# Mobile Learning for Just-In-Time Knowledge Acquisition at the Science Museum Group

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## Abstract

The Science Museum Group (SMG) Service Desk team in the United Kingdom (UK) faces the challenges of Service Level Agreement (SLA) breaches. Furthermore, the museum sector suffers significant reductions in funding made by a major sponsor in the UK. Thus, ICT Service desk staff are required to manage incidents and other demands with minimal resources. To address this problem, this paper recommends serving just-in-time knowledge in the form of knowledge articles that are also responsive to mobile devices to service users. This offering could reduce ICT support calls, increase productivity for both service desk staffs and the service user. Moreover, it presents an opportunity to develop functional technical knowledge among non-ICT SMG staff. The use of knowledge articles log files and ICT incident report log files were used to find out which staff are more likely to read knowledge articles or report ICT incidents for the purpose of targeting those staff with the just-in-time knowledge articles.

As with any technological change, challenges are pervasive in technological adoption. This study uses the unified theory of acceptance and use of technology (UTAUT) model to explain the determinants of mLearning adoption at SMG. The current study makes an original contribution to theory and practice by broadening the body of knowledge pertaining to understanding the factors contributing to mLearning adoption and its potential use for just-in-time knowledge acquisition for staff in a UK Museum context.

The results from this study indicate that the UTAUT constructs Performance expectancy, Effort expectancy, Social influence and Facilitating conditions are all significant determinants of behavioural intention to use mLearning. Surprisingly, the newly proposed construct, Self-determined learning was not a significant determinant of behaviour intentions. Further examination found age and gender moderate the relationship between the UTAUT constructs. These findings present several beneficial implications for mLearning research and practice at SMG and in a wider context. For example, to inform a broader set of technical adoption research and strategy.

## Acknowledgements

First and foremost, I am grateful to God for making this achievement possible. Through his Apostle Paul, he promised that his children “can do all things through Christ” (Philippians 4:13). This belief has sustained me throughout this journey. I would like to sincerely thank my supervisors at the University of Worcester, Temitope Alade (Director of Studies), Lynn Nichol and Mark Loon (for a brief time) for their faithful guidance and support. Their advice, commitment and insight were instrumental to the completion of this study. I would also like to thank the examiners who provided their time to read this work. I would also like to thank all study participants who provided their time and both Directors of ICT at the Science Museum Group. Many thanks also to several friends who have been a helpful and encouraging network, including Sonia Leeyou, Sonia McDonald, Sharon Planter, Sarah Benjamin, Reyaz Ali and Aslan Mackson. I would also like to thank those at the Science Museum Group that took the time to contribute to my research. Finally, this thesis and all related work is dedicated to my family (Latisha, Alex, Malachi and Ariele) and most especially to my wife, Karen.

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## Abbreviations

AMOS: Analysis of Moment Structures

AR: Augmented Reality

AVE: Average Variance Extracted

BCC: Blind Carbon Copy

BIU: Behaviour Intention to Use

BYOD: Bring Your Own Device

CFA: Confirmatory Factor Analysis

CFI: Comparative Fit Index

CIO: Chief Information Officer

CMMI: Capability Maturity Model Integration

CR: Composite Reliability

C-TAM-TPB: Combined TAM and TPB

DCMS: Department for Culture, Media and Sport

DTPB: Decomposed Theory of Planed Behaviour

EE: Effort Expectancy

EFA: Exploratory Factor Analysis

ETAM: Extended Technology Acceptance Model

FC: Facilitating Conditions

FE: Further Education

GDPR: General Data Protection Regulation

GFI: Goodness-of-Fit Index

HE: Higher Education

HNC: Higher National Certificate

HND: Higher National Diploma

HR: Human Resources

HTTPS: Hyper Text Transfer Protocol Secure

HW: Hardware

ICT: Information Communication Technology

IDT: Innovation Diffusion Theory

IFI: Incremental Fit Index

IT: Information Technology

ITIL: Information Technology Infrastructure Library

ITSM: Information Technology Service Management

KMO: Kaiser Meyer Olkin

KMS: Knowledge Management Systems

LMS: Learning Management System

MA: Museums Association

MBA: Master of Business Administration

MM: Motivational Model

MOOC: Massive Open Online Courses

MPCU: Model of PC Utilisation

NDPB: Non-Departmental Public Body

PE: Performance Expectancy

PGCE: Postgraduate Certificate in Education

QAS: Questionnaire Appraisal System

QOE: Quality of Experience

QOL: Quality of Learning

RMSEA: Root Mean Square Error of Approximation

ROI: Return on Investment

RTI: Research Triangle Institute

SCT: Social Cognitive Theory

SD: Self-Directed

SI: Social Influence

SLA: Service Level Agreement

SMG: Science Museum Group a group of 5 museums across 6 areas of England

SPSS: Statistical Product and Service Solutions

SRMR: Standard Root Mean Square Residual

TAM: Technology Acceptance Model

TEL: Technology Enabled Learning

TLI: Tucker Lewis Index

TLS: Transport Layer Security

TPB: Theory of Planned Behaviour

TQM: Total Quality Management

TRA: Theory of Reasoned Action

UK: United Kingdom

UKCES: United Kingdom Commission for Employment and Skills

UTAUT: Unified Theory of Acceptance and Use of Technology

VIF: Variance Inflation Factors

VLE: Virtual Learning Environments

VPN: Virtual Private Network

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# Chapter 1. Introduction

This chapter presents an outline of the academic and practical context for this research as well as providing a summary of the research aims, objectives and hypotheses advanced in this study. Additionally, an overview of the contributions this study has made to theory and practice is discussed.

## 1.1 Mobile learning

Mobile learning (mLearning) is a learning process where learners are not confined to fixed locations and may benefit from access to learning resources via mobile devices (Yousafzai *et al*., 2016). There has been extensive research carried out in the 21st Century focussing on mLearning (Attewell, 2005; Cheon *et al*., 2012; Cobcroft *et al*., 2006) as a knowledge acquisition tool. However, mLearning as a knowledge acquisition tool in the milieu of the work environment has not received the same level of interest as in the educational environments e.g., schools, colleges, and universities. Therefore, this thesis will focus on mLearning in the milieu of the work environment and specifically, the Museum sector.

Some of the reasons why this method of learning has been widely examined in educational institutions is due to the cost, proliferation and capabilities of mobile devices and smart phones (Naismith *et al*., 2004; Roschelle, 2003; Sarker and Wells, 2003). Additionally, due to usage trends in mobile devices and smart phones and the rapid developments made in web technologies and mobile technologies, educators e.g., teachers, lecturers and staff trainers have been leveraging these developments and capabilities to deliver learning on these devices. However, mobile devices are slowly beginning to be recognised as a useful tool in the workplace for learning and supporting work performance (Pimmer and Pachler, 2013).

According to studies by Churchill *et al*. (2014), mLearning typically falls into three paradigms. These paradigms are:

- Learning using mobile technologies (Anderson and Blackwood, 2004; Churchill and Churchill, 2008; Cochrane, 2012; Song and Fox, 2008).

- Learning while physically mobile (Gu *et al*., 2011; Kristoffersen and Ljungberg, 2000; Seppälä and Alamäki, 2003; Wong *et al*., 2010).
- Learning in a dynamic, seamless, and ubiquitous learning environment (Diaz *et al*., 2015; Kearney *et al*., 2014; Song, 2014; Ting, 2013; Wong and Looi, 2011).

The definition of mLearning that the current research will adopt is based on paradigms and themes that permeates mLearning definitions in literature and its application in the context of the Science Museum Group (SMG). Accordingly, mLearning is the provisioning of a learner-centred and flexible learning environment that enables knowledge construction, job skill development training, and performance support across a variety of locations and work performance contexts. This learning environment is ubiquitous and supported using mobile devices that enables direct access to learning materials and resources.

## 1.2 The Science Museum Group (SMG)

The cultural heritage sector comprises of build heritage, heritage landscape, conservation, archaeology, galleries with collections and museums. The sector contributes £13.1 billion to the UK economy (Centre for Economics and Business Research, 2018).

SMG operates in the cultural heritage sector as a non-departmental public body (NDPB). This is within the public sector but owes no special obligation to its sponsor department, the Department for Digital, Culture, Media & Sport (DCMS) (Open Government Licence, 2018).

SMG comprises of five national museums across England:

- The Science Museum based in London.
- The Museum of Science and Industry located in Manchester.
- The National Railway Museum situated in York and Shildon.
- The National Science and Media Museum located in Bradford.
- The Science Museum Wroughton in Wiltshire.

Each of the museums within the Group aim to put forward international stature alongside local prominence and focus. For example, The Science Museum explores the science, technology, engineering, mathematics, and medicine that shape the lives of UK residents and the rest of the world. The Museum of Science and Industry explores how ideas can change the world, from the Industrial Revolution to today. The National Railway Museum explores the enormous impact of railways on Britain and the rest of the world. The National Science and Media Museum explores the transformative impact of image and sound technologies on the lives of UK residents.

The group's 300,000+ collections are from the fields of science, technology, engineering, mathematics, and medicine. The group receives nearly 6 million visits of all age groups each year and reaches many others beyond the walls of the five museums through outreach programmes (Science Museum Group, 2015).

### 1.2.1 Catalyst for change at SMG

David Fleming, the president of the Museums Association (MA), argues, an "inevitable consequence of budget cuts is that museums will have to adjust the way they work." (Sullivan, 2015). As a response to this issue, the heads of each department across SMG were tasked with the job of exploring novel ways to cut costs, increase revenues and increase productivity e.g., work accomplishment of both individuals and groups of individuals within less time. This is the way departments at SMG typically interpret the definition of productivity as they are required to meet or exceed project targets that are benchmarked using DCMS performance indicators. Some departments decided to reduce head count. Others decided to increase income by canvasing potential donors. New business units were also created with the objective to increase the audience reach of the museum's collection, profile, brand, and income. The ICT department was tasked with the same mission. Members of the ICT department came together to strategize how they could best support the various initiatives around SMG as well as their own initiatives to increase productivity, cut costs and increase revenues. Mobile technologies offer simple methods to develop technical skills and gain constant access to a wide range of learning materials. Thus, mLearning has the potential to reach both remote and marginalized groups (i.e., volunteers and contractors), granting them easy access to learning and development materials (Sharples, 2013). This form of learning can potentially cut costs and increase productivity. It is for these reasons mLearning was incorporated into the SMG ICT Training Strategy as the ICT department believes that this agile form of learning can broaden its employee-base's core technological competencies and capabilities. The use of mLearning will reduce the number of incoming training related ICT support calls. Consequently, allow for the freeing up of service desk personnel to focus on other, high value-added aspects of their role. An example of this, would be improving customer service skills among ICT service desk staff and improving knowledge and skills to support SMG's technological infrastructure.

Government funding is a substantial part of the SMG's income along with fundraising activities, visitor giving/donations, exhibition ticket sales and Corporate Membership. In addition to these revenue streams, corporate firms provide funding to SMG (Science Museum Group, 2015). However, a major sponsor of the SMG announced in 2015 that they will be subject to a real term decrease of 30% in funding. Government says museums need to demonstrate they win the hearts and minds of patrons with a view of securing government funding in the future. Winning the hearts and minds of patrons can only be achieved by making exhibitions and associated programs accessible and relevant. This invariably leads to pressure for museums to seek innovative ways to leverage technology with a view to create and install elaborate installations and exhibitions that increase patronage.

At the time of writing this thesis, SMG was undergoing changes involving the use of new technologies. The catalyst to these changes is SMG's response to the business environment in which they operate. Subsequently, the Board of Directors have approved the Digital Strategy whose intention is to "improve audiences' digital experiences of the museums and online; embed digital across the organisation and build organisation-wide digital capability" (Science Museum Group, 2015, p. 5). These changes impact the role of ICT service desk staff who support users through these changes. Furthermore, publicly funded organisations such as museums must be meticulous in how they allocate their operating funds. This calls for efficient working practices in all departments. In practice, the application of these efficiencies has led to a recruitment freeze. As a result, SMG's ICT department have had to halt the recruitment of more ICT service desk staff to manage the current and future planned upgrade of the technological estate and the changes that ensue.

The funding cuts and the subsequent responses to these cuts have created a substantial cultural and operational challenge for SMG, and it is why aspects of the ICT training strategy proposed to mitigate the inherent issues caused by this change, is to offer bitesize learning objects (Kitchin, 2015). The intention is that learning can be achieved on demand, wherever and whenever it is needed. Accordingly, an mLearning approach is more appropriate and will be more conducive to supporting employees given the constraints (e.g., recruitment freeze and decrease in funding), as opposed to electronic Learning (eLearning), which typically provides in-depth knowledge on a subject therefore requiring a longer and broader course delivery (Gutierrez, 2015). It is envisaged that a more knowledgeable and skilled workforce will be created through the leveraging of mobile technologies which will lead to better staff productivity and provide a competitive advantage that is not replicable by other museums in the sector.

