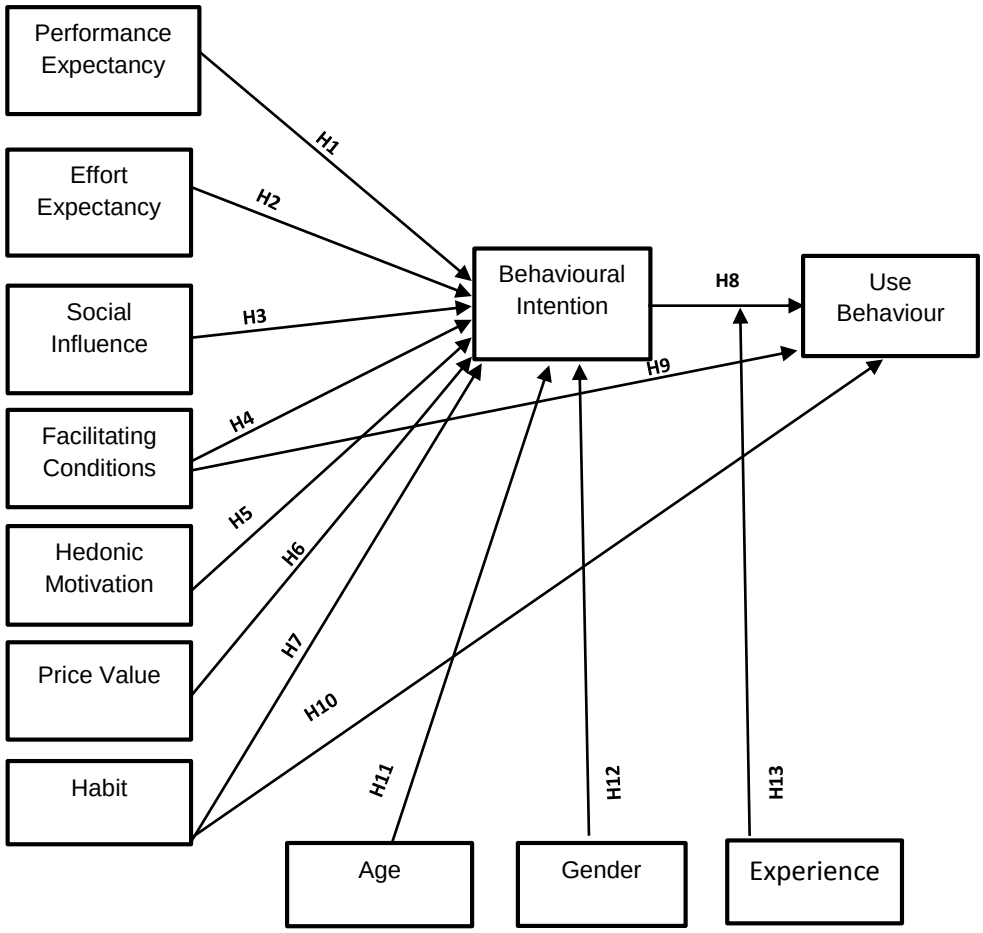

Figure 2.2 – UTAUT2 Conceptual Model.

2.12 Research Model

In the UTAUT2 conceptual model above (Figure 2.2), the constructs of performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), hedonic motivation (HM), price value (PV) and habit (HB) will be utilised to explain the behavioural intention to use smartphone medical applications by medical students' in Irish Universities.

2.13 Research Question

The UTAUT2 was selected as the theoretical framework for this research. The objective of this study is to determine the technology acceptance and usage of medical students' in Irish universities of smartphone medical applications. To answer the primary research question of this study

"What is the technology acceptance and usage of smartphone medical applications by medical students' in Irish universities?"

- "How are smartphone medical applications being used by medical students in Irish Universities?"

2.14 Summary

This research examined which theoretical model would be appropriate in examinining the technology acceptance and usage of smartphone medical applications. The consumer setting in this research specifically examines use by university medical students' at Irish Universities.

The research was prompted by the suggestion of Venkatesh, et al., (2012, p. 173) to test the extended unified theory of acceptance and use of technology (UTAUT2) in "different countries, different age groups and different technologies".

3.0 Methodology and Fieldwork

3.1 Introduction

The chapter gives an overview of the methodological approaches and research strategies considered as part of this study. The chapter will also discuss a rationale for the research approach chosen, sample selection, how the data was collected, limitations of the research methods, ethical considerations and lessons learned from the research procedures.

3.2 Research Methodology

The Research 'Onion'

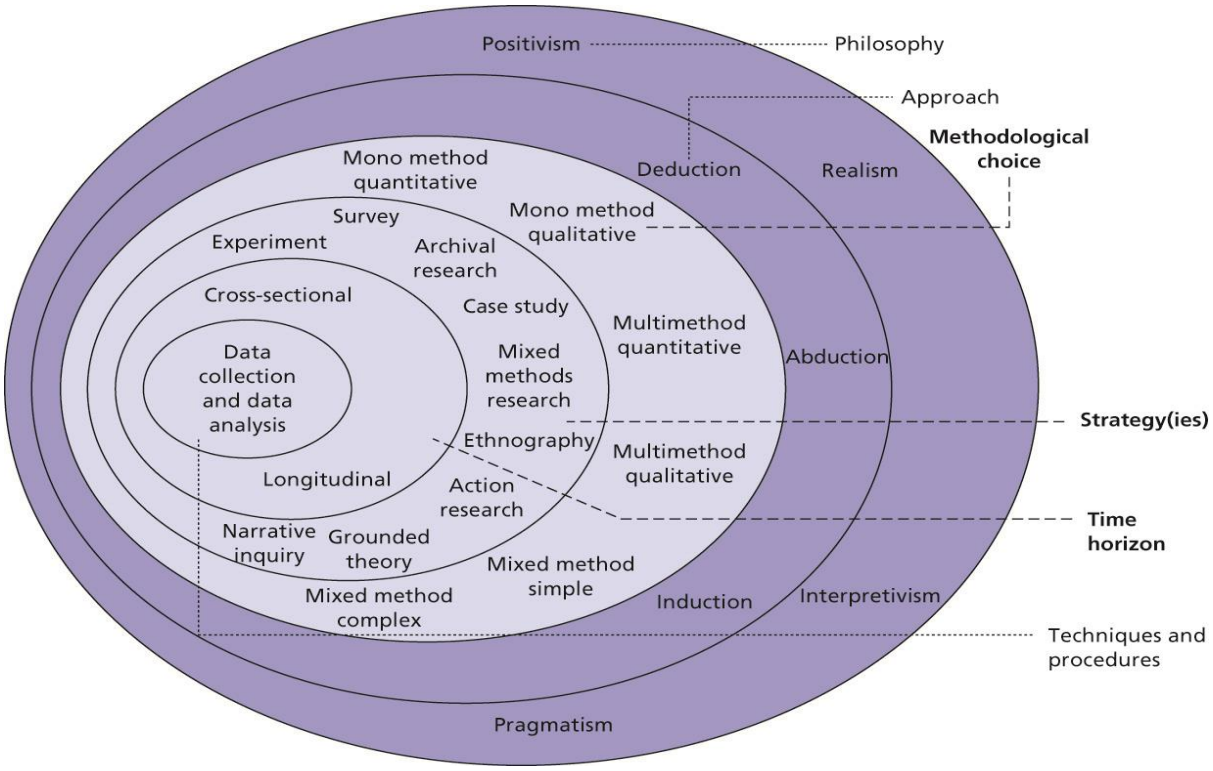

FIGURE 3.1 - The Research 'Onion'

Source: Mark Saunders, Philip Lewis and Adrian Thornhill, 2012, p.160.

Saunders, Lewis and Thornhill, (2012, p.127), posit that any researcher that is commencing research is pursuing the "development of knowledge." All research that attempts to answer a specific research question is invariably adding to the development of knowledge. There are many research philosophical choices for a researcher to make. The research philosophy will form the foundation of the research strategy and research methods employed. It is important for any researcher to support their philosophical choices as there is not one choice that is superior. The research philosophies which researchers may consider, include; Positivism, Realism, Interpretivism and Pragmatism. The outer layer of the research "onion" (Figure 3.1) as proposed by Saunders, Lewis and Thornhill, (2012), highlight these. In guiding this research the layers of the research "onion" model were used, working from the outer layer inwards.

3.2.1 Selection of Research Philosophy

3.2.2 Positivism

Positivist research is the collection of data allowing for the testing of hypotheses which are generated by a quantifiable means and the gathering of facts. Positivism states that an observable reality exists independent of people and can be objectively measured by using valid and reliable measurements, (Kim, 2003). In positivist research empirical methods are employed to ensure verification of reliability, objectivity and the non-influence of what is being investigated. Positivist research should be entered into in a value-free way by the researcher, (Saunders, Lewis and Thornhill, 2012). Positivist research would likely use a structured methodology which aids repeatability, (Creswell, 2014). Positivist research is commonly associated with quantitative methods of data collection and analysis.

3.2.3 Realism

The philosophy of realism is related to scientific enquiry. Realism is similar to positivism in that it adopts a scientific approach. There is two types of realism: direct realism and critical realism. According to Saunders, Lewis and Thornhill, (2012, p.136), direct realism is concerned with what we experience with our senses and what is actually there. Critical realism supports the idea of, what we experience as being sensations or a representation of reality and the mental process that takes place after the sensation is intuited. Critical realism combines different research methods, "mixed-method research or multimethodology", (Mingers, Mutch, Willcocks, 2013, p.797, Mingers, 2004, p.100).

3.2.4 Interpretivism

The Interpretivist philosophy adopts the approach that the researcher searches out the views of participants through their research. It is vital that the researcher understands and interprets differences between "humans in our role as social actors", Saunders, Lewis and Thornhill, (2012, p.137). Johari, (2009) citing Glaser and Strass, (1967) states that interpretivism is the best epistemology for researchers to interpret, analyse and understand participants. Research using an inductive approach and the use of qualitative methods is generally associated with interpretivism, Nandhakumar and Jones, (1997) posit that this is not always the case as reinterpretations exist with data produced from different methods. In interpretivism the researcher is not value free as they are involved in the enquiry and their background and experience change the perceptions of both parties. Generally speaking, interpretivist research data collection is with small samples which apply in-depth investigation.

3.2.5 Pragmatism

Pragmatism is a research philosophy that is guided by the research question. Pragmatism is usually concerned with mixed methods research. The research usually incorporates either qualitative, quantitative or a combination of both research methods in a mixed methods study (Burke Johnson & Onwuegbuzie, 2004). This philosophy allows the researcher to interpret the data from both objective and subjective points of view.

3.2.6 Research Approach

The research philosophy chosen for this study was pragmatism. According to (Mertens, 2009) pragmatism allows for a theory to be tested. Pragmatism is commonly associated with mixed method designs. In this study a dual approach was selected which utilised a hybrid concurrent embedded mixed methods research methodology with an overall positivist philosophy, (Tashakkori & Creswell, 2007). This design according to Tashakkori & Teddlie, (2010), incorporating a fixed mixed method approach with the use of quantitative and qualitative methods that were implemented from the beginning of the research process will allow for more coherent conclusions and inferences. The research had a quantitative priority with the point of inference embedded and mixed at the level of design. The research also implemented quantitative and qualitative strands of research in a single phase.

The design is a hybrid concurrent embedded mixed methods approach driven by a quantitative orientation with point of inference mixed at the level of design.

The hybrid concurrent embedded mixed methods research design allowed participants to provide structured and unstructured responses in the questionnaire to obtain different types of data.

The research design is explanatory as it is establishing relationships between technology acceptance and usage of medical students and smartphone medical applications.

3.3 Selection of Research Strategy

The deductive researcher works from the general to the specific, (Creswell, 2014). Deduction is concerned with the development of a theory which then must be tested leading to a hypothesis or hypotheses. A deductive research methodology would be structured to aid repeatability and ensure reliability. Finally deduction needs a sample of sufficient size so that inferences may be made about a more general population. Deduction is closely associated with positivist and pragmatist approaches. Induction is usually concerned with qualitative data and is more exploratory in nature and was not used in this research.

The research strategies that were considered were: experiment, survey, archival research, case study, ethnography, action research, grounded theory and narrative inquiry (Saunders, Lewis and Thornhill, 2012, p 173). Both experiment and surveys are generally used in quantitative research design. The research strategies of archival research or case study usually involve quantitative or qualitative research or a mix of the two. The strategy of archival reasearch was not considered as administrative data was not available on smartphone medical application usage, Saunders, Lewis and Thornhill, (2012). A case study strategy was also rejected as no organisation was identified to carry out the research in. Ethnographic research requires access to an organisation, lengthy timescale and participant observation, this strategy was also rejected. Action research's participatory nature is critical to the theoretical knowledge, experience and practical application within organisations. Action research is generally medium to long term in duration and longitudinal. This strategy was also rejected due to time considerations, (Reason, 2006). Grounded theory is usually commonly associated with research that moves between induction and deduction, (Strauss & Corbin, 1998). Grounded theory generally speaking is time consuming and requires that the researcher will be absorbed in the research process. This strategy was rejected also. Lastly Narrative enquiry was also considered and it is associated with being mainly a qualitative research strategy. Narrative enquiry also generates a large amount of data and is time consuming. As the research was not interpretative nor qualitative it was also not considered.

According to Saunders, Lewis and Thornhill, (2012), the survey is the most common research approach in deductive research. The data can be analysed using descriptive and inferential statistics. The survey strategy using probability sampling will produce findings that are representative of the whole population. The survey was the research strategy chosen for this research.

3.4 Selection of Research Method Choices

The research methodological choice chosen was multiple methods, mixed model, concurrent mixed methods within a single-phase of data collection and analysis.

3.5 Selection of Time Horizon

The research is a cross-sectional design. As the degree schedule was from October, 2014 to September, 2015, there was insufficient time to carry out a longitudinal study. A cross-sectional study is a study of particular phenomena at a given point in time. Saunders, Lewis and Thornhill, (2012, p. 190), state that longitudinal research is concerned with the observation of a phenomena over an extended period. With regard to the research in question, the survey was kept open for two months, commencing on the 4th of May, 2015 and closing on the 9th of July, 2015. This time horizon was deemed prudent in accessing the sample population.

3.6 Data Collection Method Section

The research was created and conducted using a self-administered online voluntary questionnaire using an online survey tool from www.surveymonkey.com, (Palo Alto, California) to collect the data required. Confidentiality and anonymity was guaranteed to participants' at all times in line with the School of Computer Science and Statistics, Trinity College Dublin, ethical protocols.

The questionnaire was split into three sections. The first part introduced respondents to smartphone medical applications and asked if students' owned a smartphone. The second part of the questionnaire measured smartphone medical applications technology acceptance and usage. The third part of the questionnaire gathered demographic information about respondents and also informed them of the option to enter a separate prize draw for a chance to win one of three Amazon gift vouchers.

3.7 Limitation of Methodology

The problem of self-selection bias is a limitation of online surveys. This is the bias of those respondents who ignore the survey completely while others participate.

3.8 Ethics Committees

In line with ethics protocol an application was prepared and sent to the School of Computer Science and Statistics Ethics Committee in Trinity College Dublin for consideration and approval. The application was sent on the 9th of April, 2015. Some amendments and minor revisions were required, specifically to the survey exiting protocols adding wording after every question to remind respondents that they may exit at any time without penalty. No further amendments were required and ethical approval was granted in April, 2015.

External research ethical approval was sought from University College Cork, University College Dublin, National University of Ireland Galway, Trinity College Dublin, Royal College of Surgeons in Ireland and Queens University Belfast Schools' of Medicine. This ethical approval consisted of individual ethical approval applications to the Schools' of Medicine ethics committees in the first instance. After external ethical approval was granted permission was then required from the Dean of Medicine in each Medical School to survey students. The first ethical approval was received in May, 2015 and the survey opened on the 4th of May, 2015. The research was conducted in University College Cork, National University of Ireland Galway and Trinity College Dublin medical schools. Due to time considerations and access to the sample frame it was deemed practical not to pursue the research in the other universities. Although ethical approval was granted in University College Dublin, the period of time allocated to keeping the research open had expired.

3.9 Piloting the Questionnaire

The questionnaire was pilot tested to help establish any problems or issues with the wording or answering of the questions. The pilot test population consisted of ten respondents, these respondents were friends who provided valuable feedback in relation to layout and the general flow of the questionnaire. According to Fink (2013), it is better to pretest the questionnaire as this will aid clarity and answerability. After the feedback from the pilot test respondents, minor alterations were adopted and all pilot survey responses were then deleted. Ethics approval

was sought after the pilot testing stage in April, 2015. All respondents in the pilot test were external to the sample population and were utilised to understand any omissions and ambiguites.

3.10 Sample Frame and Sample Size

The sampling frame utilized was undergraduate medical students currently studying in Irish university medical schools'. The sampling frame was up to date as it included all students' currently studying medicine in the Irish universities sampled. The sampling frame was also accurate and precise as it was the current academic year, 2014 - 2015 list of student email addresses at each individual institution's medical school. The population is finite and below 2,500 for the institutions sampled. The sampling frame was clustered using the variable of geographical location. A one-stage cluster sampling method was used to obtain a representative sample.

The preliminary sampling frame for this research consisted of the School of Medicine Trinity College Dublin, School of Medicine NUI Galway, School of Medicine University College Cork, Queens University Belfast School of Medicine, University College Dublin and the Royal College of Surgeons in Ireland Medical School. However due to time constraints and permission to access students, the sampling frame consisted of the following three University Medical Schools: Trinity College Dublin, National University of Ireland Galway and University College Cork.

The numbers of student places in each institution is as follows, (Central Applications Office, 2015). The overall population of medical students' in Ireland is made up of the following numbers:

- University College Dublin: 93 places yearly, six year cycle, 558 enrolled undergraduates in medicine.
- Trinity College Dublin: 123 places yearly, five year cycle, 615 enrolled undergraduates in medicine.
- NUI Galway: 120 places yearly, six year cycle, 720 enrolled undergraduates in medicine.
- Royal College of Surgeons in Ireland: 54 places a year, five or six year cycle, 324 enrolled undergraduates in medicine.
- University College Cork: 100 places a year, five year cycle, 500 enrolled in medicine.

- Queens University Belfast: 262 places a year, five year cycle, 1,310 enrolled in medical Education.

The sample size was calculated using the sample sizes for different sizes of population at a 95% confidence level.

The sample required was calculated using the adjusted minimum sample size calculation.

Where the population is less than 10,000, a smaller sample size is used. (Saunders, Lewis and Thornhill, 2012, p.660).

TABLE 3.1 – Adjusted Minimum Sample Size Calculation

$$n^1 = \frac{n}{1 + \frac{n}{N}}$$

Where

n^1 is the adjusted minimum sample size

n is the minimum sample size (as calculated above).

N is the total population

$$n^1 = \frac{310}{1 + \left(\frac{310}{1835}\right)}$$

$$n^1 = \frac{310}{1 + 0.1689}$$

$$n^1 = \frac{310}{1.1689}$$

$$= 265.20 \approx 265$$

3.11 Survey Response

The survey was issued to 1,835 medical students in three university medical schools' over a Two month period from May to July, 2015. Respondents were allowed adequate time to respond and given an email reminder by the school of medicine administrators in their

respective institutions. The survey received Three hundred and ten responses and this resulted in a response rate of 16.89%.

3.12 Questionnaire Scales

The survey was guided by the previous work of Venkatesh, Thong and Xu, (2012). The UTAUT constructs of performance expectancy, effort expectancy, social influence, facilitating conditions and behaviourial intention were guided and adapted by Venkatesh and Massey, (2003). The construct of habit was adapted from Limayem and Hirt, (2003), hedonic motivation was adapted from Kim and Malhotra, (2005) and price value adapted from Dodds, Monroe and Grewal, (1991). The constructs were measured using a five-point Likert scale, with anchors "strongly agree" to "strongly disagree". Use was measured by the frequency of smartphone medical application usage, the scale used was from "never" to "more than five times a day". Age was measured in years and gender was coded, where 0 represented female and 1 represented male. Experience was measured in the downloading of smartphone medical applications.

3.13 Survey Commencement

The survey was issued on the 4th of May, 2015 and was live for a period of ten weeks. Reminder emails were sent at least once in each cluster location to each medical school administrator. The survey reminder allowed for responses to be collected throughout the duration of the research and allowed those who had not already responded the opportunity to do so. As each of the individual universities controlled the sending of the reminder emails, surveymonkey.com provided data highlighting the number of new survey responses received via email as the responses were submitted.

3.14 Survey Closure

The survey was closed after a two month period which commenced on May 4th, 2015 and extended through to July, 9th, 2015. The data was extracted from www.surveymonkey.com (Palo Alto, California) for analysis and interpretation. The data was downloaded into a Microsoft Excel spreadsheet. IBM SPSS version 22 statistical package was used in the

analysis of the data. The responses that were received for the prize draw were automatically assigned numbers in Survey Monkey, a random draw of three participants was performed using the =RANDBETWEEN formula in Microsoft Excel. After three numbers were drawn randomly the three corresponding prize draw winning participants were e-mailed their £40 Amazon gift vouchers. The £40 gift vouchers were the closest currency exchange equivalent to €50 available on the amazon.co.uk website. The vouchers were sent via e-mail on the 17th of July, 2015 to the prize draw winners with a congratulatory message.

3.15 Lessons Learned

The most valuable lesson learned was the processing of individual research ethical approval applications in each of the Universities. This was a valuable and worthwhile learning experience as each Research Ethics Committee application was completed and submitted. After each ethical approval was received, permission was needed to survey students from the Deans' of Medicine of each School in the respective Universities. This further application process was time consuming but as each approval was received the survey went live in the targeted Universities.

4.0 Findings and Analysis

4.1 Introduction

An online survey was utilised as the principal method of collecting the data. The survey received 310 responses and was issued to a total of 1,835 participants using a one-stage cluster probability sampling methodology. The response rate was 16.89%. In this chapter the results of the survey questionnaire will be presented and analysed. The questionnaire results consist of participant responses from university medical undergraduate students' in three university locations in Ireland and their technology acceptance and usage of smartphone medical applications. The survey questions are contained in the (Appendices, 7.7). The findings are divided into the following sections: smartphone ownership, smartphone operating system, prior smartphone medical application usage, smartphone medical application usage frequency, smartphone medical application categories downloaded, smartphone medical applications used, amount of money willing to pay for smartphone medical applications, smartphone medical applications performance expectancy, smartphone medical applications effort expectancy, smartphone medical applications social influence, smartphone medical applications facilitating conditions, smartphone medical applications hedonic motivation, smartphone medical applications habit, smartphone medical application behavioural intention, respondents age, academic year currently completed in university, whether it is their final year or not in medical education and respondents gender.

4.2 Online Survey Demographics

4.2.1 Gender Demographic

Demographic questions were asked to determine the profile of respondents. In total 230 medical students provided a valid response to the question of gender, 57% were female and 43% were male, (Figure 4.1). These percentages equated to 131 female and 99 male responses. Eighty respondents out of 310 skipped this question. This percentage is in line with the reported 60% gender representation of medical school entrants being female, and 40% male, (O'Flynn, Mills and Fitzgerald, 2012).

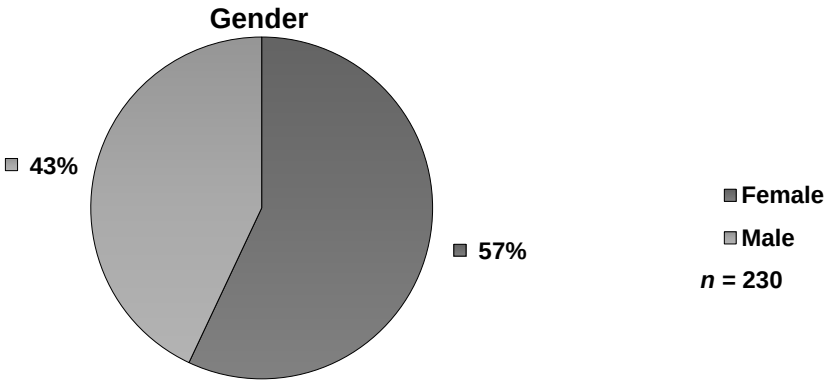

FIGURE 4.1 - Survey Response - Gender Demographic of Respondents.

4.2.2 Final Year Demographic

When asked if it was their final year in medical education 17% responded "Yes". Forty out of 230 reported that it was their final year, 79 respondents out of 310 skipped this question, (Figure 4.2).

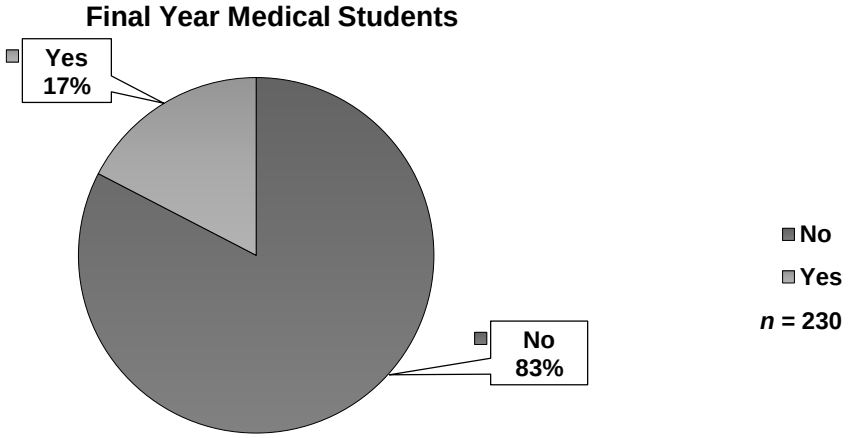

FIGURE 4.2 - Survey Response - Final Year Medical Students.

4.2.3 Current Academic Year Demographic

The next question set out to determine the current academic stage in terms of years that surveyed medical student respondents have completed in their undergraduate medical degree. As some university medical schools have a six year cycle for medicine, it allowed for a deeper classification of respondents. The results showed an even spread of responses

throughout years one to five of sampled medical students' years completed. The percentage of first year students was 17% with 39 respondents, second year students was 21% with 48 respondents, third year was 24% with 56 respondents, fourth year was 22% with 50 respondents, fifth year was 15% with 35 respondents and sixth year was 1% with three respondents. The overall response was 231 undergraduate medical students who answered the question with 79 of the 310 respondents who skipped the question, (Figure 4.3).

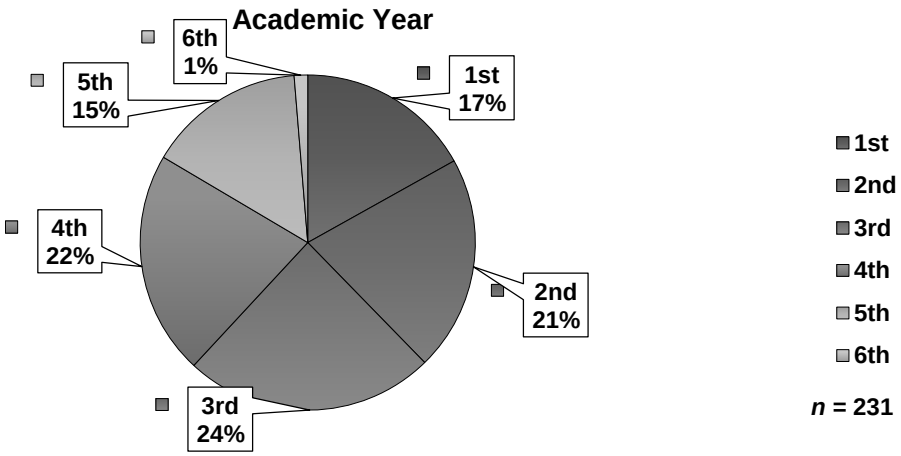

FIGURE 4.3 - Survey Response - Academic Year of Medical Students.

4.2.4 Age Demographic

The age profile of the respondents was broken into six categories. The six age categories ranged from 18 to 65 years of age and were distributed to have no overlapping age categories. The guidelines of the School of Computer Science and Statistics Research Ethics Committee stated that participants' must be 18 years of age or older and competent to supply consent to be eligible to participate in the survey. The survey generated 231 valid responses to the question. The 18 to 24 years of age category response rate was 190 responses or 82% of participants. The category of 25 to 34 years of age reported an 18% response rate which consisted of 41 respondents. No other age categories were reported. (M = 1.17 and SD = 0.38). Seventy nine respondents skipped this question out of 310 survey responses, (Figure 4.4).

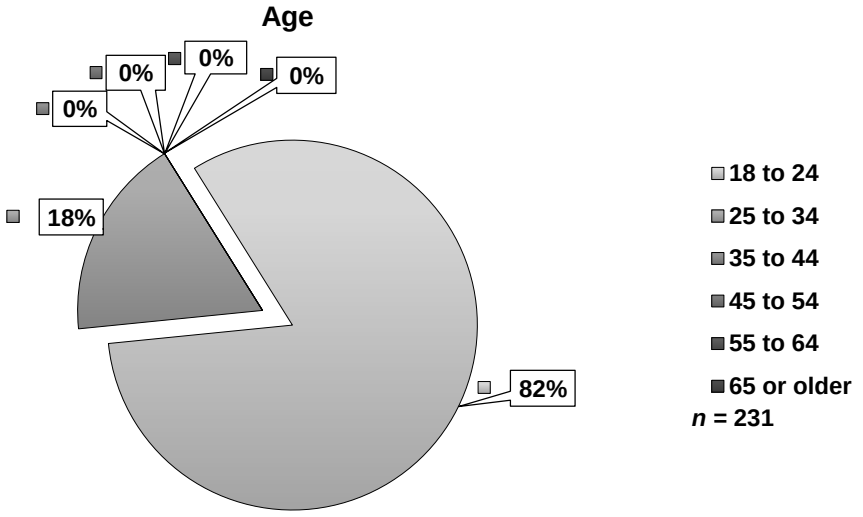

FIGURE 4.4 - Survey Response - Age Category Demographic.

4.3 Online Survey Price Question Response

4.3.1 Price Willing to Pay for Smartphone Medical Application

The next question asked respondents to indicate, how much they are willing to pay for a smartphone medical application. The respondents were given four pre-defined monetary categories that they could choose from in the ranges of €0, €1 to €5, €6 to €10, €10 to €15 and a comment box where they could specify any other responses in both text and numerical form. Thirty-six percent of respondents reported that they would pay €0, for a smartphone medical application which equated to 89 respondents. In the €1 to €5 category 43% of medical students' reported a willingness to pay which accounted for 105 participant responses. Eleven percent indicated that they would pay between €6 and €10 for a smartphone medical application. Three percent were willing to pay between €10 and €15, this accounted for seven participants. Seven percent or 18 respondents decided to specify their reasons qualitatively with some indicating how much they were willing to pay for a smartphone medical application, (Figure 4.5). The following comments were reported:

- *"Depends on the app, obviously."*
- *"Dependent on the supplier of the app, quality would lead to increased price willing to be paid."*
- *"Ideally free. For an app to access existing web database (e.g. Medscape), would be prepared to pay €1 - €5. For a self-contained reference app (e.g. Pocket Anatomy), would pay €10 - €15."*

- *"Depends on the use, I anticipate from the app e.g. For an App like Up To Date or Medscape, that I'd get a lot of use from, up to €10. Less than €5 for more niche apps."*
- *"Between €1 and €20 euro depending on the app."*
- *"Ideally free, but would consider spending more."*
- *"Depends on the quality of information, etc."*
- *"Ordinarily €0, however if I was in a speciality, when I qualify I would be willing to pay for an app."*
- *"As a student I don't subscribe to any paid apps but when qualified and working with an income I will pay for apps."*
- *"Occasionally I would be willing to pay more for a really top quality app-such as Fundamentals of Thoracic Imaging. We were given this for free in our medical school as it was designed by one of our Professors, but it is so excellent I would happily pay full price."*
- *"More than €1, I would be unlikely to buy unless I hear it was particularly good."*
- *"€0 - €25."*
- *"€1- €100."*
- *"Usually, I only download free apps, but would consider up to €5 for a well recommended medical app."*
- *"€2.50."*
- *"Depends on the app and how useful it is, e.g. I wouldn't pay for something that I use in my spare time if I'm bored, but would pay up to €20 or €30 euro for an app that I felt could have an influence on how my career progresses like the Oxford Handbook of Clinical Medicine app."*
- *"Nothing, unless the app was very, very, good."*
- *"Depends on the quality. I would be willing to pay €1 - €5 Euros if it is good quality and helpful but would prefer everything to be free but I don't mind paying if it is really that good."*

The overall response to the question about how much respondents would pay for a smartphone medical application is positive with 64% percent of the respondents indicating that they would pay for a smartphone medical application. Overall 157 respondents were willing to pay for a smartphone medical application. In the free text response comment section the themes of quality and the willingness to pay for an application that was *"good"* were reported. The range of prices respondents reported that they were willing to pay for a smartphone medical application is between €1 and €100.

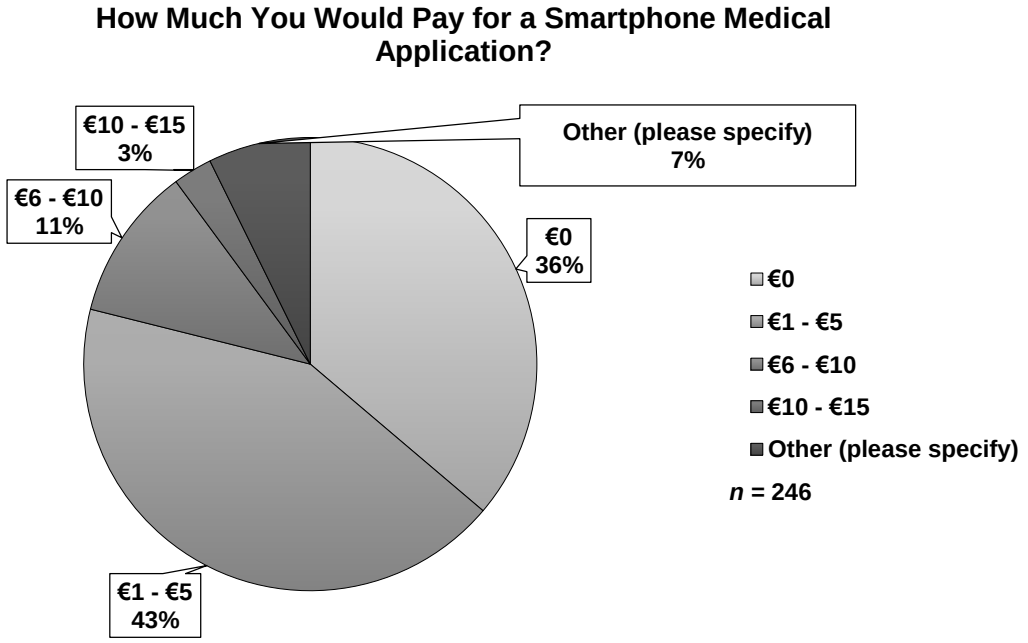

FIGURE 4.5 - Survey Response - How Much You Would Pay for a Smartphone Medical Application?

4.4 Online Survey Usage Questions

4.4.1 Smartphone Medical Application Usage Frequency

The question of smartphone medical application usage frequency was posed to undergraduate medical students'. Interestingly out of the 262 respondents, 23% do not use smartphone medical applications, a total of 59 respondents. The frequent usage by 77% of respondents, equating to 203 participants using smartphone medical applications highlights that smartphone medical application usage is prevalent among undergraduate medical students. The further breakdown of smartphone medical application usage can be seen in the response that 32% of respondents use smartphone medical applications every two-weeks, (fortnightly). Thirty percent of respondents use smartphone medical applications weekly, 79 out of 262 participants. Cumulatively the options of 'Daily', '2 – 4 times daily' and 'More than 5 times daily', which account for 15% or 39 responses indicate that the frequency levels of usage of smartphone medical applications is high. Taking the daily and weekly rates together, 45% of respondents or 118 respondents use smartphone medical applications weekly or more frequently, (Figure 4.6).

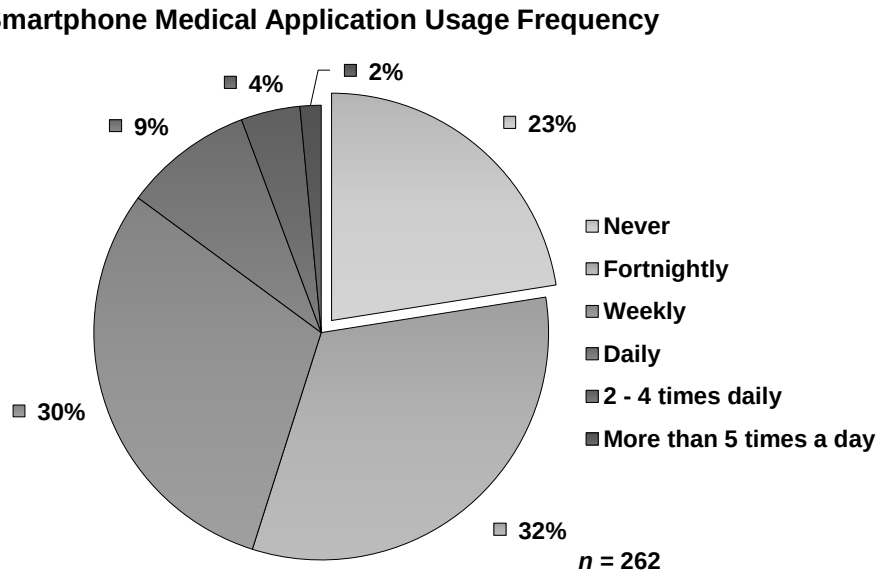

FIGURE 4.6 - Survey Response - Smartphone Medical Application Usage Frequency.

4.4.2 Have You Ever Downloaded a Smartphone Medical Application?

The question was posed to respondents if they had ever downloaded a smartphone medical application. Two hundred and ninety-seven responses were received. Twelve percent of respondents never downloaded a smartphone medical application which represented 34 respondents. This figure is an important marker as it highlights medical undergraduates who have smartphones and have never downloaded a smartphone medical application. The download frequency reported 38% of respondents or 114 who had downloaded 1 – 2 smartphone medical applications, 86 respondents had downloaded 3 – 4 smartphone medical applications or 29%. Twenty-one percent or 63 respondents had downloaded greater than 5 smartphone medical applications. Overall 88% of undergraduate medical students downloaded a smartphone medical application. Two hundred and sixty-three respondents reported that they had downloaded a smartphone medical application, (Figure 4.7).

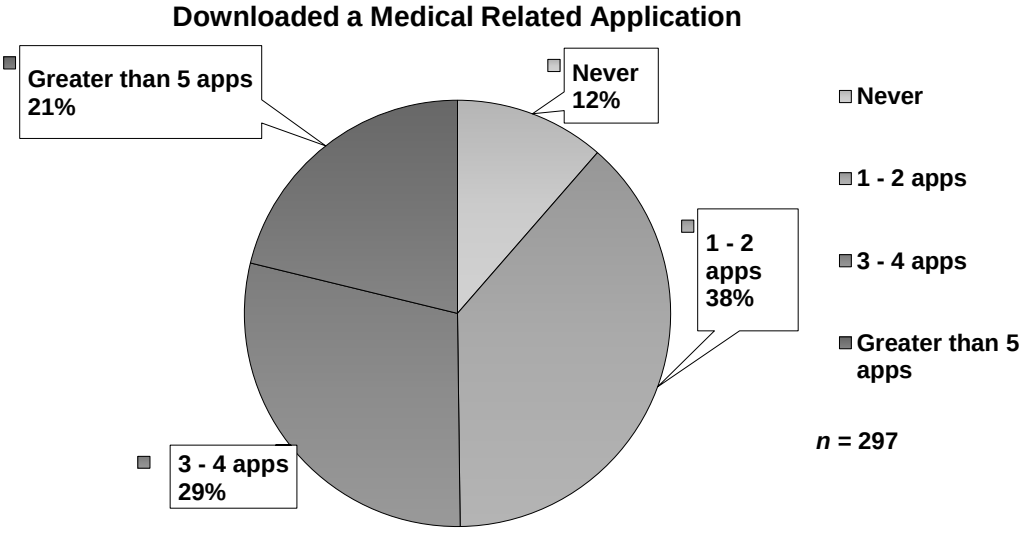

FIGURE 4.7 - Survey Response - Smartphone Medical Application Download Frequency.