### 1.2.2 New ways of working

To ascertain the potential adoption of new ways of working with IT, a survey was carried out by the Head of Design and Architecture. This survey was not part of the current research. However, it provided useful insights into SMG's staff attitude towards new ways of working with IT. The data from the survey revealed 37% of staff considered themselves reliant on mobile access to data outside the museum more than "occasionally", with 45% being more than "occasionally" reliant while mobile within our museums. The survey also revealed that 75% of staff would be happy to have more self-service to aid the access to files and other resources quicker and easier. These findings present an opportunity to explore novel ways of using mobile devices to present just-in-time knowledge to SMG staff. The concept of just-in-time originated in Japanese car manufacturing plants and it was developed for the purpose of improving its manufacturing processes. The same concept is being applied at SMG for the purpose of delivering the right information to the inquiring staff in a timely manner (Kerschberg and Jeong, 2005).

Results from the same survey revealed, the adoption of using personal or work issued mobile devices for work related purposes has had a mixed picture of success. This take up has largely been adopted by ICT staff members in the four ICT departments, Architecture and Design, Business Development and Engagement, ICT Projects, and ICT Operations. In other parts of the business, the uptake has been low. This is perhaps due to a mixture of factors, mainly the lack of education/skills in connecting SMG ICT equipment with staff's own home wireless internet networks. Additionally, insufficient skills using the SMG's portal that gives staff remote access to shared folders, SMG's intranet site and other resources. These findings are insightful as they help to understand attitudes towards different ways of working e.g., using personal or work issued mobile devices for work related tasks and how these attitudes can inform mLearning adoption strategies. A successful implementation of mLearning may therefore depend on employees' intention to adopt mLearning, of which little is known. Therefore, this research will set out a comprehensive investigation of key factors influencing employees' intention to use mLearning at SMG.

### 1.2.3 The potential impact of mLearning at SMG

According to Google analytics, 40% of staff members who access the SMG intranet, do so via a mobile device. This is important as a high percentage of those staff members can report ICT incidents via the ICT Service desk portal located on the intranet. This presents an opportunity to serve just-in-time knowledge in the form of knowledge articles to those types of service users. If adopted by non-ICT SMG staff, this offering could potentially reduce ICT support calls by 18%, increasing productivity for both service desk staffs and the service user. Moreover, it presents an opportunity to develop practical technical knowledge and skills among non-ICT SMG staff.

### 1.2.4 Unified Theory of Acceptance and Use of Technology (UTAUT) Model

Unified Theory of Acceptance and Use of Technology (UTAUT) is a technology acceptance model that amalgamates elements across eight models and was created by Venkatesh *et al*. (2003). Venkatesh *et al*.'s (2003) research found that the four constructs (i.e., performance expectancy, effort expectancy, social influence and facilitating conditions) of the UTAUT model appear to be significant determinants of user acceptance and usage behaviour of technology. Additionally, there are four moderators of the four constructs' relationships which are 1) gender, 2) age, 3) experience and 4) voluntariness of use. An adaptation of this model will be used as the lens for the assessment of behavioural intentions to adopt mLearning as a just-in-time knowledge acquisition tool at SMG.

Venkatesh *et al*. (2003) defines performance expectancy as the extent an individual considers the utility of an information system and the performance gains attained in their job from using it. Venkatesh *et al*. (2003) describes effort expectancy as the extent to which the use of the information system is achieved with ease. They also define social influence as the extent to which an individual perceives that either senior staff members or someone that can influence behaviour thinks they should use the information system. They define facilitating conditions as the extent to which an individual perceives the organisational and technical infrastructure's ability to provide support for the information system.

## 1.3 Research problem

Currently, service desk processes approximately 70 incidents per day. The team of first, second, and third-line support, closes approximately 45 – 80 incidents per day. These incidents fall into 1 of any 4 categories of priorities. 1) Critical, 2) High, 3) Moderate and 4) Low. In line with SMG's ICT Service Level Agreement (SLA), Critical priority incidents need to be closed within 2 hours. High priority incidents need to be closed within a day, Moderate incidents 3 days, and Low priority incidents within 5 days. However, current experience indicates that some critical priority incidents take up to two working days to resolve. High priority incidents have been typically resolved the same day. However, there have been a few high priority incidents which have taken between 4 and 41 working days to resolve, depending on the resource availability and the requirements needed to close the incident. Moderate incidents have taken between 30 mins to 3 months. Typically, Low priority incidents take between 1 and 2 days to resolve, the longest being 5 months. The problem facing the Service Desk team is Service Level Agreement (SLA) breaches due to an overstretched Service Desk team. To address the squeeze on resources, mLearning is proposed as an innovative technique to maximise the efficiency of the Service Desk function. Additionally, an mLearning intervention can transfer learning materials easily and rapidly among staff enabling SMG employees to engage in the continued development of knowledge, skills, and competencies (Davidson-Shivers and Rasmussen, 2006; Kahle-Piasecki *et al.*, 2012; Miner, 2009) needed in a complex and changing environment. The significance of this novel technique is that until now, little attention has been paid to how a newly emerging mLearning environment could facilitate better service provisioning and support ICT related problem calls and support excessive demand on the service desk team. There is limited understanding of such problems in literature hence why this investigation is worth conducting.

## 1.4 Research aim, objectives, and hypotheses

The main aim of this research is to investigate mLearning as a just-in-time knowledge acquisition tool for solving ICT training related incidents at the SMG. This aim is achieved by three broad objectives. 1) To determine which staff members, have the tendency to report an ICT incident using SMG's service desk system known as ServiceNow™. 2) To analyse ServiceNow™ knowledge articles to determine which staff members, have the tendency to read them. 3) To derive models for the adoption and use of mLearning as a form of just-in-time knowledge acquisition tool at SMG. These models will also consider if gender and age moderate these relationships.

Previous studies on ICT and gender have been well investigated and understood (Nsibirano, 2009). Nsibirano's review of gendered digital divide literature has found that there is a difference in the way males and females have access to and use ICT. However, their research has ignored if gender differences can predict the use of tools used for just-in-time knowledge acquisition and reporting ICT incidents. Equally, age and ICT usage has been the focus of many research projects. Hence, this study will not apply an age lens to this research. However, it is recognised that there are attitudinal differences between younger and older staff towards the adoption of new technology. For example, in management literature reviewed by Posthuma and Campion (2009) dating as far back as 2001. They have found that older staff have historically been perceived as being less keen to implement new technologies in their working practice. Older staff members have also been perceived as being less receptive to training (Warr and Pennington, 1993). Warr and Pennington (1993) define older staff as those over the age of 40. This definition was based on survey items which asked respondents whether they believed that there were differences between older and younger workers. The respondents were asked to compare workers aged 40 and over with younger workers. This insight is pertinent to the current study as 40s and over represent 33% of SMG's workforce and the respondents of the current research. Subsequently, the current study will seek to find out if age moderate the relationships between the factors that determine behavioural intention to use mLearning. All these insights are important to senior management throughout SMG as this may constitute a form of digital divide among SMG staff. Additionally, these insights are useful for managers operating in other business sectors. Therefore, it is essential for SMG to investigate these apparent disparities and stereotypes so that solutions can be derived to minimise this digital divide and maximise technological and mLearning adoption. Thus, this study will contribute to literature and ICT service desk practice by aiming to fill this gap in knowledge.

### 1.4.1 Research questions and objectives

Based on the objectives outlined below, this study will answer the following research questions (RQ):

***RQ1***: To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG?

***RQ2:*** What are the relationships between gender and reading ServiceNow™ knowledge articles?

***RQ3:*** What are the relationships between gender and reporting ICT incidents?

***RQ4:*** What factors determine SMG employees' behavioural intention to adopt and use mLearning?

***RQ5:*** To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?

The current research aim is to investigate mLearning as a just-in-time knowledge acquisition tool for solving ICT training related incidents at the SMG and will be achieved by the following specific research objectives:

- To analyse data from the tools available to SMG staff that can be used for mLearning.
- To analyse ServiceNow™ SMG's Information Technology Service Management (ITSM) solution reports, categorizing support calls into training and non-training related groups.
- To analyse ServiceNow™ reports to determine if the use of mLearning could resolve ICT support call issues.
- To measure the impact of mLearning on the frequency of ICT support calls on training related issues.
- To examine various considerations in andragogical practice, i.e., Self-directed learning.
- To analyse questionnaire data and determine the use of mLearning in SMG.
- To analyse questionnaire data and determine factors contributing to mLearning adoption at SMG.
- To provide recommendations to the SMG's Senior Management team for improving the adoption and implementation of mLearning in the SMG in order to achieve operational objectives.

See table 1.1 which clarifies the relationship between hypotheses and research questions

Table 1.1 Relationship between research questions and hypotheses

| Research questions | Corresponding Hypothesis/Research question answer |
|---|---|
| ***RQ1***: To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG? | An analysis of reported ICT incidents and knowledge article reports have shown that knowledge articles had been viewed and continue to be viewed by SMG staff. Additionally, an analysis of ICT incident reports 806 (10.94%) benefitted from a mLearning intervention such as, a knowledge article addressing the reported ICT incidents. |
| ***RQ2:*** What are the relationships between gender and reading ServiceNow™ knowledge articles? | **Hypothesis 2:** Gender and reading knowledge articles are not independent of one and other. |
| ***RQ3:*** What are the relationships between gender and reporting ICT incidents? | **Hypothesis 1:** Gender and reporting ICT related incidents are not independent of one and other.<br><br>**Hypothesis 3:** Gender and reporting an ICT incident related to knowledge articles are not independent of one and other. |
| ***RQ4:*** What factors determine SMG employees' behavioural intention to adopt and use mLearning? | **Hypothesis 4:** Performance expectancy has a positive effect on behavioural intentions to use mLearning.<br>**Hypothesis 7:** Effort expectancy has a positive effect on behavioural intention to use mLearning.<br>**Hypothesis 10:** Social influence has a positive effect on behavioural intention to use mLearning.<br>**Hypothesis 13:** Self-directed learning has a positive effect on behavioural intentions to use mLearning.<br>**Hypothesis 16:** Facilitating conditions does not impact behavioural intentions to use mLearning. |
| ***RQ5:*** To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning? | **Hypothesis 5:** Performance expectancy influences behavioural intention to use mLearning more strongly for male staff than for female staff.<br>more strongly for older staff members than for younger staff members.<br>**Hypothesis 6:** Performance expectancy influences behavioural intention to use mLearning more strongly for younger staff than for older staff.<br>**Hypothesis 8:** Effort expectancy influences behavioural intention to use mLearning more strongly for female staff than for male staff.<br>**Hypothesis 9:** Effort expectancy influences behaviour intention to use mLearning more strongly for older staff than for younger staff.<br>**Hypothesis 11:** Social influence influences behavioural intention to use mLearning more strongly for female staff than for male staff.<br>**Hypothesis 12:** Social influence influences behavioural intention to use mLearning more strongly for older staff than for younger staff.<br>**Hypothesis 14:** Self-directed learning influences behavioural intentions to use mLearning more strongly for male staff than for female staff.<br>**Hypothesis 15:** Self-directed learning influences behavioural intention to use mLearning more strongly for older staff members than for younger staff members. |

### 1.4.2 Research hypotheses

The hypotheses advanced in this research are in relation to the above research questions and are as follows:

**Is there a statistically significant relationship between gender and reporting ICT incidents?**

- Hypothesis 1: Gender and reporting ICT related incidents are not independent of one and other.

**Is there a statistically significant relationship between gender and reading knowledge articles?**

- Hypothesis 2: Gender and reading knowledge articles are not independent of one and other.

**Is there a statistically significant relationship between gender and reporting an ICT incident related to knowledge articles?**

- Hypothesis 3: Gender and reporting an ICT incident related to knowledge articles are not independent of one and other.

**What are the determinants of behavior intentions to use mLearning at SMG?**

- Hypothesis 4: Performance expectancy has a positive effect on behavioural intentions to use mLearning.
- Hypothesis 7: Effort expectancy has a positive effect on behavioural intention to use mLearning.
- Hypothesis 10: Social influence has a positive effect on behavioural intention to use mLearning.
- Hypothesis 13: Self-directed learning has a positive effect on behavioural intentions to use mLearning.

- Hypothesis 16: Facilitating conditions does not impact behavioural intentions to use mLearning.

**Does gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning at SMG?**

- Hypothesis 5: Performance expectancy influences behavioural intention to use mLearning more strongly for male staff than for female staff.
- Hypothesis 6: Performance expectancy influences behavioural intention to use mLearning more strongly for younger staff than for older staff.
- Hypothesis 8: Effort expectancy influences behavioural intention to use mLearning more strongly for female staff than for male staff.
- Hypothesis 9: Effort expectancy influences behaviour intention to use mLearning more strongly for older staff than for younger staff.
- Hypothesis 11: Social influence influences behavioural intention to use mLearning more strongly for female staff than for male staff.
- Hypothesis 12: Social influence influences behavioural intention to use mLearning more strongly for older staff than for younger staff.
- Hypothesis 14: Self-directed learning influences behavioural intentions to use mLearning more strongly for male staff than for female staff.
- Hypothesis 15: Self-directed learning influences behavioural intention to use mLearning more strongly for older staff members than for younger staff members.

### 1.4.3 The research approach

At the beginning of this project, a series of feasibility tests to ascertain viability and reliability of the proposed methods used in the study were conducted. This was in the form of a preliminary study, i.e., first phase study. The first phase of the study had two aims 1) evaluate the tools available to SMG staff used for just-in-time knowledge acquisition as well as the tools used for reporting ICT incidents and 2) develop the instrument that will be used to measure SMG staff's intention to use mLearning in the workplace for just-in-time knowledge acquisition. This instrument was based on the construction and adaptation of Venkatesh *et al*.'s (2003) UTAUT theoretical model. The second phase of the current study was to collect survey data from the survey created in the first phase of this study. Finally, an analysis of the survey data was performed using structured equation modelling (SEM). SEM provides a framework for statistical analysis, inclusive of several traditional multivariate procedures (Anderson and Gerbing, 1988).

## 1.5 Contribution to theory and practice

The extent to which mLearning can be used as a tool for knowledge acquisition and its impact on productivity and specifically, the effective management of ICT support calls in the museum sector remain largely unknown. The new knowledge and practice contributions made by this study regarding IT service desk management and mLearning adoption helps to reduce this gap in knowledge. Results from this study have revealed several interesting findings that suggests there is a significant relationship between gender and reporting an ICT incident. Female staff are more likely to report ICT related incidents than male staff. There is no significant relationship between gender and reading knowledge articles. Gender and age differences exist in the moderating effects of the determinants of behaviour intention to use mLearning. These findings are unique and informative in relation to general IT Service desk practice and research in this sector.

The knowledge acquired from this study is key to IT service desk management practice as it will help to inform the creation of future knowledge articles and ICT incident reporting processes. Additionally, IT service desk management can use the findings from this study to assist with resource allocation and decision-making pertaining to new ICT project implementations. This is the first analysis of the data from the tools available to SMG staff for knowledge acquisition and reporting ICT incidents, with consideration to gender in the milieu of the Museum sector. Thus, indicating a gap in literature and in practice, making this area seminary for further investigation.

This research measured the current use of mLearning and used the unified theory of acceptance and use of technology (UTAUT) model to investigate the determinants of mLearning adoption at SMG. UTAUT is an adoption model created by Venkatesh *et al*. (2003) who proposed a unified model, called the unified theory of acceptance and use of technology, which amalgamates elements of eight other models. The UTAUT model consists of four determinants of behavioural intention and usage, which include 1) performance expectancy, 2) effort expectancy, 3) social influence and 4) facilitating conditions. Additionally, there are four moderators of the central relationships also known as interactions, which are 1) gender, 2) age, 3) experience and 4) voluntariness of use. Insights from this study will help to understand the extent mLearning use can impact the frequency of ICT support calls. Management in other departments and within the UK and worldwide cultural heritage sector will also want to know of the benefits and if they are transferrable. This is because the findings from this study can help to shape decision making when implementing other technological change in SMG and similar museums. These research findings have also contributed to expanding the body of knowledge regarding the understanding of the UTAUT model.

This study has been conducted over a few years and the results from this research has already contributed to the implementation of several new ICT Service desk processes. For example, Senior management enabled the upgrade of the ServiceNow™ portal. This upgrade has facilitated the decommissioning of old knowledge articles and the creation of new ones. The new knowledge articles are created differently so they are more responsive to mobile devices, such as smart phones and tablets. Previously, knowledge articles were web pages that contained PDFs that the user would download or print. ICT Service Desk staff are now trained to create knowledge articles not only for the ICT department teams but for non-ICT staff members, using jargon free language. Thus, making them easier to navigate and use.

This research has also expanded the understanding of mLearning usage in a novel environment, for example, staff in the museum sector. The findings from this research have been presented and published in the following peer reviewed mLearning conference proceedings, book chapters and international journals (see Appendix 1, Appendix 2, Appendix 3, Appendix 4):

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## 1.6 Outline of the thesis

This brief overview of the upcoming chapters describes how the sections of the thesis are organised and how they will address the overall research aims and objectives.

Chapter two critically reviews the current state of knowledge regarding mLearning. It expounds the literature written about mLearning in order to ground and define the research problem. This chapter presents the literature review which explores studies gathered from several research databases. The chapter provides a critical review of the development of mLearning. It will also present definitions of other closely related topics such as Technology Enabled Learning (TEL), knowledge management, distance learning, eLearning, communities of practice and definitions pertaining to Andragogy. This chapter also investigates what the literature states about the differences and similarities of workplace learning and learning in an academic environment. Furthermore, this chapter will provide a review of Technological adoption models including the one used in the current study. Additionally, a brief exploration of the current state of knowledge regarding gender and age differences and its effects on how staff use knowledge management systems (KMS) (such as, knowledge-based articles) and Information Technology Service Management (ITSM) will be presented.

Chapter three initially describes the rationale for the methods chosen and subsequent methodological approach. Chapter three then provides a critical overview of the specific methods of data collection and analysis whilst expounding on how they address the aims of the research. It discusses how access to the participants was achieved and the sampling strategy employed in this study. It also presents a discussion on ethics and how it was applied to this research. In addition, aspects of the first phase of this study, specifically methodology and methods used will be discussed throughout this chapter. Moreover, this chapter presents a definition of each of the determinants of mLearning adoption at SMG and their relationship across the eight technology acceptance models discussed in *Chapter 2.* stating the role of the key moderators (gender and age) and proposing the theoretical rationale for the final 13 hypotheses that will be advanced in this study. Moreover, this chapter will present the rationale for the adaptation of the UTAUT model that will be used in this research.

Chapter four elucidates on the data analysis methods used to test the many hypotheses pertaining to gender and the various SMG's ICT Service desk tools used to report ICT incidents and acquire just-in-time knowledge. There will also be a discussion on the data analysis methods that derived the factors that predict mLearning adoption at SMG. Furthermore, this chapter presents the findings from the data analysis, providing evidence that either support or reject the various hypotheses. Aspects of the first phase of this study will be discussed throughout this chapter specifically the data analysis and the findings.

Chapter five includes an evaluative discussion of the findings, reporting comparisons and contrasts that were drawn between what the research found and what the literature suggested would be expected.  This chapter will also present recommendations for practice and research. These comments will be brought forward to the concluding chapter of this research study (Chapter 6).

Chapter six concludes by bringing together the discussion and overall findings of the entire thesis and explores how the research has met its intended aims and objectives and provided possible answers to the research questions and hypotheses that were outlined in this chapter (Chapter 1). This chapter also discusses contributions to theory and practice, future recommendations for investigation, methodologically and practically along with a discussion of the weaknesses and limitations of the current study.

## 1.7 Summary

This chapter offered a brief introduction to SMG and the Culture and heritage sector where SMG operates.  It presented a brief overview of why this research is being conducted.  Moreover, this chapter covered the research aim, objectives and the hypotheses that are going to be tested in this study.  In addition, a brief discussion on this research's contribution to knowledge and practice is presented.

The following chapter will critically review the current state of knowledge regarding mLearning and its various applications in a variety of environments. Moreover, the following chapter will review the current state of knowledge regarding technology adoption models.

# Chapter 2. Literature review

This literature review aims to identify relevant studies that have addressed similar research problems, in the interest of clarifying and extending the body of knowledge regarding ICT service desk practice, technological adoption and mLearning. Additionally, learner identity with regards to gender and age and how these factors contribute to the digital divide experienced in the workplace will be briefly discussed. This literature review also discusses knowledge management with regards to service desk practice.

The overall structure of this literature review chapter has six objectives:

- To delineate and analyse the common elements in related research areas such as Technology Enhanced Learning (TEL), distance Learning (dLearning), eLearning and mLearning. As well, reviewing common mLearning paradigms.
- To outline the historical development and evolution of mLearning and then present a new working definition based on current practice.
- To critically review the relevant highly cited background literature on mLearning from both a pedagogical and technological centric perspective.
- To critically review relevant literature on technology adoption models.
- To critically review relevant literature on tools used to manage ICT support calls.
- To critically review relevant literature on ICT service desk's historical and contemporary role.

The analysis of TEL, dLearning, eLearning and mLearning literature are presented in section 2.1. The evolution of mLearning and the working definition used in the current study is covered in section 2.2. Additionally, in the same section i.e., section 2.2 is the presentation of a critical review of mLearning literature from both a pedagogical and technological centric perspective. This review will involve an analysis of literature that discusses the evolution of mLearning from its beginnings to present day. Additionally, a working definition of mLearning will be derived based on the reviewed literature. In section 2.10 there is a review of commonly cited technology adoption models. This review will involve an analysis of literature pertaining to each of the models as well as their strengths and weaknesses. Additionally, there is a summary of various research papers that have used the UTAUT model along with various research papers that have adapted the model using some or all of its constructs and moderators. Section 2.11 presents a critically review of literature on tools to manage ICT support calls as well as literature on ICT service desk's historical and contemporary role.

These objectives are for the purpose of identifying gaps, weaknesses, strengths, controversies, trends, and opportunities found in the practical application of mLearning in a novel work environment. Moreover, these objectives serve as a catalyst to conduct original research i.e., the current research that will contribute to the body of knowledge relating to mLearning adoption and ICT service desk management practice. Conclusions will be drawn from literature that have used these approaches in pursuance of eliciting emerging themes that will help to inform the current research approach. Literature on ICT service desk support practice will provide a context in which to situate this discussion on the novel method of helping to manage ICT support calls.

## 2.1 Origins and perspectives

### 2.1.1 Technology Enabled Learning (TEL)

Technology enabled learning (TEL) is used to describe the expansive approach to using information and communication technologies to support teaching and learning, design, and delivery (The University of Sheffield, 2017). Some authors use the term Technology Enabled Learning (TEL) whilst others use the term Technology-Enhanced Learning (TEL). Both terms can be used interchangeably in the context of eLearning (Sharples *et al*., 2009). Earlier advances in TEL were mainly desktop computer-based learning. However, TEL innovations now include mLearning (The University of Sheffield, 2017). A comparison of eLearning and mLearning is summarised in Table 2.1.

In practice, TEL is typically used to replicate or supplement traditional teaching and learning activities (Blin and Munro, 2008; Eynon, 2008; Kirkwood and Price, 2013; Roberts, 2003). In some studies, the use of TEL has also been found to transform teaching and learning activities (Sharples *et al*., 2009).

***Table 2.1*** eLearning and mLearning comparison

| | Technology Enabled Learning (TEL) | |
|---|---|---|
| | **eLearning** | **mLearning** |
| Purpose | The purpose is to teach specific skills or impart in-depth knowledge on a subject to the learner.<br><br>Key learning objectives:<br><br>Comprehension and retention of specific skills or in-depth knowledge on a subject | Accessing information at the moment it is needed<br><br>Instant accessibility of information quick knowledge distribution<br><br>To support an ongoing learning process where the learner needs quick access to bits of information usually spontaneously |
| Approach | Formal structure - can be developed into a curriculum | More flexible and informal than eLearning |
| Medium of delivery | Computers and laptops. eLearning tethers the learner to his or her desk | Wireless devices such as Smartphones (iPhones, Androids, and Blackberries), iPad, Tablets. The keywords are: on-the-go, portability (anywhere) and accessibility (anytime) |
| Design | Large screens<br><br>Static environment<br><br>Detailed information<br><br>Space for complex graphics<br><br>More media and interactivity (less bandwidth restrictions) therefore can take advantage of various mediums like High Definition (HD) videos and game-based learning<br><br>Smoother navigation using a mouse<br><br>Content can be broad-based | Small screens limiting the scope for vast amounts of text and large graphics<br><br>Bite sized modules<br><br>1 idea per screen – Concise micro lessons<br><br>Large buttons and simple navigation<br><br>Pictures, videos, and checklists |
| Duration | Longer and broader courses than mLearning.<br><br>Varies between: 10 – 60 minutes max | Design to be completed in bite-sized modules.<br><br>Recommended: 3 – 10 minutes max |

Adapted from (CommLab India, 2017; Gutierrez, 2015; Webanywhere, 2016)

The characterisation of 'enhanced' in TEL has attracted contention among scholars as they consider it nebulous. When the term is used in the context of teaching and learning it does not clarify what constitutes an 'enhancement' to the process of teaching and learning (Kirkwood and Price, 2014). It has been argued that it suggests, somehow, the learning and teaching experience is improved or is superior in some way by simply including technology. This is a value proposition and therefore raises the question, what value is being added to the learners' experience. The reason why the current study will attempt to address this question is because both researchers and senior management teams are interested in the return of investment a learning intervention will yield. Therefore, understanding the value of the 'enhancement' to learning and how it could be measured is what will be used in a return on investment (ROI) calculation ratio and business case for a mLearning intervention (Rowden, 2005; Mehra *et al.,* 2014). Being able to use a theoretical model to predict with a confident level of certainty the factors contributing to the adoption of a novel technological learning intervention will be of interest to SMG's mLearning project sponsors. This is because management can use this information to inform how they allocate human resources. Moreover, the value that this innovation may bring if the time invested in the innovation yields a profitable return on investment will also determine whether the project will have the buy-in from senior management stakeholders, such as project sponsors. The current research will investigate the factors contributing to the adoption of a novel learning intervention.