4.4.3 Operating System of Smartphone

The majority of medical undergraduates are using an Apple iPhone iOS operating system. With the launch of the Apple iPhone 6, iPhone 6 Plus in September, 2014 along with the iPhone 5s and iPhone 5c in September, 2013, this operating system has 62.8% or 189 undergraduate medical students using iPhones with access to the Apple application marketplace. The next widely owned smartphone operating system is Android with 35.5% of

the respondents reporting usage and ownership of smartphones with this operating system. One hundred and seven of the 301 respondents own and use a smartphone which runs the Android operating system. Some popular Android smartphones manufacturers include; Acer, Asus, HTC, Huawei, LG, Kyocera, Motorola, Samsung, Sony and ZTE. The only other smartphone operating system reported was the Windows operating system, commonly available more recently with Microsoft, Nokia and HTC offerings. One point seven percent or five respondents owned a smartphone with the Windows operating system. This is a very small percentage of the 301 responses. Overall Apple iOS smartphone App Store and Android's Google Play App Store are available to undergraduate medical students to download smartphone medical applications with over 98% of respondents possessing a compatible smartphone for these marketplaces, (Figure 4.8).

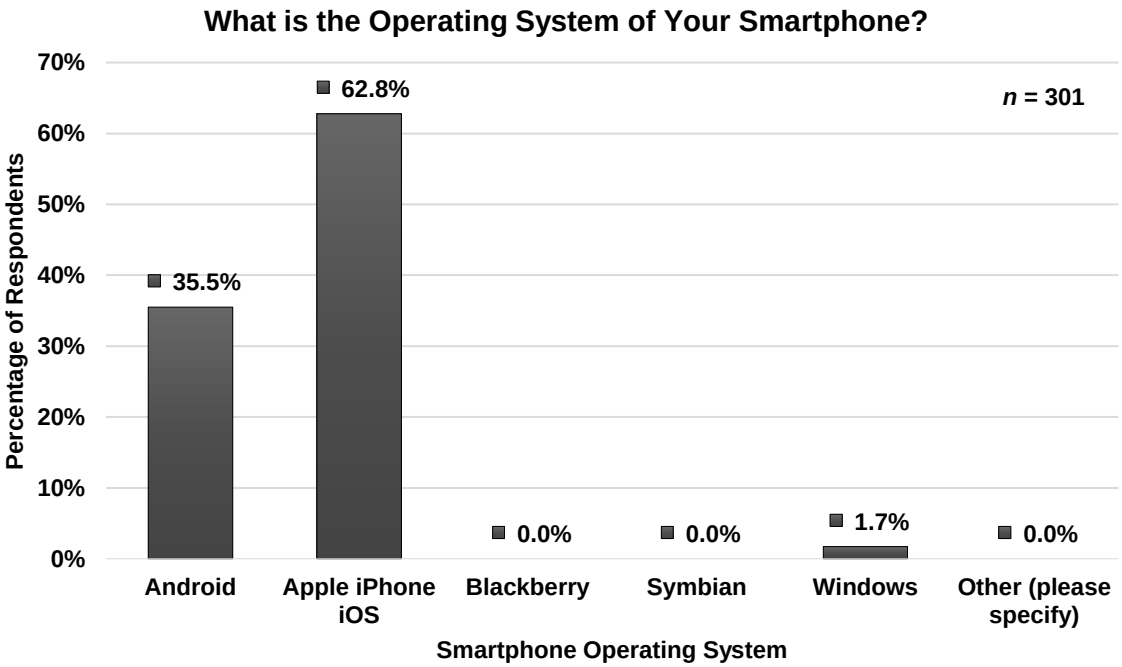

FIGURE 4.8 - Survey Response - Operating System of Smartphone.

4.4.4 Smartphone Ownership

Smartphone ownership was 98% of the 307 who provided a valid response to the question, three respondents skipped the question out of the 310 survey responses. The respondents who own and use a smartphone equalled 302 participants. Five respondents or two percent answered 'no', to the question of ownership and usage of a smartphone. This figure is

significantly larger than the 59% of all Irish mobile phones being smartphones, (Commission for Communications Regulation, 2014).

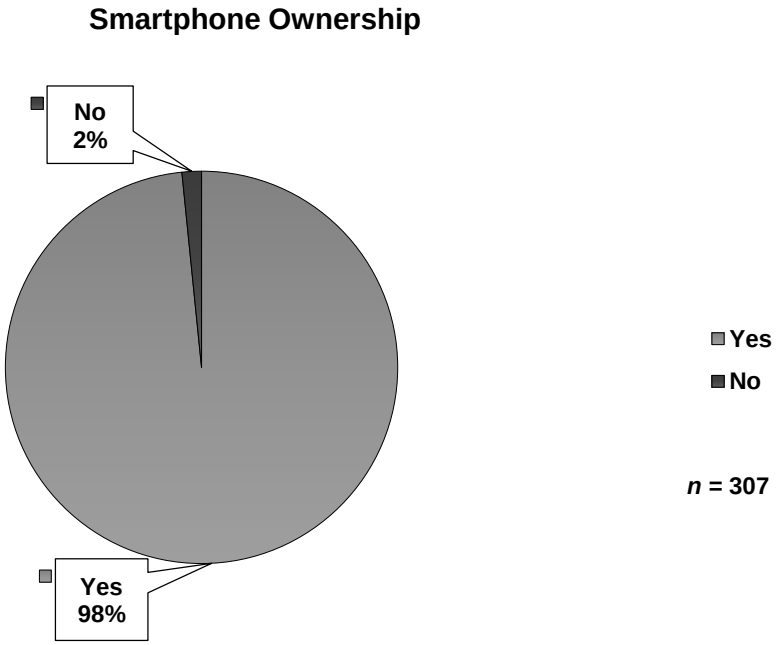

FIGURE 4.9 - Survey Response - Smartphone Ownership.

4.5 Responses for Scale Items

4.5.1 Performance Expectancy

Respondents were given statements on performance expectancy. The statements were measured using a five point Likert scale with the anchors of "strongly agree" to "strongly disagree". After data cleaning, valid responses of 248 out of a total of 310 responses were received. Sixty-two respondents skipped the question out of 310 responses. The statement of finding smartphone medical applications useful for my studies/ degree program was asked, the percentage of respondents that strongly agreed was 23.39% or 58 respondents out of 248. The percentage of respondents that agreed with the statement was 55.65% or 138 respondents of the 248 valid responses. Overall the cumulative percentage of respondents that agreed with the statement that they find smartphone medical applications useful for their studies/ degree program was 79.04% or 196 respondents out of 248 valid responses. The respondents that neither agreed nor disagreed with the statement accounted for 12.50% or

31 respondents. The percentage of respondents that disagreed with the statement was 7.66% or 19 respondents and those strongly disagreeing was 0.81% or two respondents out of 248 valid responses, (Figure 4.10). *N* = 247/ 248, (PE1, *M* = 3.93, *SD* = 0.85).

The next statement presented was using smartphone medical applications facilitates respondents in exam preparation. The percentage of respondents that strongly agreed with this statement was 12.10% or 30 respondents out of a total of 248. The respondents that agreed with the statement that using smartphone medical applications facilitates respondents in exam preparation was 41.94% or 104 respondents out of a total of 248 responses. Overall the cumulative percentage of respondents that agreed with the statement was 54.04% or 134 respondents. The respondents that neither agree nor disagree with the statement that smartphone medical applications facilitate respondents in exam preparation was 22.58% or 56 respondents. The respondents that disagree with the statement was 17.34% or 43 respondents and those that strongly disagreed with the statement was 6.05% or 15 respondents out of 248 valid responses, (Figure 4.10). *N* = 247/ 248, (PE2, *M* = 3.36, *SD* = 1.09).

The third statement stated that using smartphone medical applications helps me understand concepts more quickly. The percentage of respondents that strongly agreed with the statement was 12.10% or 30 respondents. Those respondents that agreed with the statement was 39.11% or 97 respondents out of 248. Overall the cumulative percentage of respondents that agreed was 51.21% or 127 respondents. The percentage of respondents that neither agreed nor disagreed with the statement that using smartphone medical applications helps me understand concepts more quickly was 30.24% or 75 respondents. The percentage of respondents that disagreed with the statement was 15.73% or 39 people and those who strongly disagreed was 2.82% or seven respondents out of 248 valid responses, (Figure 4.10). *N* = 247/ 248, (PE3, *M* = 3.41, *SD* = 0.98).

The next statement presented was that using smartphone medical applications is more productive for respondents. The percentage that strongly agreed with the statement was 10.89% or 27 respondents. The respondents that agreed with the statement that using smartphone medical applications is more productive for them was 31.45% or 78 respondents out of 248 valid responses. Overall the cumulative percentage that agree is 42.34% or 105 respondents. The percentage that neither agree nor disagree with the statement was 31.45%

or 78 respondents. The percentage that disagreed with the statement was 22.18% or 55 respondents and lastly the percentage that strongly disagree with the statement that using smartphone medical applications is more productive was 4.03% or 10 respondents, (Figure 4.10). *N* = 247/ 248, (PE4, *M* = 3.22, *SD* = 1.04).

The final statement was that respondents prefer to use smartphone medical applications. The percentage that strongly agreed with the statement was 8.50% or 21 of 247 valid responses. The percentage that agreed with the statement was 21.05% or 52 respondents. Overall the cumulative percentage that agree with the statement was 29.55% or 73 respondents. The percentage that neither agree nor disagree with the statement was 33.60% or 83 respondents. The respondents that disagreed with the statement that they prefer using smartphone medical applications was 28.74% or 71 respondents and 8.10% strongly disagree or 20 respondents out of 247 valid responses, (Figure 4.10). *N* = 247/ 248, (PE5, *M* = 2.93, *SD* = 1.07).

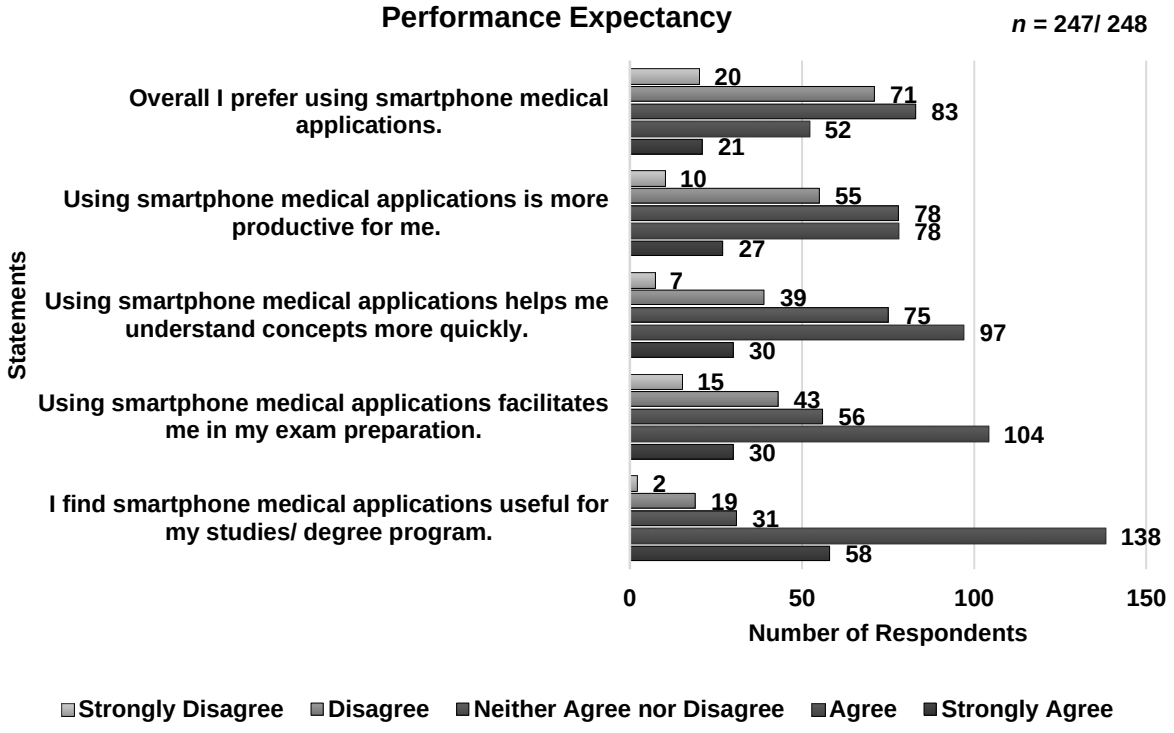

FIGURE - 4.10 Survey Response - Smartphone Medical Application Performance Expectancy.

The Cronbach's coefficient alpha for all the scale items of performance expectancy is 0.878 which is above 0.70 and acceptable, (Nunnally & Bernstein, 1994), (Table 4.1).

TABLE 4.1 - Reliability Statistics Performance Expectancy.

Reliability Statistics Performance Expectancy

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.878	.879	5

4.5.2 Effort Expectancy

Respondents were presented with a series of statements on effort expectancy, each of the statements was measured using a Likert scale with anchors "strongly agree" to "strongly disagree". After the data was cleaned 242 responses were received, 68 respondents skipped this question out of 310 participants. Firstly respondents were presented with the statement that smartphone medical applications are easy to access. The percentage who strongly agreed was 25.21% or 61 respondents. The percentage that agreed with the statement was 54.55% or 132 respondents. Overall the cumulative percentage that agree with the statement that smartphone medical applications are easy to access was 79.76% or 193 respondents. The respondents that neither agree nor disagree with the statement is 7.44% or 18 respondents out of a total of 242. The percentage that disagreed with the statement was 12.81% or 31 respondents and 0% strongly disagree or zero respondents, (Figure 4.11). *N* = 239/ 241/ 242, (EE1, *M* = 3.92, *SD* = 0.91).

The next statement presented to respondents was that their use of smartphone medical applications are clear and understandable. The percentage that strongly agree was 19.50% or 47 out of 241 respondents. The percentage that agree with the statement was 53.53% or 129 respondents out of 241 valid responses. Overall the cumulative percentage 73.03% or 176 respondents agreed with the statement. The percentage of respondents that neither agreed nor disagreed with the statement that their use of smartphone medical applications is clear and understandable was 19.50% or 47 respondents out of 241. The percentage of

respondents that disagreed with the statement was 7.05% or 17 respondents. The percentage of respondents that strongly disagree with the statement was 0.41% or one respondent, (Figure 4.11). *N* = 239/ 241/ 242, (EE2, *M* = 3.84, *SD* = 0.82).

The next statement presented was that smartphone medical applications are easy to use, the percentage that strongly agreed with the statement was 20.92% or 50 respondents. The percentage of respondents that agree with the statement that smartphone medical applications are easy to use was 53.97% or 129 respondents out of 239 valid responses. The percentage that neither agree nor disagree was 16.32% or 39 respondents. The respondents that disagree with the statement were 8.37% or 20 respondents and 0.42% or one respondent who strongly disagreed, (Figure 4.11). *N* = 239/ 241/ 242, (EE3, *M* = 3.86, *SD* = 0.85).

The next statement was that it is easy to become familiar with smartphone medical applications. The percentage that strongly agree with the statement was 23.14% or 56 respondents out of a total of 242 valid responses, 68 respondents skipped this question. The percentage of respondents that agreed with the statement was 54.96% or 133 respondents. Overall the cumulative percentage of those respondents that agreed with the statement was 78.10% or 189 respondents out of 242. The percentage of respondents that neither agree nor disagree with the statement was 15.70% or 38 respondents. The respondents that disagree with the statement that it is easy to become familiar with smartphone medical applications was 6.20% or 15 respondents and there was zero percent of respondents that strongly disagreed, (Figure 4.11). *N* = 239/ 241/ 242, (EE4, *M* = 3.95, *SD* = 0.79).

The next statement was that respondents find it easy to get smartphone medical applications to do what they want them to do. The percentage who strongly agree with the statement was 16.94% or 41 respondents out of 242. The respondents that agree with the statement was 42.98% or 104 respondents. The respondents that neither agree nor disagree with the statement was 23.14% or 56 respondents out of 242 valid responses. The percentage of respondents that disagree with the statement was 14.05% or 34 respondents and those who disagree strongly 2.89% or seven respondents, (Figure 4.11). *N* = 239/ 241/ 242, (EE5, *M* = 3.57, *SD* = 1.02).

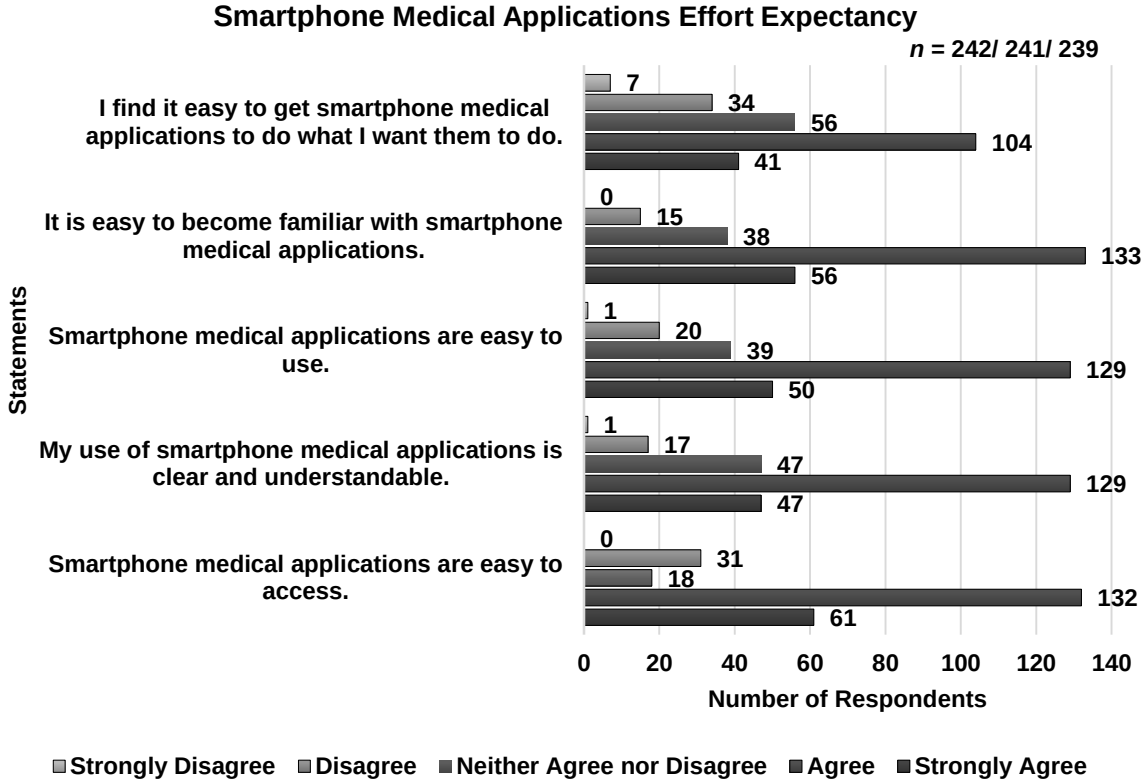

FIGURE 4.11 - Survey Response - Smartphone Medical Applications Effort Expectancy.

The Cronbach's Alpha for the five statements of effort expectancy of smartphone medical applications is 0.902 and is above 0.70 and deemed acceptable, (Nunnally & Bernstein, 1994), (Table 4.2).

Table 4.2 - Reliability Statistics Effort Expectancy.

Reliability Statistics Effort Expectancy

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.902	.906	5

4.5.3 Social Influence

In the next question, respondents were given statements on social influence. Each statement was measured using a five point Likert scale with anchors of "strongly agree" to "strongly disagree". After data cleaning 238 and 239 valid responses were received out of a total of

310 responses, 71 respondents skipped this question. The number of respondents that strongly agree with the statement that people who are important to them think that they should use smartphone medical applications was 5.02% or 12 respondents. The percentage that agree with the statement was 14.64% or 35 respondents out of 239 valid responses. The respondents that neither agree nor disagree was 56.49% or 135 respondents. The percentage of respondents that disagree was 19.25% or 46 respondents. The percentage of respondents that strongly disagree was 4.60% or 11 respondents of a total 239 valid responses, (Figure 4.12). *N* = 238/ 239, (SI1, *M* = 2.96, *SD* = 0.85).