#### 2.1.1.1 Distance Learning (dLearning)

Distance learning (dLearning) can be defined as 'improved capabilities in knowledge and/or behaviors as a result of mediated experiences that are constrained by time and/or distance such that the learner does not share the same situation with what is being learned' (King *et al*., 2001: p. 10). However, there are some contested viewpoints regarding the closeness of the relationship between dLearning, eLearning and mLearning. A small number of scholars consider eLearning as a subset of distance learning (Georgiev *et al*., 2004) as illustrated in fig 2.1. Conversely, other authors within the mLearning community do not share this viewpoint and therefore considers eLearning as separate sets that intersect with three distinct sets (Knight *et al*., 2006). Namely, dLearning, eLearning and mLearning as illustrated in fig 2.2. These viewpoints are diagrammatically displayed in fig 2.1 and fig 2.2. Furthermore, fig 2.3 presents a timeline that demonstrates the chronological evolution of dLearning, eLearning and mLearning for the purpose of highlighting the temporal relationships between these methods of learning.

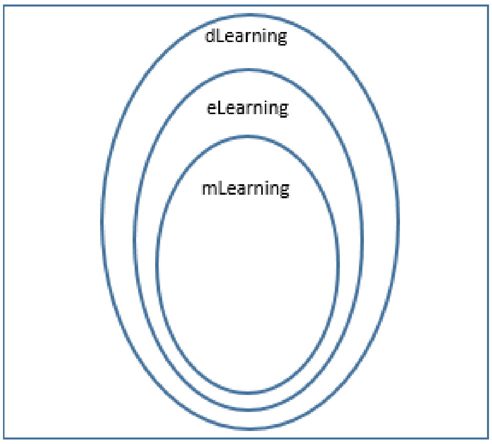



**Fig. 2.1:** Perspective on the relationship of eLearning, mLearning and dLearning (Georgiev *et al*., 2004)

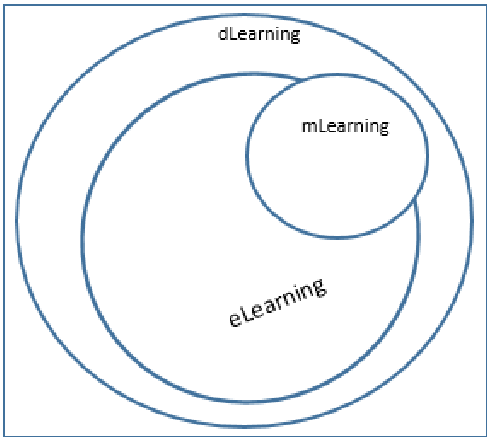



**Fig. 2.2:** Perspective on the relationship of eLearning, mLearning and dLearning (Knight *et al*., 2006)

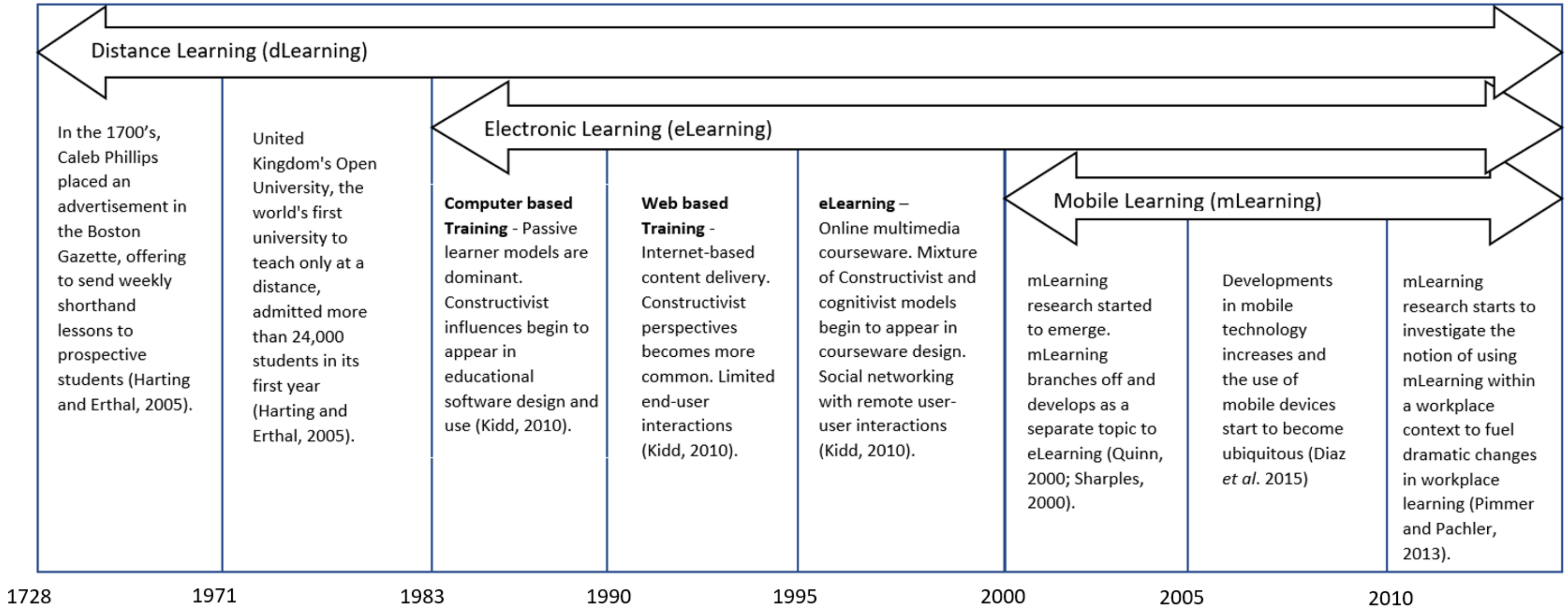



**Fig. 2.3** Timeline of the evolution of eLearning and mLearning

### 2.1.1.2 Electronic Learning (eLearning)

mLearning is closely related to eLearning and to some scholars it is considered the missing part of an overall learning solution (Rimale *et al*., 2016). eLearning can be defined as structured targeted instruction that uses multimedia computers or a wide range of mediums such as audio tapes, videotapes, satellite broadcast (ASTD, 2001), interactive TV, CD ROM, DVD and or web browsers to deliver formal or informal education to the learner. eLearning is designed to support individual learning and organizational performance objectives (Allen, 2003; Allen, 2016; Clark and Mayer, 2003; Hall, 1997).

### 2.1.1.3 Mobile Learning (mLearning)

A review of the works of several prominent mLearning authors was found to fall into three paradigms, 1) Learning using mobile technologies, 2) Learning while physically mobile and 3) Dynamic, seamless and ubiquitous learning environment, these three paradigms are listed in Table 2.2 with the proponents of the individual paradigms. Research by Churchill *et al*., (2014) confers this notion whilst later works by Churchill *et al*. (2016) found these paradigms to be lacking the comprehensiveness to represent the affordances of emerging technologies. Despite these contestations, the three paradigms present a parsimonious framework to categorise mLearning paradigms. These prominent mLearning authors' work will now be briefly discussed, categorised, and then distilled into a working definition of mLearning that will be used in the current research to help avoid theoretical ambiguity.

***Table 2.2*** Summary of mLearning paradigms

| **mLearning paradigm** | **Authors** |
|---|---|
| Learning using mobile technologies | Abdulrahman and Benkhelifa, 2017; Alasmari and Zhang, 2019; Anderson and Blackwood, 2004; Azabdaftari and Mozaheb, 2012; Churchill and Churchill, 2008; Cochrane, 2012; Lam, 2015; Ma, 2017; Song and Fox, 2008; Stockwell, 2016 |
| Learning while physically mobile | Han *et al*., 2004; Kristoffersen and Ljungberg, 2000; Looi and Wong, 2018; Rensing, 2016; Seppälä and Alamäki, 2003; Wong *et al*., 2010; Gu *et al*., 2011 |
| Dynamic, seamless and ubiquitous learning environment | Ahmad, 2020; Alsaadat, 2017; Bere and Rambe, 2019; Diaz *et al*. 2015; Kearney *et al*., 2014; Lestary, 2020; Song, 2014; Ting, 2013; Watlington *et al*., 2016; Wong and Looi, 2011 |

Anderson and Blackwood (2004) whose research explored the mobile devices shared key characteristics, which are mobility and the ability to process digital data and digital media. Moreover, during this period of technological developments, great numbers of these devices were becoming Internet-enabled. Another observation they made is that increasingly, staff and students were owning and making use of these devices for the purpose of learning. Anderson and Blackwood's (2004) research would be classified as learning using mobile technologies. Song and Fox (2008) studies presented a new dynamic to the body of knowledge pertaining to this paradigm. This was achieved by conducting a longitudinal case study spanning over one year and investigated university students' use of mLearning using dictionaries and other Personal Digital Assistants (PDA)'s applications to enhance their vocabulary learning. Their research found that students use of PDA applications improved a variety of aspects of their vocabulary learning. They also found that students integrated the applications on the PDA with computers and the integration of PDA applications and computers shaped the learning activities they undertook. The significance of their findings is that they reiterate the usefulness of mobile devices as a method of extending ways of providing learning. To categorise the emphasis of mLearning in Song and Fox's (2008) study, it can be argued that the focus was on learning using mobile technologies. Churchill and Churchill (2008) research reports on a case study of a teacher who explored the educational affordances of PDA technology. This was for the purpose of planning a suitable intervention to support pedagogically effective integration of PDA technology. Churchill and Churchill (2008) study found five affordances of PDA technology which are 1) multimedia-access tool, 2) connectivity tool, 3) capture tool, 4) representational tool and 5) analytical tool. Churchill and Churchill (2008) research can provide a useful insight to the current study regarding the educational affordances of mobile technology. The overall emphasis of mLearning in Churchill and Churchill's (2008) study was learning using mobile technologies. Cochrane (2012) research presents a new dynamic to the paradigm of learning using mobile technologies by reviewing research that investigated pedagogical success factors for the implementation of mobile Web 2.0 technologies in an educational environment. The findings of Cochrane's research were that identifying and implementing strategies to support mobile Web 2.0 technology critical success factors would advance the transformation of teaching and learning. The significance of Cochrane's study is that the insights of Cochrane's research can be used to inform the creation of new knowledge articles as well as aspects of the implementation of mLearning at SMG. This is because the upgraded ICT service desk portal enables the newly created knowledge articles to utilise Web 2.0 technology.

Seppälä and Alamäki (2003) research was a pilot study conducted in a teacher training environment. Their research focused on the experiences of supervising teachers and trainee teachers and the notion of discussing and sharing their ideas about teaching methods via mobile devices. Specifically using short message service (SMS) and digital pictures as a part of the supervisory process. Their findings were that the use of digital pictures which were delivered via the mobile device proved to be a successful method of sharing teaching and learning ideas. The pilot study aimed to provide flexible teaching solutions, which enabled access to information using different devices, and support learning in a variety of situations and locations. The significance of these findings is the insights can be used when creating the knowledge articles for staff who are physically mobile inside or outside of the museum. The use of images and videos will prove to be useful when creating the knowledge articles for SMG staff. To categorise the perspective of the role mLearning played in Seppälä and Alamäki's (2003) study was learning while physically mobile. Gu *et al*. (2011) research expanded the body of knowledge concerning this paradigm by focussing on developing practical learning content for learners on the move. Their research investigated a set of design principles from both pedagogical and usability perspectives. Their research found that the term "practical" can have contrasting meanings for different users. Furthermore, users typically have high expectations of the mobile learning content if used for practical purposes i.e., changing a fuel pump in a car. Their research failed to determine whether the design principles in their research met the practical needs of the user. Moreover, they did not report any suggestions on how to design to meet the user's needs. This information would have been useful as it would help to navigate or at least consider pitfalls when creating knowledge articles for SMG staff. However, their research provides useful insight into the importance of design principles and the consideration of both pedagogy and usability. The creation of knowledge articles as a mLearning just-in-time knowledge acquisition intervention for staff who are physically mobile within or outside of the museum needs to take into consideration the design principles developed in Gu *et al*.'s (2011) research.

According to Wong and Looi (2011) review of academic papers on mobile-assisted seamless learning, they refer to dynamic, seamless, and ubiquitous learning as the seamless assimilation of learning experiences across numerous aspects of formal or informal learning contexts. This notion of dynamic, seamless, and ubiquitous learning also includes individual and social learning in either a physical space or cyberspace. Kearney *et al*. (2014) research investigated how teachers are using distinctive pedagogical features of mLearning such as collaboration and personalisation. The researchers used a survey to capture data on these three established constructs 1) Collaboration, 2) Authenticity, and 3) Personalisation (Kearney *et al*., 2012). The purpose was to investigate current mLearning practices in the milieu of schools and universities. Kearney *et al*. (2014) research found that aspects of online collaboration, networking and student agency were rated surprisingly lower than expected. These insights help to remind learning technologists and IT trainers that despite the affordances found with mLearning, it is not a panacea for education and training. Kearney *et al*. (2014) found that device ownership was a factor that influenced adoption of mobile pedagogies. However, they did not report whether issues arose regarding governance and information access. This information would have been useful to this research as it would present another layer of considerations to governance and how to address such issues. To categorise the emphasis of mLearning in Kearney *et al.*'s (2014) study it would be dynamic, seamless, and ubiquitous learning environment. Another researcher (Song, 2014) added the dimension of Bring Your Own Device (BYOD) into this notion. Song's (2014) research revealed that the students improved their understanding of a topic well beyond what was available in textbooks. Moreover, the students in Song's study had developed positive attitudes toward seamless science inquiry supported by their own mobile devices. Ting (2013) research brought another interesting dimension by using mLearning technologies to synthesize the contents of a subject with learners' social interactions as a way of creating learning materials for the subject matter. According to Ting (2013) this was achieved by using mobile technologies to unobtrusively record specific types of social interactions among learners. The recordings were then used as instructional information for the learners to explore the subject matter from the perspective of their peers. A common characteristic of this group of literature relating to dynamic, seamless, and ubiquitous learning so far is that they pertain to a pedagogical perspective of mLearning which involves students as participants in their research. However, although other authors such as Diaz *et al*., (2015) also involved students as their research participants, they presented a technological perspective as opposed to the usual pedagogical perspective. Their work investigated creating a model of mLearning that integrated mobility, artificial intelligence, augmented reality, and gaming into learning. The purpose of this would be to create intelligent tutoring systems making tutoring available on a large scale. Although, this perspective is ambitious and futuristic, it would be unsuitable for SMG staff at this current time as the museum sector is still in its infancy stage regarding mLearning.

The three paradigms discussed will be used to inform the definition of mLearning that will be applied in this study. Thus, mLearning is the provisioning of a learner-centred and flexible learning environment that enables knowledge construction, job skill development training, and performance support across a variety of locations and work performance contexts. This environment is ubiquitous and supported by the use of mobile devices that enables direct access to learning materials and resources.

## 2.2 The evolution of mLearning 2000 - Present

This section outlines the current state of the field of mLearning and presents explanations of factors contributing to its evolution. It also provides an overview of the most common positions held by the various scholars in this field and a rationale of the positions held by the author of the current research.

mLearning is a vague term with a variety of contested definitions ascribed to it by proponents and authoritative scholars in the field such as Quinn (2000), Winters (2006), Sharples *et al*. (2007), Kukulska-Hulme (2010), Cochrane (2012) and Kearney *et al*. (2012), to name a few. This is because its definition differs among these scholars based on a variety of factors such as historical, contextual focus of the study and their philosophical position both technically and pedagogically. Hashemi *et al*. (2011) provides further reasons for this lack of consensus amongst scholars. They argue it is partly because "the field is experiencing rapid evolution, and partly because of the ambiguity of [the definition,] mobile. – does it relate to mobile technologies, or the more general notion of learner mobility?" (p. 2478). Heshemi *et al*. (2011) argument emphasises a pertinent point which is the complexity found in differentiating 'mobility' because mobility in learning is not a new concept e.g., having a focus group discussion away from your desk or reading a textbook while in transit (Cruz *et al*., 2012). These authors and others' contested viewpoints will be examined and discussed in more detail throughout the following sections as it provides context to the development of mLearning research and practice.

### 2.2.1 First wave of mLearning research

mLearning research started to emerge circa 2000, during which time, mLearning was branching off and developing as a separate topic to eLearning (Quinn, 2000; Sharples, 2000). Sharples (2000) paper sets out a theoretical framework for the design of educational technologies that support learning from any location throughout a person's lifetime. In their study, Sharples provides an early definition of mLearning which is, Lifelong learning mediated by technology. Quinn's article on the issues and challenges of mLearning also offers a definition similar to Sharples. The foundations of these definitions, perceptions, and their links to the evolution of mLearning research will be discussed in more detail throughout this section.

The early definitions of mLearning captured the embryonic stage of the concept of mLearning research and practice. Most authors characterised it as eLearning using networked and mobile technology such as Laptops, Palms, PDA, and digital cellular phones to deliver, administer, and extend learning (Cross, 2004; Quinn, 2000). This perspective is a techno-centric viewpoint as the focus is mainly on the use of technology to deliver the learning. Conversely, it could be argued that Winters (2006) was critical of such an appraisal of mLearning because Winters felt they focused chiefly on the features of mobile technology, at the cost of not including other crucial issues, for example, the mobility of the learner. Additionally, other early proponents of mLearning agreed that this type of learning either happened when the learner is not in a static and pre-agreed setting or when the learner takes advantage of the affordances offered by mobile technologies (Kristoffersen and Ljungberg, 2000; O'Malley *et al.*, 2003). However, it would be wrong to completely jettison the apparent erroneous assumption that mLearning simply being eLearning on a networked mobile device as both dLearning and eLearning gave birth to mLearning. Furthermore, there are areas of mLearning that apply the same principles to pedagogy as eLearning. For example, they both use media in the form of text, image, animation, and audio. In fact, these concepts must not be treated as rivals. Horton (2007) identifies the shared heritage among these concepts in Horton's non-technical overview of the meaning of information literacy where Horton argues, "The boundaries between the various members of this family overlap, but they should be seen as a closely-knit family" (p. 15). During this wave of research, advancements in technology began to see the production of updated models of mobile phones that had the capabilities of streaming video, albeit limited in bandwidth size and quality. Most mLearning research at this point focused on the technological aspect of mLearning because of the novel technological advances in mobile phone capabilities.

### 2.2.2 Second wave of mLearning research

As the field of study gained traction and developments in mobile technology increased, the use of mobile devices started to become ubiquitous. This trend caused some mLearning researchers (Traxler, 2007; Vavoula, 2007) to consider including lifestyle and cultural choices as part of the mLearning characterisation in their research. For example, Traxler (2007) argues that mLearning should be defined as "learning aligned to… societies and cultures in motion (rather than, for example, being defined as learning delivered by… devices or to learners whilst in motion or whilst they cross contexts)" (p. 56). Laurillard (2007) found congruence with some of her contemporaries by defining mLearning as “being the digital support of adaptive, investigative, communicative, collaborative, and productive learning activities in remote locations...” (p. 172). Sharples (2007) describes mLearning with a pedagogical focus but acknowledges the importance of the technological aspect of mLearning. Sharples asserts that mLearning is "the processes of coming to know through exploration and conversation across multiple contexts amongst people and interactive technologies" (p. 244). Sharples *et al*. (2009) criticises those authors who view mLearning through a techno-centric perspective by asserting that “the focus on technology does not assist in understanding the nature of the learning and overlooks the wider context of learning as part of an increasingly mobile lifestyle” (p. 235). Consequently, the Molenet (2009) initiative recognised the widespread trend towards smartphone usage and therefore defined mLearning as the "Exploitation of ubiquitous handheld hardware, wireless networking and mobile telephony to facilitate, support, enhance and extend the reach of teaching and learning". During this wave of research, more researchers started to focus their research efforts towards investigating the pedagogical aspects of mLearning.

### 2.2.3 Third wave of mLearning research

As more interest in the field developed, definitions emanating from the mLearning literature has led the researcher of the current study to produce two camps. The first, technologically centric authors and the second, pedagogically centric authors. These two camps will be discussed in more detail throughout this section and the following section as these viewpoints are pertinent to this study and can be found in many of the topics covered in this chapter. Kearney *et al*. (2012) recognised these viewpoints and the numerous ways to describe mLearning. They then attempted to reconcile the most prominent themes by asserting “these descriptions all consider the nexus between working with mobile devices and the occurrence of learning: the process of learning mediated by a mobile device” (p. 3). Kearney *et al*. (2012) acknowledges the processes involved in learning and the attempts to bring together the two major viewpoints from a techno-centric position. However, Kearney *et al*. fails to acknowledge the notion of the learners’ mobility (Hashemi *et al*., 2011). Conversely, Teri *et al*. (2014) challenges the notion that definitions amongst the prominent authors are indistinct by arguing that the differences between all definitions of mLearning are subtle. Based on the two camps that has been derived from various author's viewpoints, it is apparent that mLearning definitions are not subtle. However, it is evident that among numerous scholars there are several common themes that emerge from the literature, which is, the provision of a learner-centred and flexible learning environment that foster the use of knowledge acquisition, construction, skill development training, and performance support at and through work that is distributed across a variety of locations, contexts and typically facilitated by electronic means (Ally and Palalas, 2011; Behera, 2013; Pachler *et al*., 2010; Pimmer and Pachler, 2013). Teri *et al*. (2014) identifies the apparent convergence of knowledge acquisition and the provision of an ever-changing learner-centric environment across locations and context. It is within this phase of mLearning research that the notion of using mLearning within a workplace context start to emerge along with its potential to fuel dramatic changes in workplace learning.

Pimmer and Pachler (2013) asserts that mLearning is to be characterised "as learning across different contexts that bridges and connects: (1) the creation and sharing of content; (2) learning for and learning at work; (3) individual and social forms of learning; (4) education across formal and informal settings, and (5) situated, socio-cognitive, cultural, multimodal and constructivist educational paradigms" (p. 2). Their definition elucidates on the term "context" and its relationship with mLearning. This is key because the notion of context permeates most classifications of mLearning. An example of different contexts includes different geographical locations e.g., countries, different work environments, different educational institutes. These various contexts affect the 5 categories Pimmer and Pachler emphasises. Thus, impacting the overall approach to mLearning research and implementation. These characterisations are useful as many of them relate to the proposed use of mLearning at the SMG. For example, using mobile devices for learning at work and learning for work, as this is the main theme of the current study. Individual forms of learning in an informal setting are another theme that permeates this study as staff are aiming to acquire knowledge as and when they need it and not for the purpose of formal certifications.

### 2.2.4 Current working definition of mLearning

The definition of mLearning proposed in this study that will be used to help demystify any theoretical ambiguity. This definition draws on several themes permeating all the previous definitions of mLearning from the various authors discussed earlier. The current definition is grounded in the context of the work environment and have been selected from various authors for the purpose of presenting a modern and work contextual definition that expresses mLearning use in SMG. mLearning is the provisioning of a learner-centred and flexible learning environment (Kristoffersen and Ljungberg, 2000; Seppälä and Alamäki, 2003; Wong *et al*., 2010; Gu *et al*., 2011) that enables knowledge construction, job skill development training, and performance support across a variety of locations and work performance contexts (Palalas, 2011; Teri *et al*., 2013). This environment is ubiquitous (Kearney *et al*., 2014; Song, 2014; Ting, 2013; Diaz *et al*., 2015; Wong and Looi, 2011) and supported by the use of mobile devices that enables direct access to learning materials and resources (Anderson and Blackwood, 2004; Churchill and Churchill, 2008; Cochrane, 2012; Song and Fox, 2008). This amalgam of definitions helps to derive a definition of mLearning that will be used in this research.

**Benefits of mLearning**

Despite the challenges outlined in the upcoming section, *Challenges of adoption*, mLearning affords the gains of changing the training and development environment by offering employees the opportunity to benefit from asynchronous, convenient, and ubiquitous instruction (Chee *et al*., 2016; Hyman *et al*., 2014). This allows SMG employees to engage in the continued development of knowledge, skills, and competencies (Davidson-Shivers and Rasmussen, 2006; Kahle-Piasecki *et al*., 2012; Miner, 2009; Szablowska-Midor *et al.* 2017) needed in a complex and changing environment. Learning using mobile devices enables Wireless technology such as Bluetooth or Wi-Fi, to be used to transfer learning materials easily and rapidly among learners (Kukulska-Hulme, 2005; Stevens and Kitchenham, 2011). Mobile devices can also be shared among peers, further improving collaborative work. mLearning removes the barriers of time or location as tasks can be worked on and interaction with others can take place through mLearning, providing advantages to those using mobile technology (Bahri *et al*., 2020; Davidson-Shivers and Rasmussen, 2006; Miner, 2009). Other benefits of mLearning are that Smart phones and tablets require comparatively less expenditure than PCs and peripherals (Alharbi *et al*., 2017). This can lead to a decrease in training costs. Mobile technologies offer an easy and attractive way to develop technical skills and gain constant access to a wide range of learning materials. mLearning also has the potential to reach both remote and marginalized groups, granting them easy access to learning and development materials (Sharples, 2013).

## 2.3 Use and engagement with technology

Human engagement with technology can be likened to a pendulum swing. Intrinsically, humans move in and out of engagement with technology (Sharples *et al*., 2007; Tseng *et al.,* 2016). Several authors (Haji *et al.,* 2013; Vavoula and Sharples, 2002) offers an example of this, they suggest that this happens when entering and leaving mobile phone network coverage. They state that typically, the mobile device is picked up and used if there is network or wireless coverage and life in its battery. Once there is none of either type of coverage to enable certain types of engagement or if the battery dies, there is no longer any engagement with the mobile device. However, modern day mobile devices enable engagement with technology beyond the limitation of network coverage as there is a plethora of apps that can be used without utilising a mobile phone network coverage. An example of this is when staff at the SMG interact with their mobile devices in the lift using applications such as Microsoft Excel™ or Microsoft Word™ from the Microsoft Office 365™ suite of applications. These applications tend to allow users to work on a document when there is no network connectivity. Once users have regained internet connectivity either via the device's network coverage or Wi-Fi, the application automatically saves the document to a cloud storage location. Additionally, it is also common to see people in a London underground Tube station using their mobile devices despite having no network coverage. Furthermore, engagement with technology not only involves an individual and the technology. It also, on many occasions, involves other humans within social networks interacting with each other collaboratively constructing knowledge as constituent parts of a collective intelligence (Diaz *et al*., 2015).