The next statement was that people who influence the respondent's behaviour think that they should use smartphone medical applications. The percentage of respondents that strongly agreed with this statement was 5.04% or 12 respondents. The percentage that agreed with the statement was 17.23% or 41 respondents. Overall, the cumulative percentage that agree with the statement was 22.27% or 53 out of a total of 239 respondents. Respondents that neither agree nor disagree with the statement that people who influence their behaviour think that they should use smartphone medical applications was 50.42% or 120 respondents out of 238 responses. The percentage that disagree with the statement was 21.85% or 52 people and those who strongly disagree were 5.46% or 13 respondents, (Figure 4.12). *N* = 238/ 239, (SI2, *M* = 2.94, *SD* = 0.90)

The next statement presented was that people whose opinions that the respondents value prefer they use smartphone medical applications. The percentage that strongly agreed with the statement was 4.18% or 10 respondents. The respondents that agreed with the statement was 12.13% or 29 respondents. The respondents that neither agreed nor disagreed with the statement was 51.46% or 123 respondents out of a total of 239 responses. The respondents that disagreed with the statement accounted for 26.78% or 64 respondents out of a total of 239 valid responses. The percentage of respondents that strongly disagreed was 5.44% or 13 respondents, (Figure 4.12). *N* = 238/ 239, (SI3, *M* = 2.82, *SD* = 0.86).

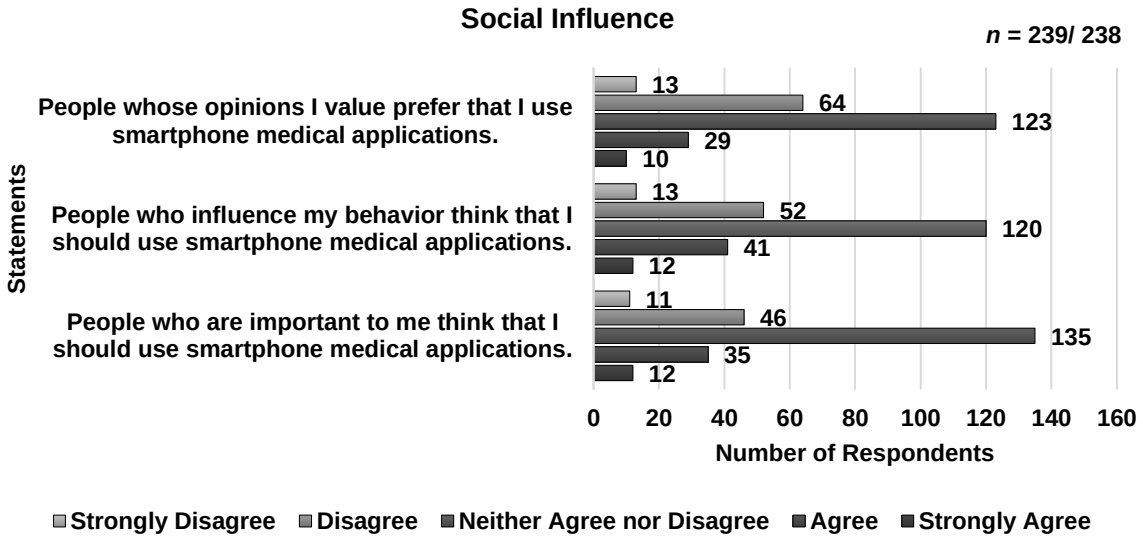

FIGURE 4.12 - Survey Response - Social Influence.

The internal reliability of the statements on social influence was calculated as 0.913 Cronbach's alpha, which is above the 0.70 acceptable measure, (Table 4.3).

TABLE 4.3 - Reliability Statistics Social Influence.

Reliability Statistics Social Influence

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.913	.912	3

4.5.4 Facilitating Conditions

In the next question respondents were given statements on facilitating conditions. Each statement was measured using a five point Likert scale with the anchors of "strongly agree" to "strongly disagree. After data cleaning, valid responses of 236 and 237 respondents were received out of a total response of 310. Respondents were presented with the statement of having the resources necessary to use smartphone medical applications, the percentage that strongly agree with the statement was 31.65% or 75 respondents out of 237 valid responses. Those respondents that agree with the statement that they have the resources necessary to

use smartphone medical applications was 55.27% or 131 respondents out of 237 responses. Overall the respondents that agree with the statement that they have the resources necessary to use smartphone medical applications was 86.92% or 206 out of 237 respondents. Respondents that neither agree nor disagree with the statement that they have the resources necessary to use smartphone medical applications was 6.75% or 16 respondents. Those who disagreed with the statement accounted for 5.49% or 13 respondents out of 237 and respondents who strongly disagreed with the statement that they have the resources necessary to use smartphone medical applications was 0.84% or two respondents out of 237, (Figure 4.13). *N* = 236/ 237, (FC1, *M* = 4.11, *SD* = 0.81).

Secondly, out of a total response of 236 respondents to the statement that they have the knowledge necessary to use smartphone medical applications, 33.90% or 90 strongly agree with the statement. Respondents that agree with the statement were 54.66% or 129 responses. Overall 88.56% of respondents agree with the statement that they have the knowledge necessary to use smartphone medical applications. Respondents that neither agree nor disagree with the statement account for 7.63% or 18 responses. Those respondents that disagree with the statement that they have the knowledge necessary to use smartphone medical applications were 3.39% or eight responses out of a total of 236 and those who strongly disagree with the statement account for 0.42% or one response, (Figure 4.13). *N* = 236/ 237, (FC2, *M* = 4.18, *SD* = 0.74).

Thirdly, respondents that strongly agree with the statement that smartphone medical applications are compatible with other technologies that they used accounted for 23.63% or 56 respondents. Those respondents that agree with the statement were 48.52% or 115 respondents out of 237 responses. Overall 72.15% or 171 respondents agree with the statement that smartphone medical applications are compatible with other technologies that they use. Those respondents that neither agree nor disagree accounted for 14.35% or 34 respondents out of a total of 237 valid responses. The percentage of respondents that disagree with the statement that smartphone medical applications are compatible with other technologies that they use was 10.97% or 26 respondents. The percentage of respondents that strongly disagree was 2.53% or six respondents out of 237 valid responses, 73 people skipped the question out of the 310 responses collected, (Figure 4.13). *N* = 236/ 237, (FC3, *M* = 3.79, *SD* = 1.00).

Lastly, the statement that respondents can get assistance from others when they have difficulties using smartphone medical applications. The percentage of respondents that strongly agree was 11.86% or 28 respondents out of 236. Those respondents that agreed with the statement that they can get assistance from others when they have difficulties using smartphone medical applications was 29.66% or 70 respondents. Overall 41.52% of respondents reported that they agree with the statement that they can get assistance from others when they have difficulties using smartphone medical applications. The respondents that neither agreed nor disagreed with the statement accounted for 32.63% or 77 responses out of a total of 236 valid responses. The respondents that disagreed with the statement accounted for 22.46% or 53 respondents and those who strongly disagreed with the statement that they can get assistance from others when they have difficulties using smartphone medical applications were 3.39% or eight respondents out of 236 valid responses, (Figure 4.13). *N* = 236/ 237, (FC4, *M* = 3.24, *SD* = 1.03).

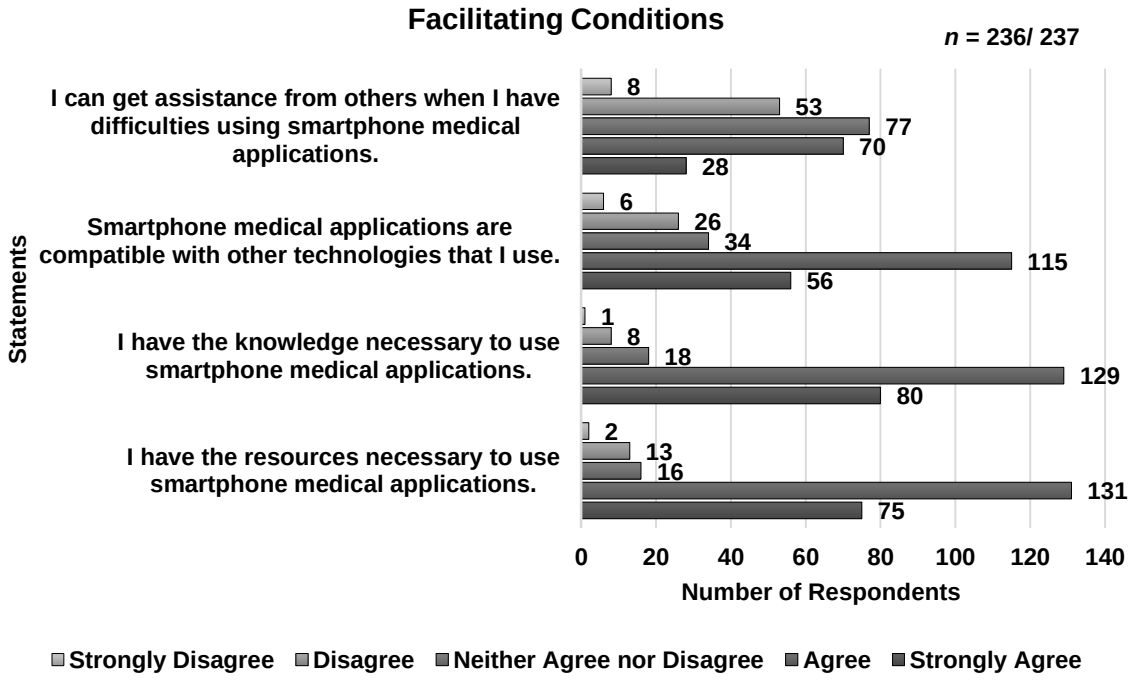

FIGURE 4.13 - Survey Response - Smartphone Medical Applications Facilitating Conditions.

The reported reliability Cronbach's alpha is 0.710 which is acceptable as it is over 0.70, (Table 4.4).

TABLE 4.4 - Reliability Statistics Facilitating Conditions.

Reliability Statistics Facilitating Conditions

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.710	.722	4

4.5.5 Hedonic Motivation

In the next question, respondents were given statements on motivation and each was measured with a five point Likert scale anchored from "strongly agree" to "strongly disagree". Two hundred and thirty-six and 237 valid responses out of 310 were received. Firstly respondents were asked if they check smartphone medical applications before looking at other medical sources, the respondents who strongly agree were 2.11% or five respondents. Respondents who agreed with the statement that they check smartphone medical applications before looking at other medical sources was 12.24% or 29 respondents. Overall the percentage of respondents who agreed that they check smartphone medical applications before looking at other medical sources was 14.35% or 34 out of 237 respondents. The respondents who neither agreed nor disagreed with the statement of checking smartphone medical applications before looking at other medical sources was 11.39% or 27 respondents. The respondents that disagree with the statement of checking smartphone medical applications before looking at the other medical sources was 51.48% or 122 respondents out of 237. Those respondents that strongly disagree with the statement of checking medical applications before looking at other medical sources was 22.78% or 54 out of 237 responses, (Figure 4.14). N = 236/ 237, (HM1, M = 2.19, SD = 0.99).

Secondly, the statement of respondents checking smartphone medical applications to confirm information from other medical sources was 2.95% or seven respondents strongly agreeing. The percentage of respondents that agree with the statement was 30.80% or 73 respondents. Those who neither agree nor disagree was 17.30% or 41 respondents out of 237. Disagreeing with the statement of checking smartphone applications before looking at other medical

sources was 35.02% or 83 respondents and those who strongly disagree was 13.92% or 33 respondents out of 237, (Figure 4.14). *N* = 236/ 237, (HM2, *M* = 2.73, *SD* = 1.12).

Thirdly, the statement of use of smartphone medical applications without consulting other medical sources reported 1.27% or three respondents who strongly agree out of 237. The number of respondents that agree with the statement that they use smartphone medical applications without consulting other medical sources was 12.24% or 29 respondents. Those who neither agree nor disagree with the statement that they would use smartphone medical applications without consulting other medical sources was 11.39% or 27 respondents. The respondents that disagree with the statement amounted to 47.26% and those who strongly disagree accounted for 27.85% or 66 respondents out of a total of 237. Overall 75.11% or 178 respondents disagree with the statement that they would use smartphone medical applications without consulting other medical sources out of 237, (Figure 4.14). *N* = 236/ 237, (HM3, *M* = 2.11, *SD* = 0.99).

Lastly the statement that respondents depend on smartphone medical applications exclusively reported 0.85% or two respondents of 236 who strongly agree with the statement. Those respondents who agree with the statement of depending on smartphone medical applications exclusively was also 0.85% or two respondents of the 236 valid responses. Those that neither agree nor disagree with the statement that they depend on smartphone medical applications exclusively was 4.66% or 11 respondents out of 236. The number of respondents that disagree with the statement that they depend on medical applications exclusively was 31.36% or 74 respondents out of 236 responses. Those that strongly disagree with the statement was 62.29% or 147 out of 236 responses. Overall the cumulative percentage of respondents that disagree with the statement that they depend on smartphone medical applications exclusively was 93.65% or 221 respondents, (Figure 4.14). *N* = 236/ 237, (HM4, *M* = 1.46, *SD* = 0.70).

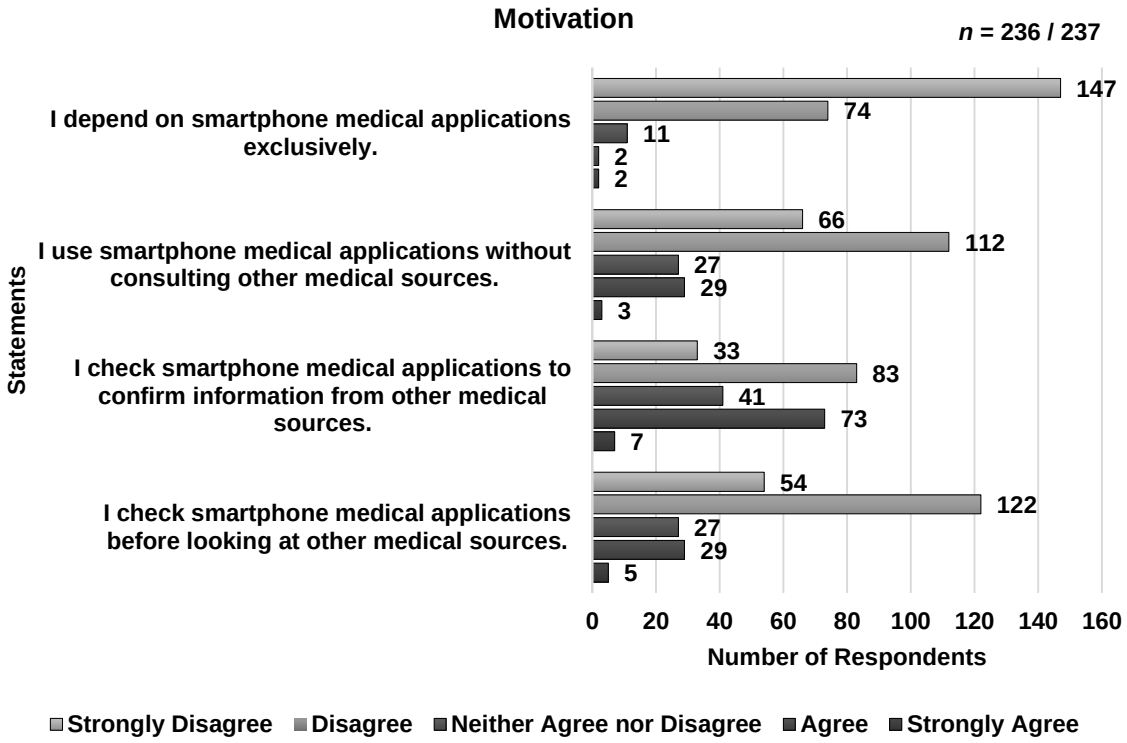

FIGURE 4.14 - Survey Response - Smartphone Medical Applications Motivation.

The Cronbach's alpha is 0.731, which is deemed acceptable as it is over 0.70, (Table 4.5).

TABLE 4.5 - Reliability Statistics Motivation.

Reliability Statistics Motivation

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.731	.741	4

4.5.6 Habit

In the next question respondents were given statements on habit. Each statement was measured using a five-point Likert scale with anchors from "strongly agree" to "strongly disagree". Two hundred and thirty-five valid responses out of 310 responses were collected after the data was cleaned. Respondents were presented with the statement that smartphone medical application use has become a habit, 5.11% or 12 respondents from a total of 235

strongly agreed with the statement. The percentage of respondents that agreed that smartphone medical application use has become a habit for them was 21.70% or 51 respondents. Overall 26.81% or 63 respondents reported that using smartphone medical applications has become a habit for them. The respondents that neither agreed nor disagreed with the statement that using smartphone medical applications has become a habit was 22.53% or 55 respondents. The percentage of respondents reported that disagreed with the statement that using smartphone medical applications has become a habit was 37.45% or 88 respondents out of a total of 235 and those strongly disagreeing with the statement was 13.19% or 31 respondents. A total of 75 respondents skipped this question out of a total of 310 responses, (Figure 4.15). *N* = 235, (HB1, *M* = 2.68, *SD* = 1.10).

The next statement that was presented to respondents was the use of smartphone medical applications have become natural to me, in the survey responses 5.53% or 13 respondents out of 235 strongly agreed with the statement. Those who agree that using smartphone medical applications has become natural to them was 31.91% or 75 respondents. Overall the respondents that agreed with the statement that smartphone medical applications use has become natural to me was 37.44% or 88 respondents out of 235. Those who neither agreed nor disagreed with the statement that using smartphone medical applications has become natural to me was 19.15% or 45 respondents. Those that disagreed with the statement that smartphone medical application use has become natural to me was 33.19% or 78 respondents while those who strongly disagree was 10.21% or 24 respondents, (Figure 4.15). *N* = 235, (HB2, *M* = 2.89, *SD* = 1.12).

Lastly the statement of using smartphone medical applications becoming regular for respondents was asked with 6.81% or 16 participants strongly agreeing. Those agreeing with the statement that using smartphone medical applications is becoming regular to them was 37.87% or 89 respondents. Overall 44.68% agree with the statement that using smartphone medical applications is becoming regular to them. Those who neither agree nor disagree with the statement that using smartphone medical applications is becoming regular to me was 14.47% or 34 respondents out of 235. Those that disagree with the statement of using smartphone medical applications is becoming regular for them was 28.09% or 66 respondents. Finally the percentage of respondents that strongly disagree with the statement was 12.77% or 30 respondents out of 235, (Figure 4.15). *N* = 235, (HB3, *M* = 2.97, *SD* = 1.20).

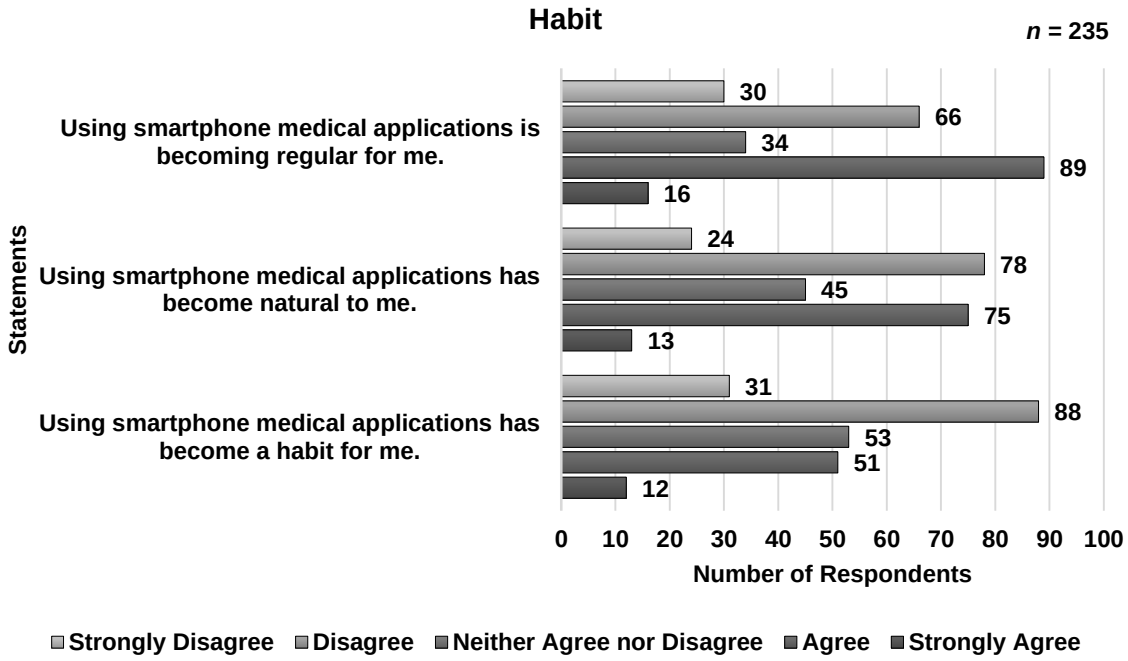

FIGURE 4.15 - Survey Response Smartphone Medical Applications Habit.