Scholars such as Yousafzai *et al*. (2016) believes that for one to use technology to facilitate mLearning, it typically involves having the technical infrastructure to support connectivity for downloading, uploading resources, and/or linking to institutional systems e.g., virtual learning environments (VLE) and management information systems (MIS) (Hashemi *et al*., 2011). Whilst it is true that it is crucial to provide the technical infrastructure for connectivity, in a workplace, the MIS at SMG is not typically used to record and report on staff performance, learning and development. This is the role of the learning management system (LMS). It is, however, worthy to draw a distinction between LMS and VLE as each term has significant connotations for the educational approach which they inherently advocate in their usage. Furthermore, it is not necessary to have the types of resources proposed in the current study linking to the LMS. This is because much of the knowledge being generated or acquired does not need to be recorded or reported on. Unlike, in the case of mandatory training such as health and safety or the SMG finance system training where staff must comply with governmental legislation or are only allowed to access the finance system once they have undergone training.

Kukulska-Hulme (2010) indicates that handheld technology permits the learners to adopt an active stance in relation to the process of learning and developing their digital competency as well as knowledge production and communication skills. This can be achieved during episodes of learning in formal and informal settings through the delivery of a range of multimedia material such as graphics, audio, and video (Lim and Churchill, 2016; Sharples, 2013).

### 2.3.1 Web 2.0 technologies

Numerous authors (Ahmed et al., 2016; Cochrane and Bateman, 2010) describe Web 2.0 technologies as Web 2.0 services such as YouTube, Flickr, Twitter, QR Codes, file sharing, and blogging sites that are formatted for use with mobile devices. The other features of Web 2.0 technologies are that it provides a platform for people to work in collaborative groups and peer critique whilst providing formative feedback and improving content (Diaz *et al*., 2015). An example of this are sites like Wikipedia, YouTube, and LinkedIn where Internet users upload information and share with others in their social networks.

Other affordances of Web 2.0 are the ability to create user generated content and user tagging (categorizing and collating). Cochrane (2010) likens these affordances to the processes used in social constructivist learning environments where the focus is on what the learner encounters and accomplishes on the learning journey. The significance of this is that ServiceNow™ knowledge articles are based on Web 2.0 technologies and could potentially be leveraged to facilitate just-in-time knowledge acquisition. Furthermore, ServiceNow™ has functionality that allow SMG staff to create Wiki style sites like Wikipedia where SMG staff can collaborate and share good practice ideas and gain knowledge on a plethora of SMG related ICT topics. Leveraging Web 2.0 technologies will help to enable mLearning at SMG. Scholars like Owen (2005) and Traxler (2007) recognised the affordances offered by Web 2.0 in its infancy stage. They forecasted the growth of citizen-journalism and the expansion of internet user generated web content. This has led to the decentralisation of the control of ideas and information. This phenomenon has been brought about by the use of mobile technologies converging with social software (Abbdulrahman and Soetan, 2018; Ahmed et al., 2016; Traxler, 2007). Developments in technological advancements has also contributed to accelerating this growth. Despite the dearth of literature on the adoption of Web 2.0 technologies, the insights from authors such as (Abbdulrahman and Soetan, 2018; Owen, 2005; Traxler, 2007) are useful to the service desk management team. These insights may help to inform the implementation of some of the Web 2.0 functionalities in SMG's KMS, ServiceNow™. Further consideration into the adoption of Web 2.0 type technologies such as those offered by ServiceNow™ and how they can support service desk management would help to reduce this gap in knowledge. The current study aims to investigate the adoption of mLearning using Web 2.0 types of technologies as these are functionalities available in ServiceNow™ knowledge articles. Therefore, helping to fill this knowledge gap.

## 2.4 Teaching and Learning

It is relevant to this study to discuss what the literature asserts regarding the current state of learning and teaching approaches that are currently being employed in the field of mLearning. This is because teaching and learning theories play a central role in the process of building knowledge and skills (Abdurrahman *et al.,* 2015; Udanor and Nwodoh, 2010). Using mobile devices in SMG is a novel approach to knowledge acquisition for the purpose of building knowledge and skills to perform a work-related task. Furthermore, teaching and learning approaches support the existing practice of mLearning. The focus on teaching and learning within the milieu of mLearning has attracted interest from many authors and researchers. Hwang and Tsai (2017) offer a reason for this interest, they say it is because of the 'proliferation of [countries] that have embarked on this new and trendy paradigm of teaching and learning [methods] in [various educational] fields' (p. 124). Therefore, in this section, learning theory pertaining to informal learning will be reviewed as this is the most popular approach to teaching and learning in the milieu of mLearning research and practice (Chee *et al*., 2016; Wu *et al*., 2012). Namely, Self-directed learning as it is an aspect of informal learning and is closely linked to the proposed use of ServiceNow™ knowledge articles at SMG.

### 2.4.1 Self-directed learning

Livingstone (2006) defines Informal learning as 'any activity involving the pursuit of understanding, knowledge, or skill that occurs without the presence of externally imposed curricular criteria' (p. 206). Chee *et al*.'s (2016) research on MLearning trends between 2010 and 2015, found that Informal learning was the most common approach to teaching and learning within mLearning research, compared to other learning approaches such as formal and non-formal learning. Formal learning can be defined as a highly institutionalized, bureaucratic and curriculum driven environment where the curriculum is taken from a pre-established body of knowledge that typically leads to a recognized certification (Wu *et al*., 2012). Non-formal learning can be described as learning that is grounded in activities organised by a trainer, teacher, or mentor (Wu *et al*., 2012). Although Wu *et al.'s* definition of non-formal learning is useful, it lacks a more definitive temporal dimension. Eraut's (2000) topology of non-formal learning expands on this notion by presenting two aspects that are not covered in depth in Wu *et al.'s* definition. They are time of stimulus and the intent of the learning. However, collectively, both Eraut's definition of non-formal learning and Wu *et al*.'s definition of informal learning presents an accurate characterisation of informal learning in the context of its use in the current research. For example, using Eraut's topology, the time of stimulus of the use of just-in-time knowledge articles is current need and the intention, is deliberate for the purpose of decision-making and problem-solving (Eraut, 2000; Law et al., 2016; Tucker, 2016). Within the context of informal learning, people constantly learn from accomplishments, mistakes, and experiences etc. (Diaz *et al.*, 2015; Siemens 2005). In other words, the knowledge and/or skill acquisition in informal learning may occur fortuitously because of everyday activities or experiences found with family, during leisure or at work (Cedefop, 2011; Wu *et al.*, 2012). One aspect of informal learning is self-directed learning. Self-directed learning is based on the same principles as andragogy, specifically the first learning principle which assumes that adults choose self-direction to determine and achieve learning objectives. Knowles (1975) introduced the concept of andragogy and describes the process of self-directed learning as:

'... individuals tak[ing] the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying human and material resources for learning, choosing, and implementing appropriate learning strategies, and evaluating learning outcomes' (p. 18).

According to Knowles (1980), andragogy is the theory of adult education. Andragogy is underpinned by five principles

- Adults are self-directed
- Adults use their experiences as a resource for learning
- Adults learn more readily when they experience a need to know
- Adults seek immediate application of knowledge
- Adults are best motivated by internal rather than external factors

Quinney *et al*. (2010) believes that Knowles's five principles of andragogy can successfully help employees develop technology skills. Conversely, Blaschke (2012) claims that some educators are falling out of favour with andragogy because it is considered old-fashioned due to the rapid development in new teaching methods, learning resources, and digital media. However, other authors (Slavkovic and Savic, 2015) suggest that the assumptions of andragogy complement mLearning as a large aspect of mLearning is the capacity to self-direct learning so that one may solve on-the-job and real-life problems. Furthermore, another assumption of andragogy is that the learning resources are designed by the instructor according to the learner needs. In accordance with andragogy, this role of instructor is more akin to the role of facilitator rather than lecturer or assessor. In the context of the current study, ICT operations staff, as well as ICT staff trainers, play the role of the instructor/facilitator that will create the learning resources based on the trends of certain types of reported ICT incidents. Moreover, there are no formal assessments, only the ability to perform the required task in the workplace.

## 2.5 Workplace learning and training

Pimmer and Pachler (2013) propounds that the use of mobile devices in the workplace bolsters learning and sense-making especially if there is an immediacy of knowledge. This can be achieved by linking codified knowledge from internet sources with situated experiences (Pimmer *et al*., 2012) using mobile devices to access those internet sources. However, this notion can be problematic as it does not consider if the user of the mobile device is confident and cognisant of using the mobile device for knowledge acquisition and if this approach to learning is within their learning preference. Further criticisms of workplace learning are some authors (Le Maistre and Paré, 2004; Pimmer and Pachler, 2013; Traxler, 2007), believe that copious forms of corporate training are fundamentally based on the notion of "Just-in-case learning". It can be argued that this type of learning is declarative, abstract and only beneficial for acquiring generic knowledge that qualifies learners for their job role (Pimmer and Pachler, 2013). An example of this is the mandatory health and safety eLearning training or the General Data Protection Regulation (GDPR) eLearning training delivered at the SMG. However, it must be acknowledged that both academia and corporate training provide practical disciplinary knowledge, and "just-in-case" learning and on-the-job training for a variety of practical knowledges and "just-in-time" learning. Thus, it is accepted by SMG that neither of these are sufficient on their own as a comprehensive learning solution.  That is why the use of mLearning at SMG is proposed as one of many learning interventions. Other learning solutions are for specific purposes and are beyond the scope of the current study. Staff at SMG currently attend just-in-case and on-the-job training for various types of skill and knowledge acquisition. However, using mobile devices for just-in-time knowledge acquisition for work purposes is a relatively new phenomenon.

(Eraut, 2007) acknowledges that a substantial amount of competence development is rooted in "learning from other people". The staff who create the mLearning resources are experts in the field of technology. Thus, service users will be developing their competency in technology from those experts. Barnes (2008) makes an insightful observation, rarely discussed in the literature reviewed, regarding the temporal nature of competence development. Barnes points out that competence development rarely occurs from one moment to another but evolves over time through connected learning experiences. Equally, Ling and Donner (2009) acknowledges that the organisation of ‘‘time-space’’ in any learning environment greatly affects mLearning experiences.

### 2.5.1 Learning environments

It is useful to this study to discuss learning environments as they define the spaces where learning takes place. It is worthwhile exploring and comparing the two most prominent learning environments such as, outside of the classroom and inside the classroom (academia, corporate training, and training at work).

The Glossary of Educational Reform (2014) offers a definition of a learning environment albeit situated in the context of schools.

> “Learning environment refers to the diverse physical locations, contexts and cultures in which students learn. Since students may learn in a wide variety of settings, such as outside-of-school locations and outdoor environments, the term is often used as a more accurate or preferred alternative to classroom, which has more limited and traditional connotations – a room with rows of desks and a chalkboard, for example.
>
> The term also encompasses the culture of a school or class, its presiding ethos and characteristics, including how individuals interact with and treat one another - as well as the ways in which teachers may organize an educational setting to facilitate learning…”

However, aspects of this definition will be discussed and juxtaposed with workplace learning environments in the following section.

### 2.5.2 Academic and workplace learning environments

At this point, it is worthwhile illustrating some of the distinctions between academic and workplace learning environments as both, in various areas, are radically different activities, with distinct objectives, rules and divisions of labour (Ahlstrand *et al*., 2020). This insight into the different activities within these learning environments will help to present a better understanding of the difference between learning in academic environments (e.g., schools, colleges, or universities) and learning in the workplace environment. This is because the current research investigates how using a learning intervention (i.e., mLearning) in a learning environment such as the work environment can transform new knowledge into practice. According to Le Maistre and Paré (2004) the transformation of objectives into tangible artefacts, whereby the focus of learning becomes the means of practice, is the critical distinction between academia and work. Moreover, this viewpoint can also be argued about other academic environments. Inherently, transformation of objectives also transforms activities; for example, the rules and divisions of labour are dramatically different in each environment.

In academic environments, there may be certain rules in place to discourage collaboration in some activities as it may be considered cheating, whereas many workplace activities typically encourage or demand collaboration (Le Maistre and Paré, 2004; Meades *et al*., 2008). Workplace rules that are codified and studied in the classroom, such as ethics, are far more difficult to apply in the work environment than in academic assignments (Le Maistre and Paré, 2004). Unspoken rules that are tacit and deeply entrenched in the company's culture, is also difficult to learn at a distance (Le Maistre and Paré, 2004). The divisions of workplace labour may lie along professional boundaries, so that the tasks that a new service desk analyst is expected to perform are, in practice, handled initially by more experienced service desk analysts (Paré and Le Maistre, 2006). Most importantly, workplace activities, in locations such as museums, can be complex and fraught with corporate politics.