Cronbach's alpha reliability coefficient normally ranges between 0 and 1. According to George and Mallery, (2003), when the coefficient is > than 0.9 it is considered (Excellent), the Cronbach alpha for Habit is 0.916 and it is reliable to internal items consistency, (Table 4.6).

TABLE 4.6 - Reliability Statistics Habit.

Reliability Statistics Habit

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.916	.916	3

4.5.7 Behavioural Intention

In the next question, respondents were given statements on behavioural intention and each was measured with a five point Likert scale anchored from, "strongly agree" to "strongly

disagree". Two hundred and thirty-three valid responses were received after the data was cleaned out of a possible 310 responses. Firstly, in the survey, the majority of respondents agree with the statement that they intend to use smartphone medical applications in the future and the reported percentage was 60.52% or 141 of the 233 respondents. The respondents who strongly agree with the statement that they intend to use smartphone medical applications in the future was 27.04% or 63 respondents of the 233 respondents. Overall, 87.56% cumulatively of respondents agree that they intend to use smartphone medical applications in the future. The reported percentage of respondents that disagree was 2.15% or five respondents. The percentage that neither agree nor disagree was 10.30% or 24 respondents, (Figure 4.16). N = 233, (BI1, M = 4.12, SD = 0.66).

Secondly, respondents were asked if they will use smartphone medical applications as part of their degree/ studies. The percentage of respondents that strongly agree with the statement was 18.88% or 44 out of 233 responses. The percentage that agree with the statement, if they will use smartphone medical applications as part of their degree/ studies was 57.94% or 135 respondents. Overall the majority of respondents agree that they will use smartphone medical applications as part of their degree/ studies, 76.82% cumulatively or 179 out of 233 respondents reported agreement with the statement. The percentage of respondents that neither agree nor disagree with the statement that they will use smartphone medical applications as part of their degree/ studies was 16.74% or 39 out of 233 responses. Those who disagree amounted to 5.58% or 13 respondents and the respondents who strongly disagreed accounted for 0.86% or two respondents, (Figure 4.16). N = 233, (BI2, M = 3.88, SD = 0.80).

Thirdly when given the statement about planning to use smartphone medical applications regularly 16.74% or 39 respondents strongly agreed with the statement, 51.07% or 119 respondents agreed that they planned to use smartphone medical applications regularly. Overall 67.81% of respondents plan to use smartphone medical applications regularly. The respondents who neither agreed nor disagreed with the statement that they planned to use smartphone medical applications regularly were 23.61% or 55 respondents of 233 valid responses. The respondents that disagreed with the statement that they plan to use smartphone medical applications regularly was 6.44% or 15 respondents. The respondents that strongly disagreed with the statement that they intend to use smartphone medical applications regularly was 2.15% or five respondents, (Figure 4.16). N = 233, (BI3, M = 3.73, SD = 0.88).

Fourthly when respondents were given the statement that they will use smartphone medical applications in the future, 23.18% or 54 respondents strongly agree with the statement, 65.67% or 153 respondents agree with the statement. Overall 88.85% cumulatively or 207 respondents agree that they will use smartphone medical applications in the future. The respondents that neither agree nor disagree with the statement that they will use smartphone medical applications in the future amounted to 8.58% or 20 respondents. Disagreeing with the statement that they will use smartphone medical applications in the future was 1.72% or 4 respondents out of 233. The respondents that strongly disagree with the statement that they will use smartphone medical applications in the future was 0.86% or two respondents out of 233, (Figure 4.16). N = 233, (BI4, M = 4.08, SD = 0.67).

Finally when given the statement that respondents will recommend the use of smartphone medical applications to others 16.31% or 38 respondents strongly agree. Respondents that agree with the statement that they will recommend the use of smartphone medical applications to others accounted for 48.93% or 114 respondents out of 233. Overall respondents who agree with the statement that they will recommend the use of smartphone medical applications to others was 65.24% cumulatively or 152 respondents out of 233. Those who neither agree nor disagree with the statement that they will recommend smartphone medical applications to others was 26.61% or 62 respondents. Respondents disagreeing with the statement that they will recommend smartphone medical applications to others was 6.87% or 16 respondents and lastly 1.29% or three respondents strongly disagreed, (Figure 4.16). N = 233, (BI5, M = 3.72, SD = 0.86).

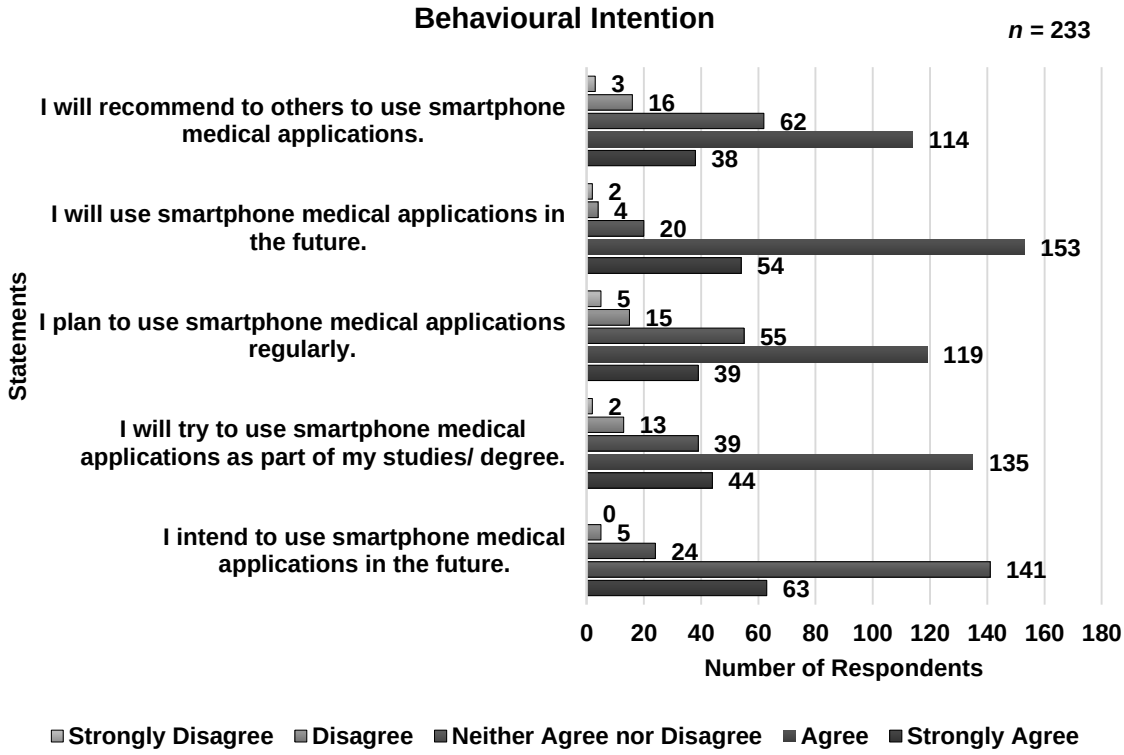

FIGURE 4.16 - Survey Response - Smartphone Medical Applications Behavioural Intention.

TABLE 4.7 - Survey Statistics - Smartphone Medical Applications Behavioural Intention.

Statistics

Behavioural Intention		I intend to use smartphone medical applications in the future.	I will try to use smartphone medical applications as part of my studies/ degree.	I plan to use smartphone medical applications regularly.	I will use smartphone medical applications in the future.	I will recommend to others to use smartphone medical applications.
N	Valid	233	233	233	233	233
	Missing	77	77	77	77	77
Mean		4.1245	3.8841	3.7382	4.0858	3.7210
Std. Deviation		.66757	.80374	.88821	.67684	.86320

The alpha coefficient for the five items is 0.892, which suggests that the items have relatively high internal consistency. The reliability coefficient of 0.70 or higher is considered acceptable, (Table 4.8)

TABLE 4.8 - Reliability Statistics Behavioural Intention.

Reliability Statistics Behavioural Intention

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.892	.898	5

4.6 Smartphone Medical Applications Categories

4.6.1 Categories of Smartphone Medical Applications Downloaded

Respondents were asked which categories of smartphone medical applications they had downloaded. Participants could select more than one category from a list, the totals do not add up to 100%. The categories of medical applications downloaded were guided by the previous research of (Carter, et al., 2014). The most popular category of smartphone medical application download was Encyclopaedia or Medical Reference with 63% of respondents, 162 reporting use. This was followed by Anatomy smartphone medical applications with 61.5% of respondents or 158 reporting usage. Drug Reference smartphone medical applications were the next most popular smartphone medical application with 45.5% or 117 using these applications. Clinical Guidelines applications had 37.4% reporting a usage of 96 respondents. Calculator use was 26.5% of respondents with 68 students. Sixteen point three percent used Dictionaries or 42 respondents. Eleven point three percent or 29 respondents used Instruction and Procedure applications. A free response section was provided which was categorized as "Other", and 16.3% reported using other applications or 42 respondents. In the downloaded applications category classified as "Other", after data analysis the following categories were reported: Radiology, Medical Journals, Exam OSCE Trainers, Study and Revision, Medical Case Studies, Figure 1 App Photo Sharing, Clinical Information, Question Banks and Figure 8 Applications. Two hundred and fifty-seven valid responses were received with another 53 respondents skipping the question. Three hundred and ten respondents in all took the survey, (Figure 4.17).

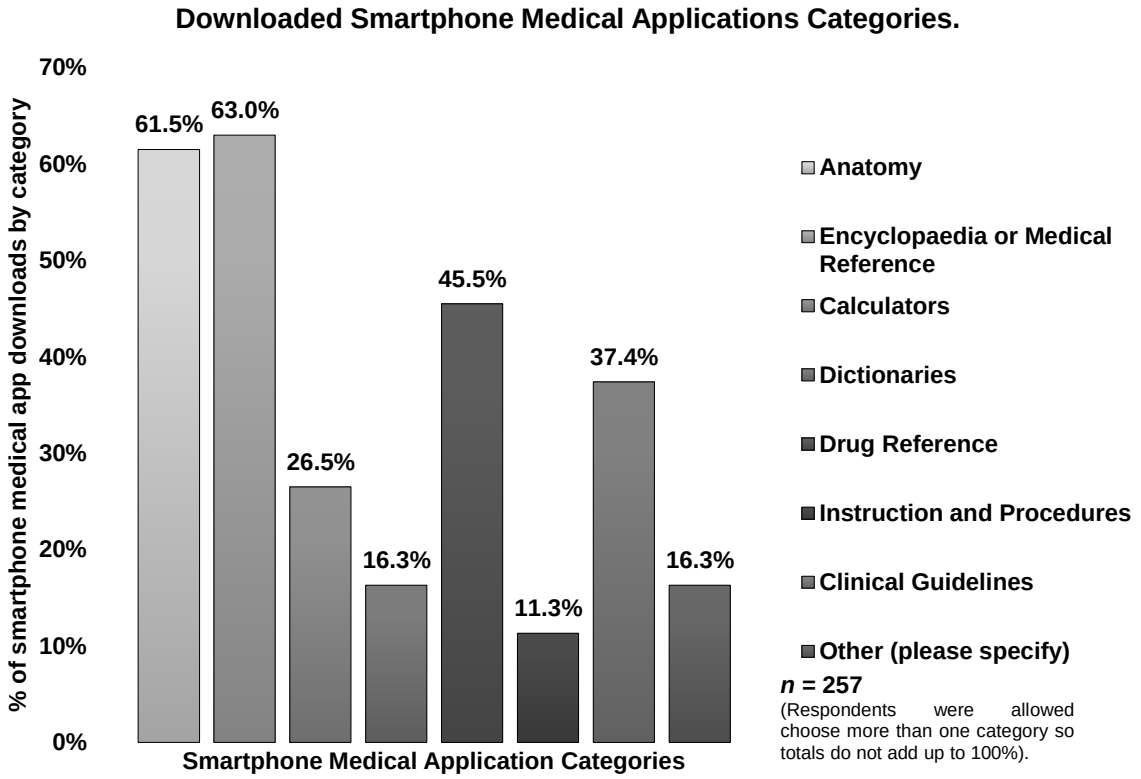

FIGURE 4.17 - Survey Response - Downloaded Smartphone Medical Application Categories.

4.6.2 Smartphone Medical Applications Used

Respondents were asked: What smartphone medical applications they use? Two hundred and fourteen respondents answered the question. There was 96 respondents who skipped the question out of 310 responses.

In this free text response question, *n* = 214/ 53 (24.77%) of the respondents used Anatomy applications, *n* = 214/ 41 respondents (19.16%) reported using the Figure 1 application, *n* = 214/ 15 respondents (7.01%) use Prognosis: your diagnosis applications, *n* = 214/ 14 respondents (6.54%) reported using GAPP, Galway University Hospitals (GUH) Antimicrobial Prescription Policy, *n* = 214/ 12 respondents (5.61%) reported using the BNF application, *n* = 214/ 11 respondents (5.14%) reported using a Radiology application, n = 214/ 10 respondents (4.67%) use NICE guidelines applications, *n* = 214/ 10 respondents (4.67%) use the Oxford Handbook application, *n* = 214/ 10 respondents (4.67%) use the Web MD application, *n* = 214/ 8 respondents (3.74%) use OSCE skills application, *n* = 214/ 8 respondents (3.74%) use

MedCalc application, *n* = 214/ 6 respondents (2.80%) use Medical dictionaries applications, *n* = 214/ 5 respondents (2.34%) use QX calculate application, n = 214/ 5 respondents (2.34%) use Antimicrobial prescribing applications, *n* = 214/ 5 respondents (2.34%) use Medscape BMJ applications, *n* = 214/ 4 respondents (1.87%) use Soundbuilder application, *n* = 214/ 4 respondents (1.87%) use Quiz applications, *n* = 214/ 4 respondents (1.87%) deleted the applications, *n* = 214/ 4 respondents (1.87%) used Surgery applications, *n* = 214/ 3 respondents (1.40%) used a Tallaght Hospital application, *n* = 214/ 2 respondents (0.93%) used Flashcard applications, *n* = 214/ 2 respondents (0.93%) used 3D Atlas applications, *n* = 214/ 2 respondents (0.93%) used Bio Digital Human applications, *n* = 214/ 2 respondents (0.93%) used a Drug Dictionary application, *n* = 214/ 2 respondents (0.93%) used GAP application and *n* = 214/ 2 respondents (0.93%) used USMLE applications.

4.7 Validity and Reliability

4.7.1 Reliability

Cronbach's α is a measure of reliability and is considered acceptable if over 0.70. Cronbach's coefficient alpha (Cronbach, 1984) was utilised in the statistical analyses. The reliability of the 29 scale items for smartphone medical applications is a Cronbach's alpha of 0.936, based on 223 valid cases. Internal consistency was fulfilled with Cronbach's Alpha of 0.936 on all items > 0.7.

TABLE 4.9 - Reliability Statistics All Scale Items.

Reliability Statistics All Scale Items

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.936	.937	29

The Cronbach's Alpha for the Performance Expectancy variables, PE1 – PE5 is 0.878, Effort Expectancy variables, EE1 – EE5 is 0.902, Social Influence variables, SI1 – SI3 is 0.913, Facilitating Conditions variables, FC1 – FC4 is 0.710, Hedonic Motivation variables, HM1 –

HM4 is 0.731, Habit variables HB1 – HB3 is 0.916 and Behavioural Intention variables, BI1 – BI5 is 0.892.

4.7.2 Validity

Using Correlation Analysis, the validity of the scale items used was assessed. Validity is the degree that an instrument measures what it is designed to measure, (Saunders, et al., 2012).

4.7.3 Correlations

The Pearson *r* correlation coefficient for each scale item within the constructs was performed. Performance Expectancy, there was a significant positive relationship between the scale items measuring performance expectancy, $r = 0.488$ to $r = 0.748$, p (1-tailed) < 0.001. The lower coefficient of determination is $r = 0.488 \times 0.488 = 0.238$, converted to a percentage of variance of 23.8% shared variance. The upper coefficient of determination is $0.748 \times 0.748 = 0.5595$, converted to a percentage of variance of 55.95% shared variance.

Effort Expectancy, there was a significant positive relationship between the scale items measuring effort expectancy, $r = 0.581$ to $r = 0.749$, p (1-tailed) < 0.001.

Social Influence, there was a significant positive relationship between the scale items measuring social influence, $r = 0.699$ to $r = 0.821$, p (1-tailed) < 0.001.

Facilitating Conditions, there was a significant positive relationship between the scale items measuring facilitating conditions, $r = 0.247$ to 0.605, p (1-tailed) < 0.001.

Hedonic Motivation, there was a significant positive relationship between the scale items measuring motivation, $r = 0.297$ to $r = 0.556$, p (1-tailed) < 0.001.

Habit, there was a significant positive relationship between the scale items measuring habit, $r = 0.748$ to $r = 0.812$, p (1-tailed) < 0.001.

Behavioural Intention, there was a significant positive relationship between the scale items measuring behavioural intention, $r = 0.556$ to $r = 0.758$, p (1-tailed) < 0.001.

4.7.4 Regression Analysis

Regression analysis was carried out to analyse the relationship between the dependent variable and the independent variables.
Linear regression analysis was completed on the constructs of Performance Expectancy, Effort Expectancy, Facilitating Conditions, Social Influence, Hedonic Motivation, Price Value, Habit, Age, Gender and Experience as the predictors or constant and the dependent variable of Behavioural Intention, BI.

4.8 Interpretation of the findings

4.8.1 Regression Analysis of Variables

The constructs were measured using five-point Likert scale measurement. Linear regression analysis was performed on the variables. The variables were computed in SPSS 22 using a mean function.
Performance expectancy variables was averaged and a linear regression was performed. Performance expectancy accounts for 63.2% variation in the behavioural intention to use smartphone medical applications. The F ratio and significance value ($F = 152.742$, $p < 0.001$). Performance expectancy averaged has a significant positive effect on BI averaged, ($\beta = 0.632$, $p \leq 0.001$).

Effort expectancy variables were averaged and a linear regression was performed. Effort expectancy. Effort expectancy averaged accounts for a 41.0% variation in the behavioural intention to use smartphone medical applications. The F ratio ($F = 45.95$, $p < 0.001$). Effort expectancy averaged has a significant positive effect on BI averaged, ($\beta = 0.410$, $p \leq 0.001$).

Social Influence variables were averaged and a linear regression was performed. Social Influence averaged accounts for a 50.7% variation in the behavioural intention to use smartphone medical applications. The F ratio ($F = 79.402$, $p < 0.001$). Social Influence averaged has a significant positive effect on BI averaged, ($\beta = 0.507$, $p \leq 0.001$).

Hedonic Motivation variables were averaged and a linear regression was performed. Hedonic Motivation averaged accounts for a 39.6% variation in the behavioural intention to use

smartphone medical applications. The F ratio (F = 42.847, p < 0.001). Hedonic Motivation averaged has a significant positive effect on BI averaged, (β = 0.396, $p \leq 0.001$).

Habit variables were averaged and a linear regression was performed. Habit averaged accounts for a 61.1% variation in the behavioural intention to use smartphone medical applications. The F ratio (F = 137.289, p < 0.001). Habit averaged has a significant positive effect on BI averaged, (β = 0.611, $p \leq 0.001$).

Facilitating Conditions variables were averaged and a linear regression was performed. Facilitating conditions averaged accounts for a 34.9% variation in behavioural intention to use smartphone medical applications. The F ratio (F = 31.671, p < 0.001). Facilitating conditions averaged has a significant positive effect on BI averaged, (β = 0.349, $p \leq 0.001$).

Price Value variables were averaged and a linear regression was performed. Price Value averaged accounts for a 1.4% variation in behavioural intention to use smartphone medical applications. The F ratio (F = 0.044, p > 0.05). Price value averaged has not a significant effect on BI averaged, (β = 0.014, $p \geq 0.834$).

A linear regression was performed on the Age variable. Age accounts for 17.8% variation in behavioural intention to use smartphone medical applications. The F ratio (F = 7.488, p < 0.001). Age has a significant positive effect on BI averaged, (β = 0.178, $p \leq 0.007$).

A linear regression was performed on the Gender variable. Gender accounts for 7.4% variation in behavioural intention to use smartphone medical applications. The F ratio (F = 1.249, p < 0.05). Gender has a significant positive effect on BI averaged, (β = 0.074, $p \leq$ 0.265).

A linear regression was performed on the Experience variable. Experience accounts for 30.7% variation in behavioural intention to use smartphone medical applications. The F ratio (F = 24.020, p < 0.001). Experience has a significant positive effect on BI averaged, (β = 0.307, $p \leq 0.001$).

From the analysis of the findings the UTAUT2 model is updated. (Figure 4.18)

Updated UTAUT2 Model

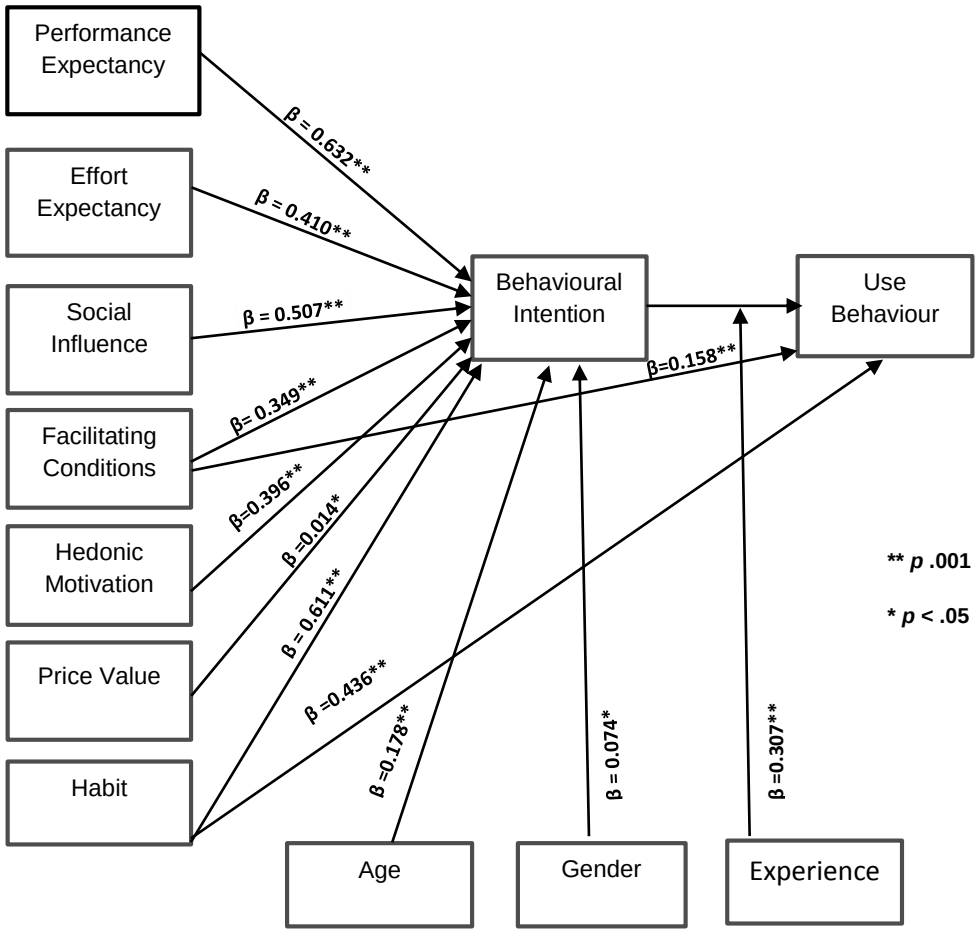

FIGURE 4.18 - UTAUT2 Model with Standardised Path Coefficients

The structural model statistics are presented in (Figure 4.18). The results of the direct effects on the dependent variable Behavioural Intention are as follows: Performance Expectancy on Behavioural Intention was β = 0.632 (*t* = 12.35, *p* ≤ 0.001), Effort Expectancy on Behavioural Intention was β = 0.410 (*t* = 6.779, *p* ≤ 0.001), Social Influence on Behavioural Intention was β = 0.507 (*t* = 8.911, *p* ≤ 0.001), Facilitating Conditions on Behavioural Intention was β = 0.349 (*t* = 5.628, *p* ≤ 0.001), Hedonic Motivation on Behavioural Intention was β = 0.396 (*t* = 6.546, *p* ≤ 0.001), Price Value on Behavioural Intention was β = 0.014 (*t* = 0.210, *p* ≥ 0.834), Habit on Behavioural Intention was β = 0.611 (*t* = 11.717, *p* ≤ 0.001), Age on Behavioural Intention, β = 0.178 (*t* = 2.736, *p* ≤ 0.007), Gender on Behavioural Intention β = 0.074 (*t* = 1.118, *p* ≤ 0.265), Experience on Behavioural Intention was β = 0.307 (*t* = 4.901, *p* ≤ 0.001), Habit on

Use Behaviour β = 0.436 (*t* = 7.815 *p* ≤ 0.001), Experience on Use Behaviour was β = 0.307 (*t* = 4.901, *p* ≤ 0.001).

The effects of Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation and Habit on Behavioural Intention were statistically significant. The hypotheses H1 – H4 and H6 – H10 were supported. The effect of Price Value was not statistically significant on Behavioural Intention. Consequently the hypothesis H5 was not supported.

The moderator variables of age and gender were not statistically significant and were not considered in the final model.

The results of the data analysis are highlighted in the test of the UTAUT2 model with standardized path coefficients, (Figure 4.18). The analysis of the results of the direct effects support the hypotheses H1 – H4 and H6 – H10.

TABLE 4.10 – Analysis of Dependent Variable on Predictors in Model.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.718[a]	.516	.495	2.32593

a. Predictors: (Constant), GEND, HM_AVE, FC_AVE, AGE, EXPER, SI_AVE, EE_AVE, PE_AVE, HB_AVE

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	1204.093	9	133.788	24.730	.000[b]
	Residual	1130.683	209	5.410		
	Total	2334.776	218			

a. Dependent Variable: BI_AVE

b. Predictors: (Constant), GEND, HM_AVE, FC_AVE, AGE, EXPER, SI_AVE, EE_AVE, PE_AVE, HB_AVE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.077	1.269		6.363	.000

	PE_AVE	.244	.057	.315	4.291	.000
	EE_AVE	.075	.056	.087	1.339	.182
	SI_AVE	.218	.080	.165	2.715	.007
	FC_AVE	.088	.072	.072	1.231	.220
	HM_AVE	-.092	.075	-.083	-1.216	.226
	HB_AVE	.298	.078	.297	3.834	.000
	EXPER	.345	.220	.084	1.571	.118
	AGE	-.035	.429	-.004	-.081	.936
	GEND	.018	.323	.003	.056	.956

a. Dependent Variable: BI_AVE

H1. Performance expectancy is positively related to consumers' behavioural intention to use smartphone medical applications. (Supported).

H2. Effort Expectancy is positively related to consumers' behavioural intention to use smartphone medical applications. (Supported).

H3. Social Influence is positively related to consumers' behavioural intention to use smartphone medical applications. (Supported).

H4. Hedonic Motivation is positively related to consumers' behavioural intention to use smartphone medical applications. (Supported).

H5. Price Value is positively related to consumers' behavioural intention to use smartphone medical applications. (Not Supported).

H6. Facilitating Conditions positively influence behavioural intention to use consumers' smartphone medical applications. (Supported).

H7. Habit positively influence consumers' behavioural intention to use smartphone medical applications. (Supported).

H8. Behavioural intention is positively related to use behaviour in the adoption of smartphone medical applications by consumers'. (Supported).

H9. Facilitating conditions are positively related to use behaviour in the adoption of smartphone medical applications. (Supported).

H10. Habit is positively related to use behaviour in the adoption of smartphone medical applications. (Supported).

H11. Age moderates smartphone medical applications adoption. (Dropped from Model).

H12. Gender moderates smartphone medical applications adoption. (Dropped from Model).

H13. Experience moderates smartphone medical applications adoption. (Dropped from Model).

The aim of the UTAUT2 model is to explain the use of smartphone medical applications technology.

4.8.2 Cross tabulation of Gender and Smartphone Medical Applications Downloaded

A cross tabulation of Gender and the question of how many smartphone medical applications have you downloaded was performed, the results are as follows: 27% (62) Female and 16.5% (38) Male respondents downloaded 1 – 2 applications, $n = 230$, χ^2 (2) = 4.643, $p = 0.98$, 19.6% (45) Female and 13.5% (31) Male respondents downloaded 3 – 4 applications and 10.4% (24) Female and 13% (30) Males downloaded more than 5 applications.

Participants were also asked, How often they use smartphone medical applications and a cross tabulation with Gender was performed, the results of the analysis are as follows: 19.7% (45) Female and 12.3% (28) Male respondents use smartphone medical applications fortnightly, n = 228, χ^2 (5) = 8.385, $p = 0.136$, 15.4% (35) Female and 14.9% (34) use smartphone medical applications weekly, 3.9% (9) Female and 4.8% (11) Male respondents use smartphone medical applications daily, 2.6% (6) Female and 2.2% (5) Males use smartphone applications 2 – 4 times daily and 1.3% (3) Males use smartphone applications more than 5 times per day.

Female respondents also show a higher propensity and willingness to pay for smartphone medical applications. A cross tabulation of how much they would actually pay for a smartphone application and Gender was performed. The analysis of the data highlighted n = 226, In the €0 category 20.4% (46) of Female respondents and 15.9% (36) Male respondents would download a smartphone medical application for free. χ^2 (4) = 5.451, $p = 0.244$. Those willing to pay between €1 - €5, 26.5% (60) Female respondents and 16.8% (38) Male respondents. Those respondents willing to pay €6 - €10, 5.3% (12) Female and 4.0% (9) Male respondents. Those willing to pay €10 – €15 are 2.2% (5) Female and 0.9% (2) Male respondents.

4.8.3 Cross tabulation of Smartphone Operating System and Gender

A cross tabulation of Smartphone Operating system and Gender was performed and 19.1% (44) Female and 16.1% (37) Males used Android smartphone devices, n = 230, χ^2 (2) = 4.612, $p = 0.100$. 37.8% (87) Females and 25.7% (59) Males reported using Apple iOS smartphones and 1.3% (3) Male respondents used Windows smartphones.

4.8.4 Cross tabulation of Current Academic Year Completed and Gender

A cross tabulation of current academic year completed and Gender was performed and the following analysis is reported, There is 11.4% (26) Female 1st year students and 5.7% (13) Male 1st year respondents that took the survey, n = 229, χ^2 (5) = 4.866, p = 0.432, 12.2% (28) Females are completing 2nd year and 7.9% (18) Males are completing 2nd year. In 3rd year, 14.8% (34) Females and 9.6% (22) Males. In 4th year, 10.5% (24) Females and 11.4% (26) Males. In 5th year, 7.4% (17) Females and 7.9% (18) Males. In 6th year, 0.9% (2) Females and 0.4% (1) Male respondent.

5.0 Conclusions and Future Work

5.1 Introduction

The purpose of this research was to determine the technology acceptance and usage of smartphone medical applications by medical students at Irish Universities. The chapter aims to conclude what this research is claiming, demonstrate that the research questions have been answered, highlight new and interesting findings, explain the limitations of the research and identify any possible future directions for furthering research in this area.

5.2 Research Question

The primary research question that this dissertation addressed was;

"What is the technology acceptance and usage of smartphone medical applications by medical students' in Irish Universities?"

The following sub-question was also addressed:

- "How are smartphone medical applications being used by medical students in Irish Universities?"

In order to address the research question and sub-question an online survey was employed to collect the data. Three hundred and ten responses were received from which the data was analysed.

5.2.1 Technology Usage and Acceptance of Smartphone Medical Applications by Medical Students in Irish Universities

The extended Unified Theory of Acceptance and Usage of Technology (UTAUT2) was utilized in the study in the consumer context of the acceptance and usage of smartphone medical applications by medical students' in Ireland. The study demonstrated that medical students are regularly using smartphone medical applications as part of their information retrieval process. In this study a 98% smartphone ownership by Irish medical students' is significantly

higher than that reported by Sandholzer, et al., (2014) for other countries, United Kingdom, 79% and Australia, 64%. The ownership rates reported by Sandholzer, et al., (2014), in their study of smartphones device ownership by medical students in the Leipzig medical school was 64.2%, this too is lower than the level of use reported in this research.

The research model utilised in the study was the UTAUT2 which aided in the analysis of the behavioural intention and usage behaviour of smartphone medical applications in a consumer context, (Venkatesh, et al., 2012). The relationships of hedonic motivation (HM), price value (PV) and habit (HB) were added to the UTUAT theoretical models constructs, (Venkatesh, et al., 2003) of performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC).

5.2.2 Performance Expectancy

Smartphone medical applications are a relatively new technology with the initial offering by Apple in 2008 in their App Store and then the Android marketplace now called the Goole Play Store the same year. Performance expectancy has a direct effect on Behavioural intention to use smartphone medical applications. The performance expectancy is the benefit that undergraduate students will derive from using smartphone medical applications. The research structural model explains 63.2% direct effect variance of Performance Expectancy (PE) on Behavioural Intention (BI).

5.2.3 Demographics

The moderators of age and gender were not confirmed by the model. The classification of the results of smartphone ownership was 56.8% (130) Female and 43.2% (99) Male, (n = 229). The age profile was 48% (110) Female participants and 34.5% (79) Male, 18 to 24 year olds, and 8.7% (20) Females and 8.7% (20) Male participants who were 25 – 34 years of age, n = 229.

5.2.4 Smartphone Medical Applications Categories Used

Smartphone medical applications, are offering the consumer the possibility of 24/7 access to information. These smartphone medical applications are portable, versatile, updateable, ubiquitous technologies. The Medical Universities in Ireland can use the results of this study to incorporate smartphone medical applications onto their curriculum with the most frequently

downloaded categories of smartphone medical applications reporting usage as Anatomy 61.5%, Medical reference 63%, Drug reference 45.5% and Clinical Guidelines 37.4%.

5.3 Generalizability of the Findings

The question of generalizability of the research refers to the likelihood that the research findings would be similar if the research was replicated in a different location with a different sample, Blanche, et al.,(2007), and if the sample size was large enough to be representative. It was important that the sampling method employed was correct and that the findings were valid. The survey collected 310 responses, which was statistically representative of the 1,835 medical students sampled. The sample required was calculated using the adjusted minimum sample size calculation. Where the population is less than 10,000, a smaller sample size is used. (Saunders, Lewis and Thornhill, 2012, p.660), (Table 5.1). Although an inclusive sampling frame was utilised, systhematic bias may still be prevalent due to sample members non participation.

$$n^1 = \frac{n}{1 + \frac{n}{N}}$$

Where

n^1 is the adjusted minimum sample size

n is the minimum sample size (as calculated above)

N is the total population

Table 5.1 - Adjusted Minimum Sample Size Calculation

$$n^1 = \frac{310}{1 + \left(\frac{310}{1835}\right)}$$

$$n^1 = \frac{310}{1 + 0.1689}$$

$$n^1 = \frac{310}{1.1689}$$

$$= 265.20 \approx 265$$

5.4 Limitations of the Research

This study had a number of limitations. Firstly due to time and financial constraints a cross sectional one-stage cluster sampling technique was utilized. Future research could employ stratified random sampling as this is more accurate than cluster sampling, as pointed out by Saunders, Lewis and Thornhill, (2012). The study focussed on smartphone medical applications acceptance and usage by medical students' at three of the Irish Universities.

The protracted nature of external ethical approval and permissions to survey students' was another limitation of the research. Each University required separate research ethics approval and individual applications were submitted through each of their Research Ethics Committee online application portals, (Appendices 7.1 – 7.6). This was a limitation, as the research was kept open for a longer period of time than was at first anticipated. Future researchers should progress all required ethical applications simultaneously to each institution at the earliest opportunity, secure letters of indemnity, letters of support and obtain permissions to survey students.

The research had mainly a quantitative priority and data analysis approach with some open ended qualitative questions. Future researchers could employ qualitative methods to gain further insights into smartphone medical application usage and acceptance. This research could take the form of focus groups or in-depth interviews.

The research concentrated on medical students in Ireland, with an age demographic of between 18 and 34 years of age and a median age of 21 years of age. Other age groups could be identified to research to achieve a broader demographic.

5.5 Future Directions for Research

The future directions for research of this nature may include the recruitment of doctors, medical students' and other healthcare workers from different geographical locations in a longitudinal analysis. Future research may include consumers' of smartphone medical applications in other countries and different age groups. Also an interesting study may incorporate a diary of how medical students use smartphone medical applications as part of their daily work or study? This longitudinal study could create a diary in a secure repository for each student throughout their medical education and allow them to interact with pharmaceutical and medical device businesses in their individual usage of downloaded

smartphone medical applications. Furthermore if the above suggestions were incorporated as a technology module within the medical curriculum of universities' it could allow students' to gain academic credits for their respective course. It would also be beneficial for application providers as current medical learning could be designed into new updates of existing applications or new applications could be created.

5.6 Summary

The study empirically tested the UTAUT2 model for consumer technology acceptance. The results show that the model explains smartphone medical application acceptance and usage. The construct of habit was analysed by asking medical undergraduate students about the frequency and prior experience they had with smartphone medical application downloads. The usage rate asked respondents if they had downloaded smartphone medical applications previously, this question highlighted historical usage. This was consistent with the study by Kim and Malhotra, (2005) on habit, where they espoused prior use as a predictor of future usage. The question results in the survey that reported the quantity of smartphone applications that were downloaded, highlighted the extent of usage and lastly the frequency of smartphone medical applications use was also analysed. These questions allowed the measurement of habit within the UTAUT2 model.

The fact that the price value hypothesis was not supported by the study may indicate that smartphone medical application pricing should stay free or at a very low level. The price value construct could be investigated in relation to the quality of smartphone medical applications. The construct of quality was a theme that is reported by university medical student respondents in the survey, they advocated that the price of the application would depend on "quality", (Figure 4.5). The constructs of hedonic motivation and habit influenced smartphone medical applications usage by medical undergraduates. The consumer acceptance of these smartphone medical applications was confirmed by the updated UTAUT2 model.

The research used statistical analysis to determine the associations between the constructs and usage behaviour using IBM SPSS Statistics 22.

In summary, smartphone applications are pervasive and ubiquitous. They allow both medical students' and professionals alike the flexibility and portability of their smartphone in any location and setting. This proliferation of smartphones and accessibility to smartphone medical applications is allowing decisions to be made more efficiently which highlights the utilization of Information Systems. Smartphones and smartphone medical applications have

joined the traditional information retrieval methods and are becoming the essential source of information for medical students' as they are carried in their pockets at all times.

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7.0 Appendices

7.1 Indemnity Cover Letter – Postgraduate Research

Willis

WILLIS
GRAND MILL QUAY, BARROW ST
DUBLIN 4

T: +353 1 661 6211
F: +353 1 661 4369
E:
W:

TO WHOM IT MAY CONCERN

Our Ref AMM/EXT.6403
Your Ref
Date 10 October 2014

Dear Sirs,

Re: Our Client - Trinity College Dublin

We act as Insurance Brokers to the above named Client, and confirm details of their insurance cover as follows:-

• **Insured Title**	Provost, Fellows, Foundation Scholars and other members of the Board of the College of the Holy and Undivided Trinity of Queen Elizabeth near Dublin
• **Business Description**	University
• **Period of Cover**	1st October 2014 – 30th September 2015
• **Insurer**	Irish Public Bodies Mutual Insurance Ltd.
• **Limit of Indemnity**	€15,000,000 in the aggregate
• **Territorial Limits**	Worldwide
• **Excess**	€25,000 each and every claim
• **Principal Exclusions**	Clinical Trials Medical Malpractice

The policy provides an indemnity against legal liability for claims arising from all of the Insured's activities as a University. This includes but is not limited to research activities.

Cover is subject to the terms, conditions and exceptions of the policy.

This letter is provided as a courtesy to our client as a matter of information only and confers no rights on the holder. Our duties in relation to this insurance are to our client and we accept no duty of care or responsibility to you or any other third party and any liability to you or any third party is excluded. This letter does not amend, extend or alter the coverage afforded by the policies, nor does it purport to set out all of the policies' terms, conditions and exclusions. The policy terms, conditions, limits and exclusions may alter after the date of this document or the insurance may terminate or be cancelled, and the limits shown may be reduced by paid claims. We have no obligation to advise you of any changes which may be made to the policies or to advise you of their cancellation or termination

Should you have any queries please contact the undersigned.