The philosophies and systems governing learning environments, especially those where the learning takes place in both the academic and corporate training classrooms are traditionally designed from that of a top-down or cascading approach, typically from a legacy methodology (Corder, 2002; Karalis, 2016). Despite the seemingly radical difference between the academic and corporate learning environment activity systems with quite distinct objectives, mediational means, rules, divisions of labour, and so on (Paré and Le Maistre, 2006), both environments subsequently apply the same top-down approach which occasionally occurs outside both academic and corporate learning environments (Karalis, 2016). An example of this is when a new staff member joins an organisation, these staff members are typically issued work mobile phones and then told by the issuer how to use the mobile device. These instructions may be contrary to the way they usually use their technology if they are owners of such technology. This can also be true in an academic environment when a new student or teacher joins an academic environment (e.g., school, college, university) and an incumbent onboards that new student/teacher. Criticism of this approach is that it does not acknowledge multiple perspectives, e.g., the teacher/trainer and learner. In addition to these criticisms, Kukulska-Hulme (2010) argues that 'owners of personal technologies do not normally receive training in their use; instead, they learn informally from friends, work colleagues and family' (p. 7).

The ubiquitous nature of mLearning means that the learning environment must embrace the considerable amount of learning that occurs outside offices and other training environments e.g., colleges, universities, and corporate training providers (Sharples *et al*., 2007). Thus, enabling learning as opposed to enabling solutions. When technology acts as the solution this then drives the learning as opposed to enhancing it (Sharples *et al*., 2009). Technology can bring enhancements to a certain point of application and then past that point, they are no longer provide an enhancement to the learner (Lim and Churchill, 2016). In other words, up to a certain degree, technology can bring the opposite benefits to the purpose it was initially intended. Therefore, technology should be self-limiting, playing only a limited role in the ecosystem that it fosters. Cochrane (2012) claims that one way of going forward is to create flexible learning spaces that bridge formal and informal learning. Thus, there is a need for careful consideration of the content of the training materials in both contexts as well as a contemporaneous need for collaboration between the agencies involved in preparing and welcoming the new professionals into a community of practice.

## 2.6 Learner identity and digital divide

Learner identity deserves particular attention with regards to this research because it is founded on experiences of participation in learning activities. Learner identity can be defined as how an individual feels about learning and how they describe themselves as a learner (Lawson, 2014). The users of knowledge articles would be considered as learners. The nexus between the formation of multiple identities and learning has been acknowledged by researchers who also argue that the learner's identity is the basis for the building of other identities (Bernstein and Solomon, 1999; Gee, 2000; Lawson, 2014; Taylor, 1994). One of these identities are change agents and therefore, need acknowledging when demonstrating specific competences and behaviours in their journey to becoming full members in a community of practice (Brandt *et al*., 2005; Wallace, 2011). This is a relevant concept as SMG is undergoing continuous technological changes and it is important that staff develop these competences with the view to keep up to date with these changes. Furthermore, it is equally important that SMG as an organisation equip staff with the learning resources to help staff stay relevant with the technological changes.

Learners do not always use Technology for the activities they were originally intended. This is especially true with young people entering the workforce who typically adopt technology designed for the workplace (e.g., media file sharing, SMS messaging) into their social world. This has profound implications for learning, and in particular, learning in the workplace. For example, in the past people needed to memorize facts. However, as societies develop, so do the expectations regarding how much and for how long these facts are kept. Nowadays, there is no longer a need for people to have to memorize some of these facts because they can now look them up on a search engine like Google using their mobile device, as and when the fact is needed (Sharples *et al*., 2009). Educational institutes and organisations' learning and development departments need to provide individuals with the support enabling them to have the critical skills to discern credible sources.

There are authors that postulate that modern organisations as well as society depend on its individual citizens to be intellectually flexible for the aim of maintaining and securing economic and social growth (Coll and Falsafi, 2010). Therefore, it is imperative for organisations and educational institutes to leverage the opportunities to develop and apply frameworks that promote Learner identity narratives. The reason for this is so that these narratives can be used as a mediating tool to foster growth in individuals as learners and as participants in communities of practice.

The availability of equipment is not enough to avoid differences between how staff use ICT and benefit from using ICT in the workplace. To counterbalance an emergence of a second digital divide (Cameron *et al.,* 2011), senior leadership teams must emphasize the educational and operational use of ICT in the workplace.

### 2.6.1 Gender differences

Applying a gender lens to the use of ICT has been well investigated over the years and understood. However, a much closer review of gender differences in the use of ICT as a tool for just-in-time knowledge acquisition and ICT incidents reporting is needed. Just-in-time knowledge acquisition and reporting ICT incidents will be investigated in the current study due to the dearth of literature on this specific topic. The current study will investigate if there is a form of digital divide among SMG staff. Therefore, it is essential to the current research to investigate the apparent disparities so that solutions can be derived to minimise this apparent digital divide. Thus, this study will contribute to filling this gap in knowledge.

Numerous authors (Chen, 1986; Nsibirano, 2009; Buchem *et al.,* 2013; Shashaani, 1994) suggests that male and female experience ICT usage differently. This viewpoint can also be applied to gender and their experiences with the participation in technology enabled learning activities. This concept is supported by Beck's (1983) research on cognitive therapy which supports the notion that men are more likely to possess autonomous personality traits than women. The current study will test this notion to determine whether female staff at SMG experience ICT usage differently to their male counterparts.

### 2.6.2 Age differences

With the prevalence of an increasingly aging labour force and the influx of technology, staff will need to be either trained or retrained so that they can keep up with changes in job demands (Elias *et al*., 2012). As a result of these challenges, it is becoming more important to understand how employees' age affect the adoption and use of new technology and learning methods such as mLearning in the workplace. Elias *et al* (2012) conclude that it is important for management to understand the moderating effect of age on attitudes towards technology. This insight can be transposed to the current research on mLearning adoption since previous mLearning research has used age as a moderator. Elias *et al.'s* (2012) research on the relationships that exist between attitude towards technology in the workplace and overall job satisfaction concluded that age moderates those relationships. This is especially true in baby boomers and Gen X staff. According to Zemke *et al*. (2000), baby boomers are born between 1943 and 1960, gen X are born between 1960 and 1980. The current study will test this notion to determine whether age moderates the relationship between the factors that determine technological adoption.

## 2.7 mLearning: The state of the art

Several authors (Chee *et al*., 2017; Hung and Zhang, 2012; Wu *et al*., 2012) have found that mLearning research has attracted the attention of many researchers and consequently, steadily increased over time. Chee *et al*. (2017) states that this interest is continuing to increase to date. The main purpose of much of these studies according to Chee *et al*., (2017) has been on evaluating the effectiveness of mLearning. Hung and Zhang (2012) and Wu *et al*., (2012) have corroborated these findings. Hung and Zhang's (2012) reviewed and grouped mLearning research into four categories 1) Strategies and Frameworks, 2) Acceptance and Issues, 3) Effectiveness, Evaluation, and Personalized systems and 4) mLearning case studies. Their research found that the most common mLearning research topic was Effectiveness, Evaluation, and Personalized systems. The second most researched topic was mLearning case studies followed by strategies and frameworks and finally, acceptance and issues. These findings present an opportunity to increase the body of knowledge around mLearning acceptance and issues as it has received the least attention. As such, the topic of the current study is the acceptance of mLearning as a just-in-time knowledge acquisition intervention.

Chee *et al*.'s (2017) review of 144 published mLearning research papers on mLearning trends from 2010 to 2015 found that Quantitative approach (47.92%) was the most employed research design, followed by mixed methods (18.75%) and then Qualitative methods (14.58%). The remaining (18.75%) were found to be unspecified research approaches. These findings were corroborated by earlier research by Wu *et al*. (2012) who found that quantitative methods were the preferred approach in their review of 164 mLearning research. They also found that the use of surveys was the most dominant primary research method followed by experiments. The current research will use a quantitative approach as it is the most used research design in the field of mLearning research.

The focus of most mLearning research is largely on educational institutions such as higher education (36.17%), followed by unspecified (35.11%), primary school (21.28%), secondary school (6.38%) and finally, working adults (1.06%) (Chee *et al*., 2017). These findings are consistent with those from Wu *et al*. (2012). This means that mLearning research in the context of higher educational institutions and primary schools are more established than mLearning research in the workplace environment. Both Wu *et al*. (2012) and Chee *et al*. (2017) findings identified a gap in mLearning research that the current study aims to fill as the emphasis of this research is the context of working adults in the workplace.

In the mLearning literature reviewed, learning domains or discipline-orientation (e.g., applied sciences, humanities, and professional studies) appear to be a theme in several mLearning research. According to Chee *et al*.'s (2017) research, numerous authors have focused on the following areas, Language and Art (12.93%), Science (12.24%), Social Science (8.16%), others (6.80%), Engineering (4.08%), and Mathematics (2.72%). Unfortunately, they have not specified what the discipline-orientation 'others' refers to.

It is perhaps because this category contains many individual specialist subjects that are too few to categorise. Furthermore, over half of their reviewed mLearning research have unspecified learning domains. This means that there is an opportunity to investigate the use of mLearning in a context that is beyond the discipline-orientations defined by schools, colleges, and universities.

According to Chee *et al*. (2017), informal learning (11.11%) was found to be the most preferred approach in the mLearning studies they reviewed compared to formal learning (8.33%) and a combination of both informal and formal learning (6.25%). These findings were incongruent with results from Wu *et al*. (2012) who reported dissimilar findings regarding educational context popularity. Wu *et al*. (2012) research found that mLearning research was dominant in formal educational contexts such as higher education institutions. A possible reason for this is because both studies have contrasting definitions of informal learning. Wu *et al*. (2012) fails to acknowledge that informal learning can be achieved in educational environments such as higher education institutes. Wu *et al*. (2012) outlines informal learning in the context of 'work, family or leisure' (p. 882). On the other hand, Chee *et al*. (2017) recognises that informal learning can also take place in an educational environment. In the current study, informal learning is characterised as pursuing understanding, knowledge, or skills without imposing a curricular (Livingstone, 2006).

In the mLearning literature, authors have recommended that future research should be conducted on topics like, the technological improvements to mobile devices (Hashemi *et al*., 2011), evaluating the return on investment (ROI) on mLearning (Kahle-Piasecki *et al.*, 2012) and company security issues with lost and stolen mobile devices (Yousafzai *et al*., 2016). Whilst all these topics are significant, most research on mLearning mainly, focus on factors to consider when implementing and using mobile devices in the workplace (Kahle-Piasecki *et al.*, 2012) and not directly the potential impact it has on productivity and knowledge transfer in the workplace and very little focus on mLearning adoption. The current study aims to fill this gap in knowledge.

### 2.7.1 mLearning in Museums

Despite, this research not being the first study of mLearning in the Museum sector, e.g., focus on visitors (Collins *et al*., 2009; Pendit *et al*., 2014; Sung *et al*., 2010; Vavoula *et al*., 2009), it is the first to focus on mLearning as a just-in-time knowledge acquisition tool for Museum staff. Bristow *et al.'s* (2002) research, presents contextually-aware mobile systems suited to the museum environment. The systems are designed to respond to changes in the museum visitors' location, modifying the information displayed on the mobile device supplied to the visitor by the museum. Although their research presents some interesting findings, their paper has not specified its research approach, nor did it mention methods of collecting or analysing the data. However, they do mention the use of a device that they place on the participant's head. This approach would not work at SMG as it is intrusive. However, their research found that handheld devices lead to better interaction with objects in the museum. Another interesting finding was that contextual information significantly enhances users' ability to find information in comparison to simply surfing the Internet. In the current study, the proposed use of contextual knowledge articles will be used to serve just-in-time knowledge to staff. Moreover, the use of the knowledge articles on handheld devices such as smartphones and tablets as a just-in-time knowledge acquisition tool will be investigated to determine factors contributing to mLearning adoption at SMG.

Sung *et al.'s* (2010) research was based on empirical observations of the learning behaviours of elementary-school students whose average age was 12 years old. These students were visitors to a Taiwanese museum. The aim of their study was to understand how mobile guide systems affect the interactions between learners and the museum's exhibits. Sung *et al.'s* (2010) research was particularly interested in the level of attention these students employed in the learning process. The research employed a quantitative approach using sequential analysis as a method of calculating a behavioural-frequency transition table so that they could analyse behavioural patterns in the use of educational technologies. This method involved the use of mini cameras to video record the participants' learning behaviour. The researcher of the current study is cognisant that the use of cameras for the current research would also be considered intrusive and would result in a much lower participation rate, if at all. Sung *et al.'s* (2010) research also used a coding scheme that they had created based on Bakeman and Gottman (1997). Their research found that the mobile guide system allowed for more peer-peer and learner-exhibit interaction than the audio-visual guides and traditional paper-based learning sheets. The current study is not concerned with the behaviour patterns of SMG staff. Therefore, the employment of sequential analysis would not be useful. Instead, the current study is concerned with the potential museum-wide adoption of mLearning and the factors that contribute to mLearning adoption. Moreover, the current study is not concerned with the learning that is derived from museum visitors, instead it is concerned with the learning derived from museum staff.