Yours sincerely

ANN MARIE MURPHY
Client Service Executive, Corporate Risks
DD: +353 (0) 1 639 6403
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E: annmarie.murphy@willis.ie

7.2 Research Ethics Approval University College Dublin

Dear Kenneth

Thank you for notifying the Human Research Ethics Committee - Sciences (HREC-LS) of your declaration that you are exempt from a full ethical review. Should the nature of your research change and thereby alter your exempt status you will need to submit an application form for full ethical review. Please note for future correspondence regarding this study and its exemption that your Research Ethics Exemption Reference Number (REERN) is: EXR-15-02-Waters-TCD. This exemption from full ethical review is being accepted by the Office of Research Ethics on the condition that you observe the following:

- **Access to UCD Students: (if applicable) Researchers requesting permission to access students in one UCD School only must seek approval from the Head of the School before data collection begins. Should you require access to students in an additional school you should also seek the approval from the relevant Head of School. Please note that any campus-wide surveys are subject to approval from the University Student Survey Board (USSB) and that you should contact this office again if required.**

- **External REC Approval and/or Permission to Access/Recruit Human Participants/or Their Data:** ***I confirm receipt of a copy of a letter confirming ethical approval from the School of Computer Science & Statistics REC in TCD – no further action is required.***

- **UCD Insurance Requirement:** ***I confirm receipt of a copy of public liability insurance cover letter from the TCD Insurance broker – no further action is required.***

- **Researcher Duty of Care to Participants: please ensure that ethical best practice is considered and applied to your research projects. You should ensure that participants are aware of what is happening to them and to their data whether a study is de-identified or not. All researchers have a duty of care to their participants who have the right to be informed, the right to consent to participate and the right to withdraw from the study.**

Any additional documentation should be emailed to exemptions.ethics@ucd.ie quoting your assigned reference number (provided above) in the subject line of your email.
Please note that your research does not require a committee review and also note that this is an acknowledgment of your declared exemption status. All Exemptions from Full Review are subject to Research Ethics Compliance Review.
Regards
Jan

Janette Stokes
Administrator
UCD Office of Research Ethics
Roebuck Castle
Belfield
Dublin 4

T: + 353 1 716 8762
E: research.ethics@ucd.ie

W: www.ucd.ie/researchethics

7.3 Trinity College Dublin – School of Computer Science and Statistics Ethical Approval

COLAISTE NA TRIONOIDE, BAILE ATHA CLIATH | TRINITY COLLEGE DUBLIN
Ollscoil Atha Cliath | The University of Dublin

To whom it may concern:

The Project entitled "Smartphone Medical Applications: Technology Acceptance and Usage by Medical Students in Ireland" (reference number #083/15), conducted by Kenneth Waters has been approved by the School of Computer Science and Statistics Research Ethics Committee of Trinity College Dublin on 28th April 2015.

Yours faithfully,

Gaye Stephens
Research Ethics Committee School of
Computer Science and Statistics
Trinity College Dublin

An Dr Jeremy Jones BA MA
Cathaoirleach
Ceann na Scoile
Scoil na nEolaíochta Ríomhaireachta agus na Staitisticí

Dámh na hInnealtóireachta na Matamaitice
agus na hEolaíochta,
Coláiste na Tríonóide,
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7.4 Ethical Approval University College Cork.

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Oifig an Leas - Uachtaráin Taighde agus Nuálaíochta
Office of the Vice President for Research and Innovation

4th Floor, Block T,
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E vpresearch@ucc.ie
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Mr. Kenneth Waters,
Postgraduate Student,
MSc Management of Information Systems,
School of Computer Science and Statistics,
University of Dublin,
Trinity College, Dublin.

27th May 2015

Dear Kenneth,

Thank you for your recent enquiry to the Social Research Ethics Committee, concerning the distribution of a survey related to your dissertation topic *Smartphone Medical Applications: Technology Acceptance and Usage among Medical Students*. The committee chair has reviewed the details which you supplied, including the TCD ethical approval documentation, and is satisfied that the project has been adequately reviewed by your institution and therefore does not require submission to SREC for ethical approval. As such, SREC has no objection to the survey, as detailed, being circulated to UCC students, though this is of course conditional on obtaining consent from UCC's School of Medicine.

We wish you every success in your research.

Yours sincerely,

pp Mairéad Mooney

Mike Murphy,
Chair of Social Research Ethics Committee

Professor Ashok Maguire BSc PhD CChem MRSC
Vice President for Research and Innovation

Ollscoil na hÉireann, Corcaigh
National University of Ireland, Cork

7.5 Online Questionnaire

Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

Smartphone Medical Applications

Participant Information Sheet

'Smartphone Medical Applications: Technology Acceptance and Usage by Medical Students in Ireland'.

You are being invited to participate in this research project which is being carried out by Kenneth Waters as part of a dissertation in the Taught Master's Programme M.Sc. in Management of Information Systems in the School of Computer Science and Statistics, University of Dublin, Trinity College. Email: kewaters@tcd.ie and Phone: 0878135073.

The purpose of the project is to investigate the technology acceptance and usage of smartphone medical applications among medical students enrolled in medical universities in Ireland.

Smartphone medical applications or '*apps*' are computer programs that can be downloaded and run on smartphones.

Smartphone medical applications for the purpose of this study are defined as any medical related smartphone application that is downloaded and installed by the smartphone owner from any of the app stores. Examples of some app stores include Apple's App Store, Amazon App Store, Google Play, Blackberry App World, Nokia OVI Store, Windows Phone Store.

The justification for this academic research is to identify whether or not smartphone medical applications are being used as part of the everyday information systems retrieval by medical students and interns in Ireland.

The research may benefit manufacturers' of smartphone medical applications, university medical faculty members, medical researchers, medical students, junior doctors and doctors that access medical information via smartphone medical applications.

Anonymity is required of all responses given by participants and care will be taken that any revealing information mistakenly given will be edited to ensure anonymity of all data.
I declare that there is no conflict of interest with the research topic or with any of the participants either individually or at an organisational level.

Your participation is voluntary; you have the right to omit individual responses without penalty and you can withdraw at any time without any consequences of any kind.

Participants are to be selected from enrolled medical students of the medical universities in Ireland.

If you agree to participate, you will be invited to answer a list of questions as part of an anonymous survey on the technology acceptance and usage of smartphone medical applications among medical students' in Ireland.

This will be an online survey and will take approximately 10 minutes to complete.

Smartphone Medical Applications

Informed Consent

Participant's Informed Consent Form

Title of the Study: 'Smartphone Medical Applications: Technology Acceptance and Usage by Medical Students in Ireland.'

Declaration of all conflicts of interest: The researcher would like to declare no conflict of interest witl the research topic or with any of the participants either individually or at an organisational level.

Background context of the research explaining its relevance: The relevance of this study is to ident the technology acceptance and usage of smartphone medical applications by enrolled medical students Ireland.

Procedures of this study: relevant to the participant

This study is based on an online survey that should take approximately 10 minutes to complete and participation is voluntary.

The survey will be conducted for 4 weeks only.

You have the right to omit individual responses without penalty and you have the right to withdraw from survey at any time. The researcher would appreciate it if all questions in the survey were answered.

Please do not name any third parties in any open text field of the survey.

Any such replies will be anonymised.

The information gathered in the survey will be used anonymously in the analysis, scientific publication a presentation of resulting data and findings.

All names and email addresses will be held in a separate section to the survey responses in relation to the Prize Draw.

The data gathered will be encrypted and stored securely.

When the study is completed all data will be deleted by the 1st of November, 2015.

Publication: A hardcopy of the final dissertation will remain in the Trinity College Library and a soft cop will be available from the course website where access will be restricted to postgraduate students throu a system of authentication.

Individual results will be aggregated anonymously and research reported on aggregate results.

Smartphone Medical Applications

Informed Consent

Declaration

I am 18 years or older and am competent to provide consent.

I have read or had read to me, a document providing information about this research and this consent form. I have had the opportunity to ask questions and all my questions have been answered to my satisfaction and understand the description of the research that is being provided to me.

I agree that all the data is being used for scientific purposes and I have no objection that my data is published in scientific publications in a way that does not reveal my identity.

I understand that if I make illicit activities known, these will be reported to appropriate authorities.

I freely and voluntarily agree to be part of this research study, though without prejudice to my legal and ethical rights.

I understand that I may refuse to answer any question and that I may withdraw at any time without penalty.

I understand that my participation is fully anonymous and that no personal details about me will be recorded.

I understand that if I or anyone in my family has a history of epilepsy then I am proceeding at my own risk.

I agree to the terms and conditions detailed above.

Yes, (If selected, questionnaire continues.)

No, (If selected, questionnaire terminates and participant is thanked.)

Statement of investigator's responsibility: I have explained the nature and purpose of this research study, the procedures to be undertaken and any risks that may be involved. I have offered to answer any questions and fully answered such questions. I believe that the participant understands my explanation and has freely given informed consent.

RESEARCHERS CONTACT DETAILS: Kenneth Waters, (Postgraduate Student, MSc Management of Information Systems, School of Computer Science and Statistics, University of Dublin, Trinity College), Phone No.: 0878135073 and Email: kewaters@tcd.ie

1. Do you agree to the terms and conditions of completing this survey?

- ◯ Yes
- ◯ No

Smartphone Medical Applications

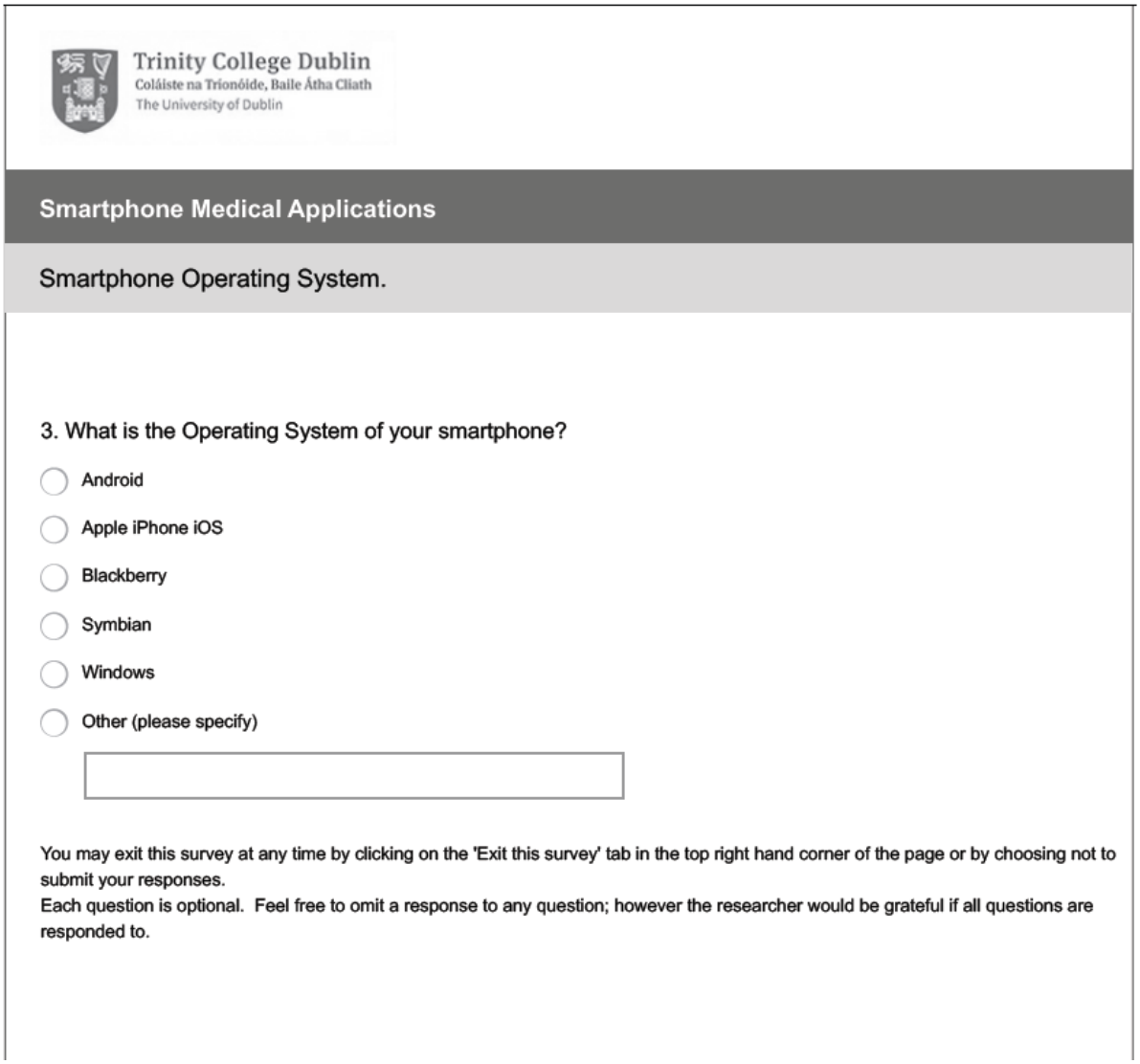
Smartphone ownership.

2.
Do you own and use a smartphone?

(A Smartphone is a mobile communications device that enables access to the internet and the download and usage of applications/ apps.)

- ◯ Yes
- ◯ No

You may exit this survey at any time by clicking on the 'Exit this survey' tab in the top right hand corner of the page or by choosing not to submit your responses.
Each question is optional. Feel free to omit a response to any question; however the researcher would be grateful if all questions are responded to.



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The University of Dublin

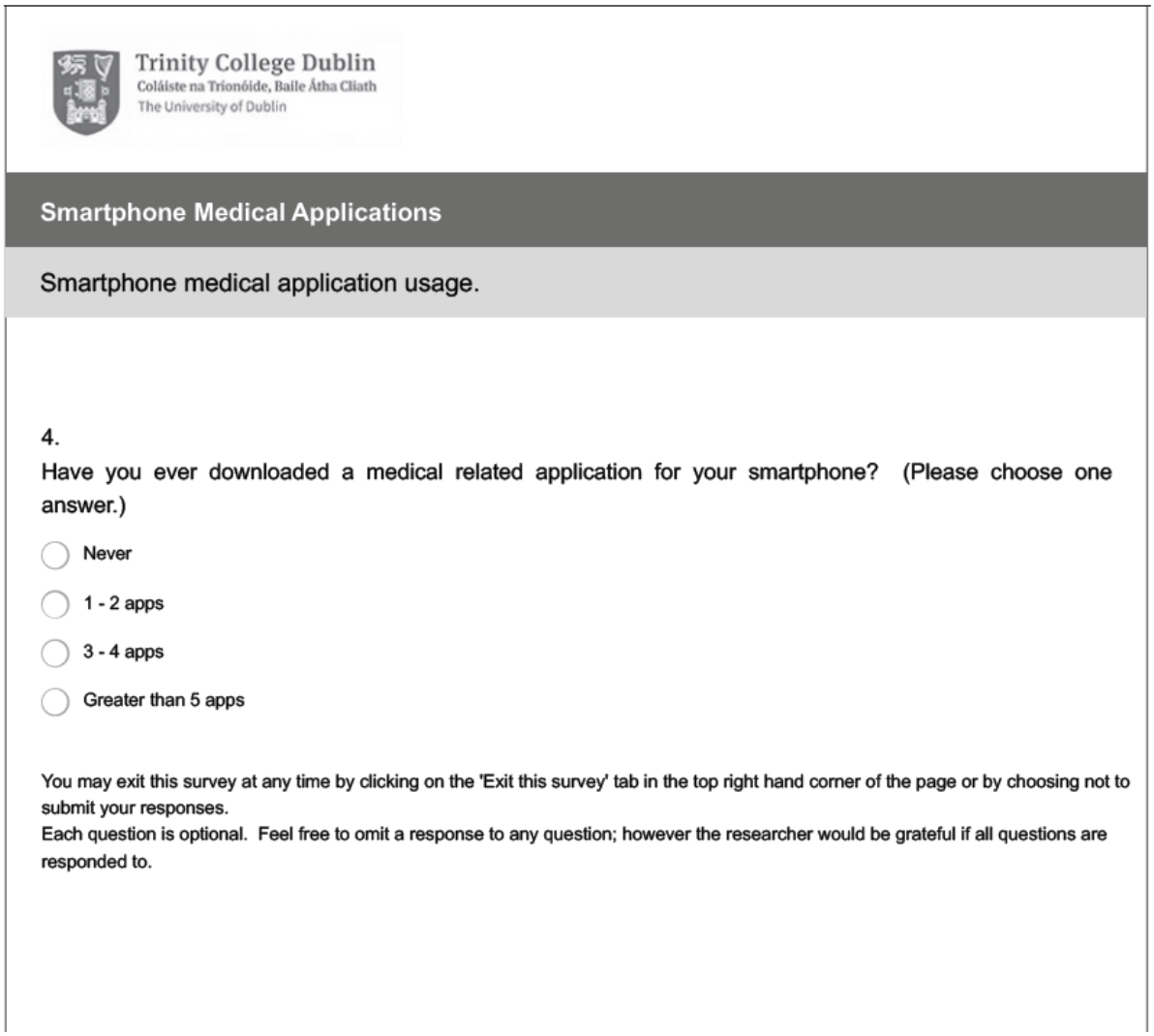
Smartphone Medical Applications

Smartphone Operating System.

3. What is the Operating System of your smartphone?

- ◯ Android
- ◯ Apple iPhone iOS
- ◯ Blackberry
- ◯ Symbian
- ◯ Windows
- ◯ Other (please specify)

You may exit this survey at any time by clicking on the 'Exit this survey' tab in the top right hand corner of the page or by choosing not to submit your responses.
Each question is optional. Feel free to omit a response to any question; however the researcher would be grateful if all questions are responded to.



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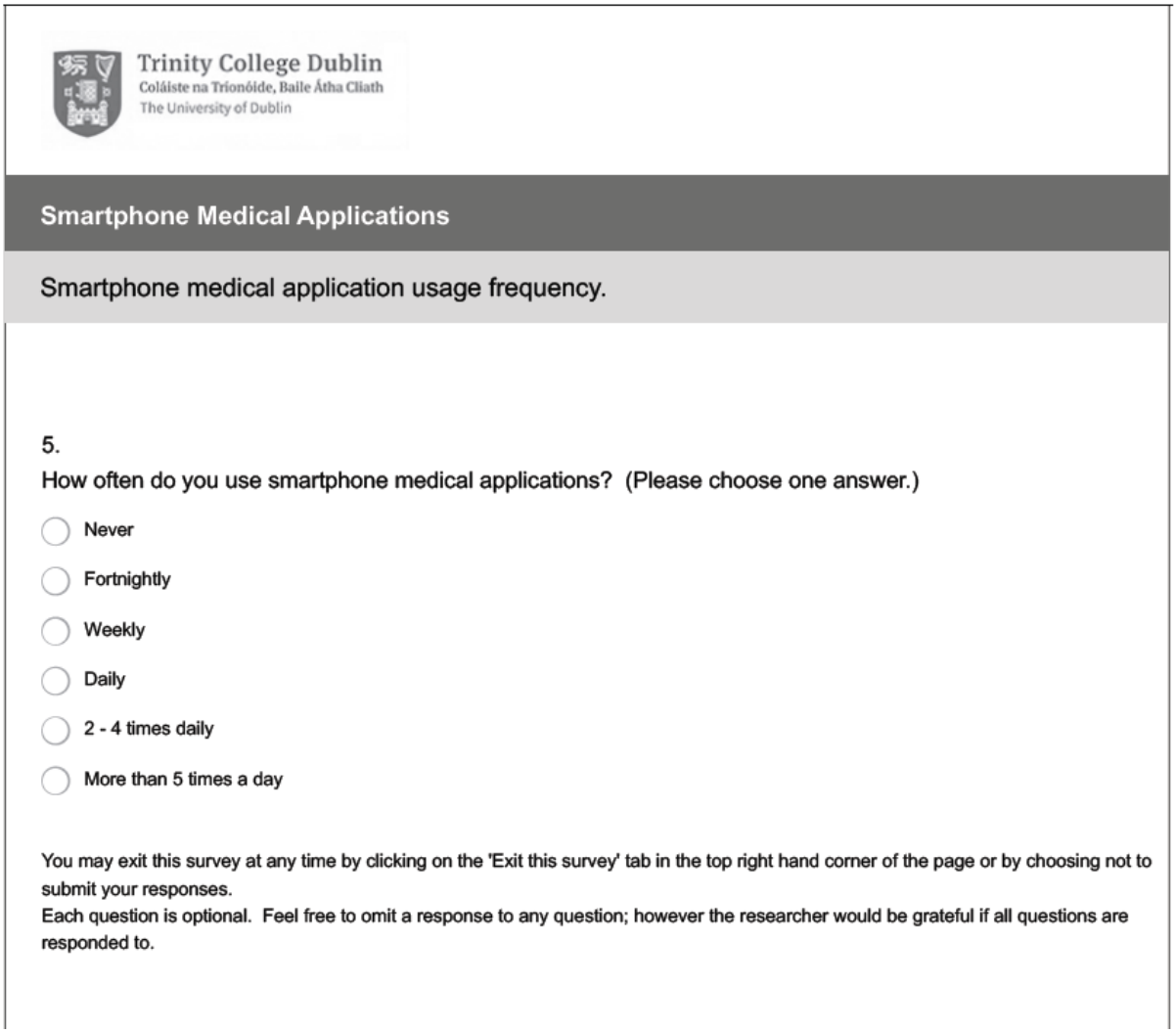
Smartphone Medical Applications

Smartphone medical application usage.

4.
Have you ever downloaded a medical related application for your smartphone? (Please choose one answer.)

- ◯ Never
- ◯ 1 - 2 apps
- ◯ 3 - 4 apps
- ◯ Greater than 5 apps

You may exit this survey at any time by clicking on the 'Exit this survey' tab in the top right hand corner of the page or by choosing not to submit your responses.
Each question is optional. Feel free to omit a response to any question; however the researcher would be grateful if all questions are responded to.



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Smartphone Medical Applications

Smartphone medical application usage frequency.

5.
How often do you use smartphone medical applications? (Please choose one answer.)

- ◯ Never
- ◯ Fortnightly
- ◯ Weekly
- ◯ Daily
- ◯ 2 - 4 times daily
- ◯ More than 5 times a day

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Smartphone Medical Applications

Types of smartphone medical applications used.

6.
What categories of smartphone medical applications have you downloaded? (Please choose any that apply, you may choose more than one.)

- [ ] Anatomy
- [ ] Encyclopaedia or Medical Reference
- [ ] Calculators
- [ ] Dictionaries
- [ ] Drug Reference
- [ ] Instruction and Procedures
- [ ] Clinical Guidelines
- [ ] Other (please specify)

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Smartphone Medical Applications

Usage.

7. What smartphone medical applications do you use? (Please name any that you use.)

8. Please indicate how much you would pay for a smartphone medical application?

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Smartphone Medical Applications

Performance Expectancy.

9.

You will be presented with some statements designed to measure the importance of smartphone medical applications.

Please answer all statements using the scale provided (Strongly Agree to Strongly Disagree.) Please provide a response to each statement.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I find smartphone medical applications useful for my studies/ degree program.	○	○	○	○	○
Using smartphone medical applications facilitates me in my exam preparation.	○	○	○	○	○
Using smartphone medical applications helps me understand concepts more quickly.	○	○	○	○	○
Using smartphone medical applications is more productive for me.	○	○	○	○	○
Overall I prefer using smartphone medical applications.	○	○	○	○	○

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Smartphone Medical Applications

Ease of Use.

10.

Please answer all statements using the scale provided.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Smartphone medical applications are easy to access.	○	○	○	○	○
My use of smartphone medical applications is clear and understandable.	○	○	○	○	○
Smartphone medical applications are easy to use.	○	○	○	○	○
It is easy to become familiar with smartphone medical applications.	○	○	○	○	○
I find it easy to get smartphone medical applications to do what I want them to do.	○	○	○	○	○

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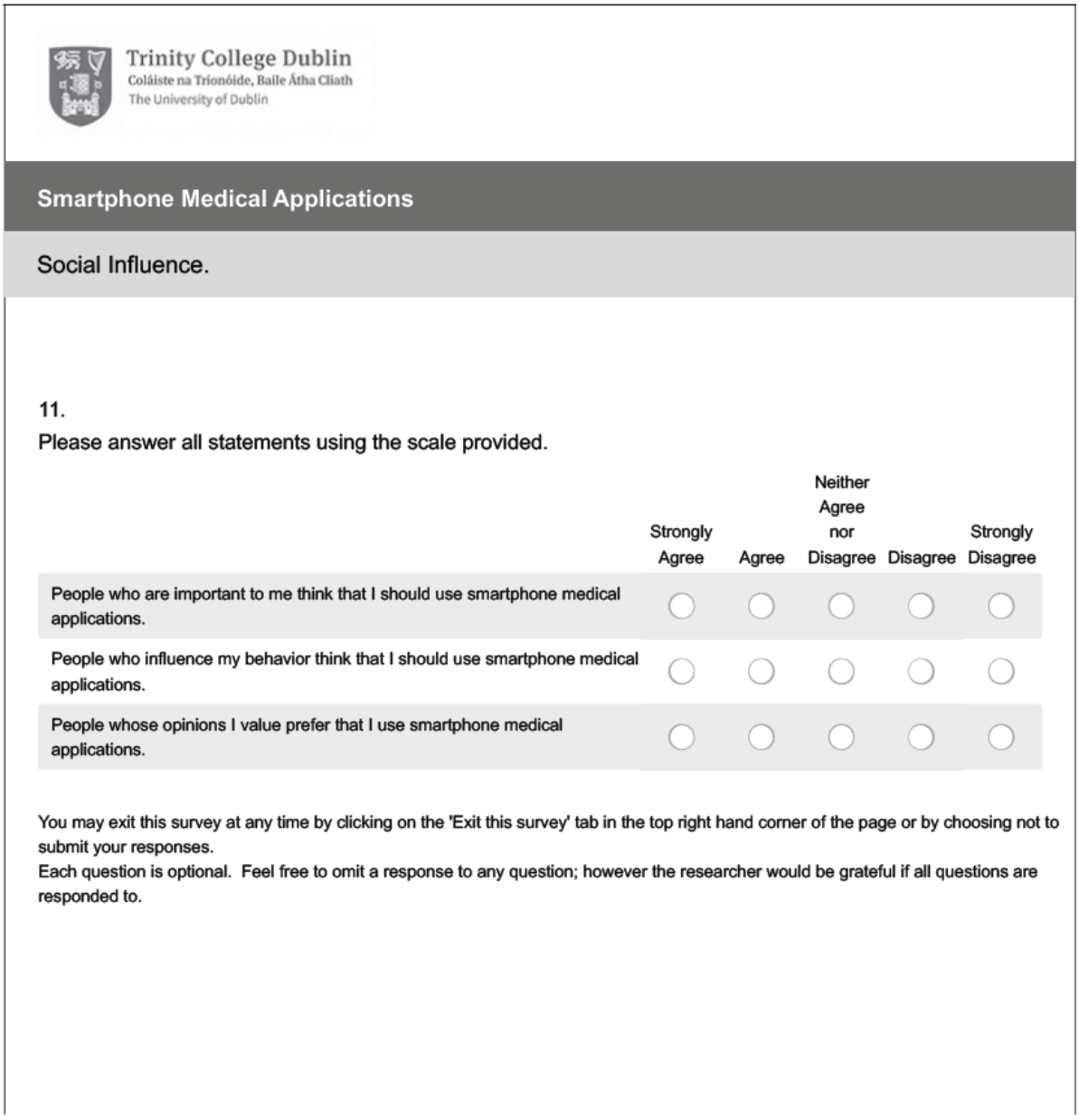

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Smartphone Medical Applications

Social Influence.

11.

Please answer all statements using the scale provided.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
People who are important to me think that I should use smartphone medical applications.	○	○	○	○	○
People who influence my behavior think that I should use smartphone medical applications.	○	○	○	○	○
People whose opinions I value prefer that I use smartphone medical applications.	○	○	○	○	○

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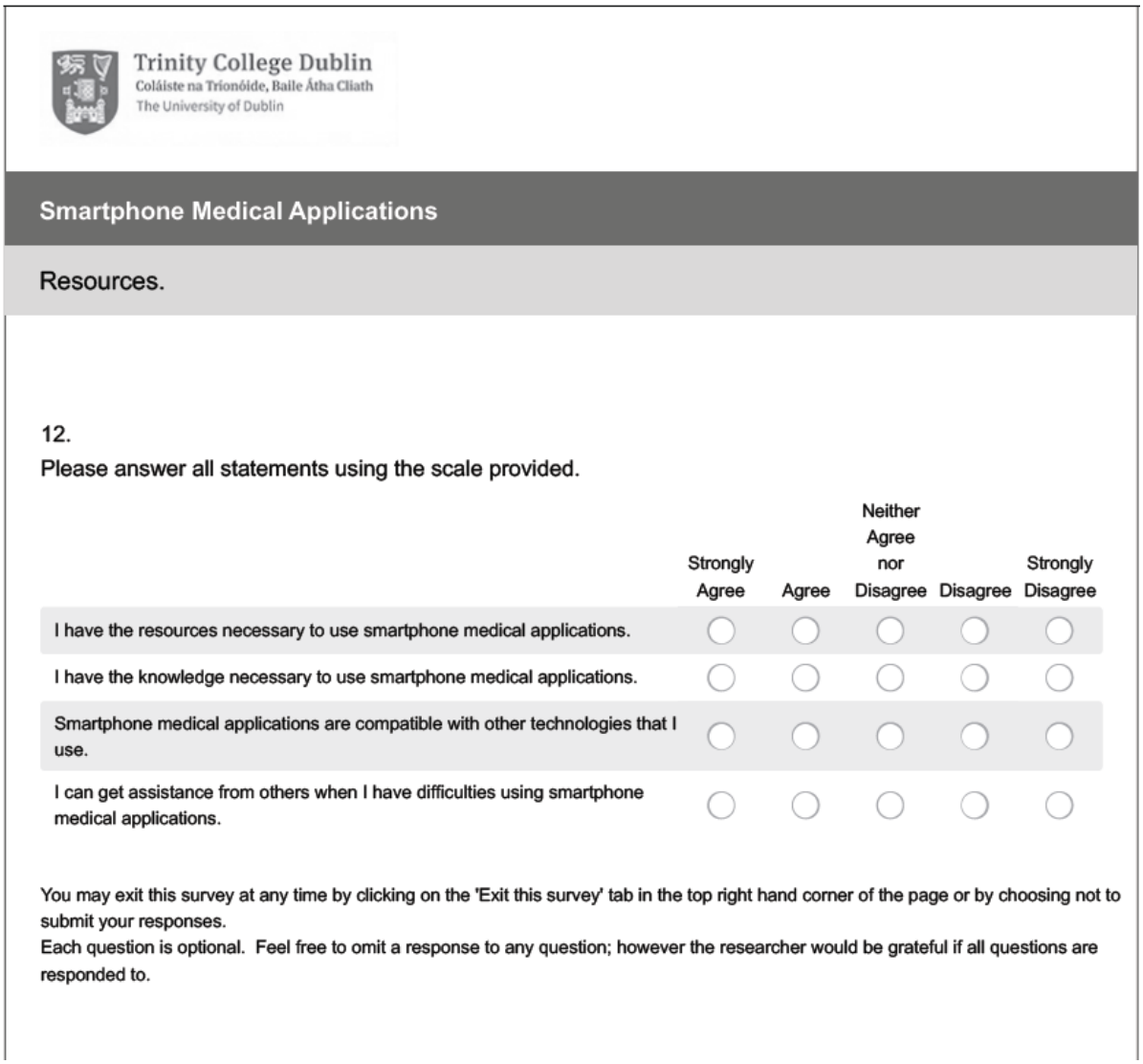

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Smartphone Medical Applications

Resources.

12.

Please answer all statements using the scale provided.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I have the resources necessary to use smartphone medical applications.	○	○	○	○	○
I have the knowledge necessary to use smartphone medical applications.	○	○	○	○	○
Smartphone medical applications are compatible with other technologies that I use.	○	○	○	○	○
I can get assistance from others when I have difficulties using smartphone medical applications.	○	○	○	○	○

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Motivation.

13.

Please answer all statements using the scale provided.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I check smartphone medical applications before looking at other medical sources.	○	○	○	○	○
I check smartphone medical applications to confirm information from other medical sources.	○	○	○	○	○
I use smartphone medical applications without consulting other medical sources.	○	○	○	○	○
I depend on smartphone medical applications exclusively.	○	○	○	○	○

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Habit.

14.

Please answer all statements using the scale provided.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Using smartphone medical applications has become a habit for me.	○	○	○	○	○
Using smartphone medical applications has become natural to me.	○	○	○	○	○
Using smartphone medical applications is becoming regular for me.	○	○	○	○	○

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Smartphone Medical Applications

Smartphone medical application behavioral intention.

15.

Please answer all statements using the scale provided.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I intend to use smartphone medical applications in the future.	○	○	○	○	○
I will try to use smartphone medical applications as part of my studies/ degree.	○	○	○	○	○
I plan to use smartphone medical applications regularly.	○	○	○	○	○
I will use smartphone medical applications in the future.	○	○	○	○	○
I will recommend to others to use smartphone medical applications.	○	○	○	○	○

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Demographics.

16.
What is your age?

- ◯ 18 to 24
- ◯ 25 to 34
- ◯ 35 to 44
- ◯ 45 to 54
- ◯ 55 to 64
- ◯ 65 or older

17.

What year are you currently completing in University?

- ◯ 1st
- ◯ 2nd
- ◯ 3rd
- ◯ 4th
- ◯ 5th
- ◯ 6th

18. Is this your final year?

- ◯ No
- ◯ Yes

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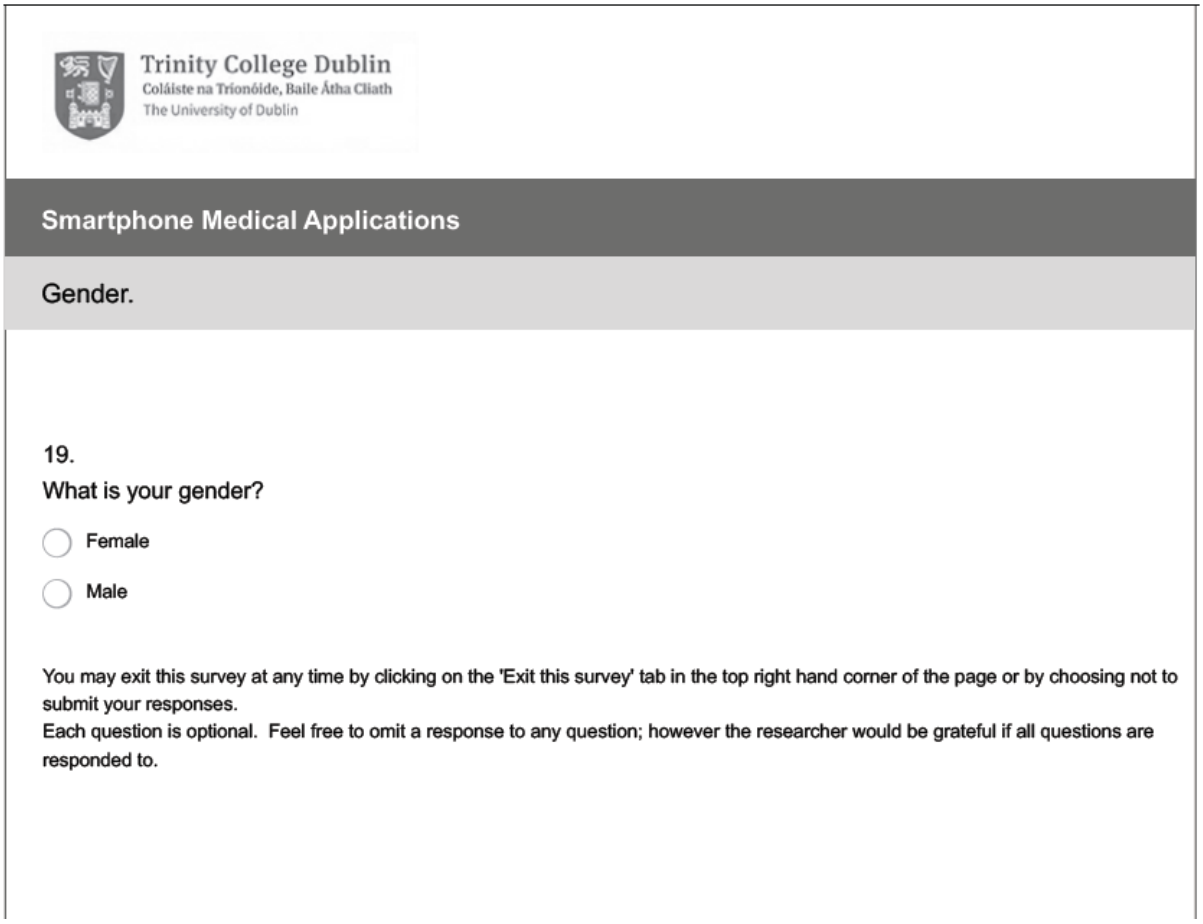

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Gender.

19.
What is your gender?

- ◯ Female
- ◯ Male

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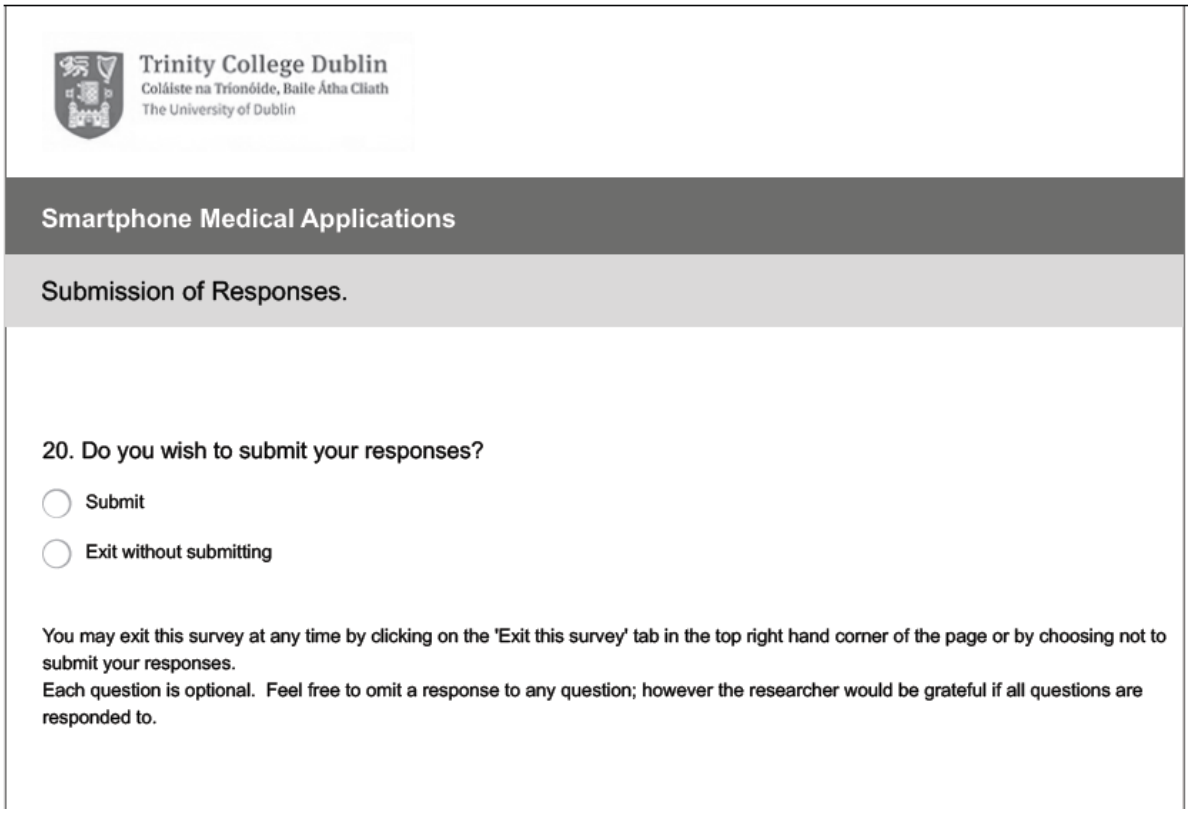

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Submission of Responses.

20. Do you wish to submit your responses?

- ◯ Submit
- ◯ Exit without submitting

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7.6 Ethical Approval SOMREC, Trinity College Dublin

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Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin

Kenneth Waters
128 Oakton Park
Killiney
Co. Dublin

24th June 2015

Ref: 20150606

Title of Study: Smartphone Medical applications: technology acceptance and usage by Irish Medial students

Dear Mr Waters,

Further to a meeting of the School of Medicine Research Ethics Committee held in June 2015, we are pleased to inform you that the above project has been approved.

Yours sincerely,

Professor Thomas Rogers
Chairperson
School of Medicine Research Ethics Committee

An tOllamh Paul Browne MB, FRCPI, FRCPath
Ceann Scoil an Leighis

Ms. Orla Bannon
Riarthóir na Scoile

Professor Paul Browne MB, FRCPI, FRCPath
Head of School of Medicine

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