In the same way Sung *et al.'s* (2010) research focused on elementary-school students, Vavoula *et al*.'s (2009) study focused on how mLearning enabled them to gather information during a school field trip visit to a museum. However, Vavoula *et al*.'s (2009) research was concentrated on a website service that supports learning between classrooms and museums, using mobile phones. Their research adopted a qualitative 3 stage approach which involved, 1) collecting data via interviews with teachers, students, and museum staff. 2) collecting data using video and audio recordings to substantiate the reality of the technology that was used by the different users (e.g., teachers, students, and museum staff). 3) Analysing the gaps between user expectations via reflective interviews with the users. Although, Vavoula *et al*.'s (2009) research captured rich data, this type of data collection makes it difficult to generalise across the participants and is often labour intensive. Additionally, there is the potential for bias, inaccuracies, and inconsistencies (Bryman, 2012). However, their research found that learners adopt new educational technology in ways that designers and educators do not typically expect. Another finding was that continuous evaluation and fine-tuning of the new technology will enable it to reach its full potential which is to transform educational practice. This finding is significant with regards to the current research as the goal, post research, is to transform aspects of the current SMG educational practice in the context of workplace learning.

Collins *et al*. (2009) research participants were not just elementary school students but museum visitors of all ages. The participants were asked to use their own mobile devices to interact with the physical and digital exhibits in the museum gallery as opposed to being issued with mobile devices from the museum. The purpose for this was to generate content that promotes the work of museum's experts. Furthermore, this was for the purpose of encouraging repeat visits to the museum. The research method used in their study is unspecified. Their research describes the research and presents unanalysed facts. However, their research argues that mobile technologies support mobile learners. Moreover, merely improving access to the resources is not sufficient to ensure their use. The resources need to be presented in a manner that enables the user to engage with them (Collins *et al*., 2009). The aim of the current study is to use mLearning to inform the ongoing content production of the museum's staff's community knowledge base. This knowledge base is used by SMG staff for just-in-time knowledge acquisition.

Pendit *et al.*'s (2014) research used an adaptation of the theory of mindfulness, theory of enjoyment and design of enjoyable technology to contribute the study of enjoyable informal learning. Their study used these theories to develop an Augmented Reality (AR) mobile application to be used by visitors to a cultural heritage site in Malaysia. Pendit *et al.* (2014) found that the visitors using the application showed positive responses to its use. Unlike previous research on mLearning in Museums, the current research focuses on the development of museum staff knowledge as opposed to museum visitors and the factors that contribute to mLearning adoption of museum visitors.

## 2.8 Culture, change and technological appropriation

Change is an inevitability and Kotter's 8 step change model (Kotter and Rathgeber, 2006) is often used to manage transformational change in a continuously evolving environment. Therefore, it is appropriate to discuss the use of a popular change model with regards to this study. Additionally, SMG and the ICT Department uses change models due to the current economic inevitabilities such as departmental restructuring due to funding cuts. These types of changes are recently prevalent in the sector. The ICT project team also use a loose version of Kotter's 8 step change model when delivering ICT projects across SMG. Moreover, change is part of the evolutionary nature of innovative technology. Kotter's 8 step change model recognises culture as one of the key factors that needs to be considered if an organisation wants to adopt a change. The adoption of a mLearning approach to knowledge acquisition can be considered a change, especially if mLearning is not a social norm in the organisation. In order to facilitate this adoption, within a culture where mLearning has not historically been employed. Kukulska-Hulme (2010) suggests that the organisation needs to cultivate an environment where the voice of the learner is heard. This is for the purpose of discovering the learners' current practices with mobile technologies. Assuming, the learner uses a mobile device, the purpose of this is to expand the learner's current practice and channel their paradigm shift from pedagogy (highly teacher centred) to andragogy (highly learner directed approach) (Cochrane, 2012; Palaiologos, 2011). An understanding of the learner's current practice can become stimuli for teachers/trainers to employ innovative designs for learning (Kukulska-Hulme, 2010). Additionally, in the context of the current study, the learner voice is listened to via the trends emanating out of the ServiceNow™ ICT incident reports. The ServiceNow™ ICT incident reports will form the basis of which the knowledge articles are created.

The role of early adopters is crucial as they can form a powerful coalition (step 2 in Kotter's 8 step change model) that is able to communicate the vision (Step 4 Kotter's 8 step change model) and remove some of the barriers to change (step 5 Kotter's 8 step change model) through demonstration and coaching. Early adopters help to steward their colleagues through the change process by assisting in raising the number of mLearning users to reach a critical mass point (Wenger *et al*., 2009). Thus, causing the number of late majority of mLearning adopters to grow rapidly over time, leading to mLearning adoption becoming self-sustaining (Rogers, 2003; Wang *et al.*, 2009). According to Rogers (2003) this theory delineates the diffusion process which follows an S-shaped curve as illustrated in Fig 2.4.

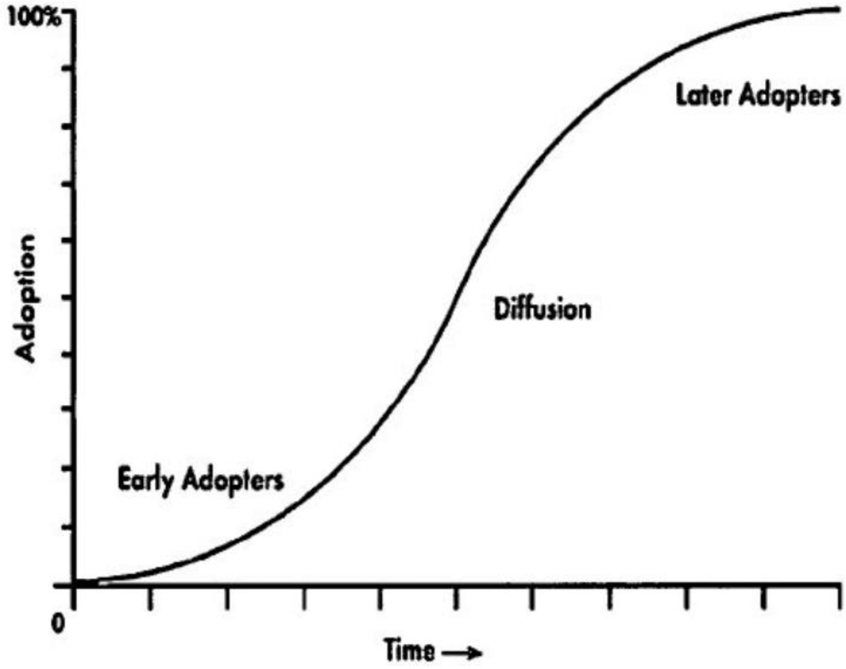



**Fig 2.4** The Diffusion S-Curve (Rogers, 1995; Mahler and Rogers, 1999)

In practice, early adopters will employ mLearning as a way of acquiring just-in-time knowledge. The early adopters may begin to convince their colleagues of its benefits and application. This may require the use of dedicated ICT project champions who occupy various roles within SMG and who have influence among peers.

Technology appropriation is the goal of any new implementation of Technology. Carroll *et al*. (2002) defines technology appropriation as “the way that [the late majority] evaluate and adopt, adapt and integrate a technology into their everyday practices” (p. 58). The central point to this discussion and a requirement to achieve successful technological appropriation is dependent on whether SMG staff are willing to adopt the new technology that is different from what they have become accustomed to, in this case, mLearning. This is the rationale for investigating the determinants of mLearning adoption at SMG.

## 2.9 mLearning adoption

Most research on mLearning adoption focus on Educational institutes like Schools, Colleges and Universities (Chee *et al*., 2016; Hong *et al*., 2011; Hwang and Tsai 2011; Wu *et al*., 2012). Therefore, mainly reporting on the challenges faced by teachers and students (El-Gayar and Moran, 2007; Liao *et al*., 2004; Pynoo *et al*., 2011; Wu *et al*., 2012). Venkatesh *et al*. (2016) reported a small number of studies measuring technology use at the feature level. Few studies report the challenges faced by the adoption of mLearning in the milieu of the workplace (Hong *et al*., 2011). However, the most pertinent principles of technological adoption can be applied to both environments e.g., the workplace and educational institutes.

### 2.9.1 Challenges of adoption

Challenges are pervasive in technological adoption. They typically fall into three categories but not limited to the following, finance, people, and technology (Paul *et al*., 2014). Finance can impede adoption due to competing budgetary priorities or lack of finances to sustain the technological innovation. People challenges usually consists of user perceptions and expectancy of reliability and performance of the technology. Equally, the effort needed to learn the new technology or lack of leadership buy-in or support can inhibit technological adoption (Paul *et al*., 2014). Technological barriers usually present reliability or performance issues. Earlier authors (Sian, Lim and Shen, 2001) have identified several technological challenges facing the adoption of mLearning. These challenges are related to the use of mobile devices such as '(1) small screens and small multifunction keypads; (2) less computational power, limited memory, and disk capacity; (3) shorter battery life; (4) complicated text input mechanisms; (5) higher risk of data storage and transaction errors; (6) lower display resolution; (7) less surfability; (8) unfriendly user-interfaces; and (9) graphical limitations' (p. 6). Since then, current capabilities have significantly improved. Examples of these improvements are screens sizes have increased along with the availability of a wider range of screen sizes and improved display resolution. Multifunction keypads are integrated into mobile device screens. Computational power has increased along with the limitation of memory and disk capacity. Typically, service providers mitigate device disk capacity limitations by offering additional cloud storage. This can be increased for a subscription fee. Battery life has improved, and recharging time has dropped significantly. User-interfaces have become increasingly simplistic and user friendly. Yousafzai *et al*., (2016) research can attest to these assertions. Other benefits of mobile devices are their low cost, portability, and ability to access training materials in remote areas. Thus, extending learning spaces beyond the training/conference room. However, when compared with the traditional desktop computers they are still floundering behind. An example of this is that a mobile device version of some applications are significantly less powerful than the desktop version therefore providing the users with much less functionality. Another example is the capabilities of mobile devices which are still restricted by their battery life. This becomes more apparent when staff are mobile and do not have immediate access to plug sockets. Additionally, the technological challenge that is prevalent in mobile technology is connectivity, wireless mobile networks generally suffer from persistent bandwidth fluctuations (Hashemi *et al*., 2011; Wang *et al*., 2009; Yousafzai *et al*., 2016). SMG front of house staff who use mobile devices occasionally experience issues with bandwidth fluctuations. Thus, operationally limited until connectivity is restored. Consequently, the benefits gained from wired networking compared to the inherently unreliable wireless networking impacts sustaining a satisfactory quality of experience/learning (QoE/QoL) (Hashemi *et al*., 2011; Yousafzai *et al*., 2016).

## 2.10 Technological adoption models

This section will present a brief overview of four influential technological adoption models, 1) Technology Acceptance Model (TAM), 2) Technology Acceptance Model (TAM2), 3) Unified Theory of Acceptance and Use of Technology (UTAUT) and 4) Unified Theory of Acceptance and Use of Technology 2 (UTAUT2). Additionally, it will expound in more detail the rationale for the chosen technological acceptance model for this research.

### 2.10.1 Technology Acceptance Model (TAM)

TAM (Fig. 2.5) was derived from the Theory of Reasoned Action (TRA) model (Fishbein and Ajzen, 1975), due to various theoretical limitations found in the TRA model. TAM seeks to explain the motivation of users to use technology by exploring three factors: perceived usefulness, perceived ease of use, and attitude toward use.

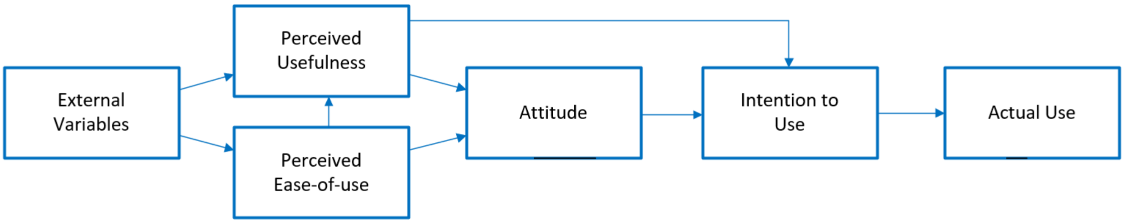



**Fig. 2.5**: The Theoretical Model of TAM (Davis, 1989)

#### 2.10.1.1 Strengths

TAM is one of the most influential technological acceptance models that has been empirically supported. It is also considered one of the most parsimonious and robust models within the field of technological acceptance (Plouffe *et al*., 2001).

#### 2.10.1.2 Weaknesses

Despite being one of the most cited technological acceptance models, numerous weaknesses have been found. One of which is that TAM disregards the impact of social influence on technological adoption (Bagozzi, 2007). Intrinsic motivations are also not addressed in this model. Some scholars (Benbasat and Barki, 2007) believe TAM has the inability to stay relevant. Thus, currently having limited usefulness when performing research in a continuously evolving IT environment, such as an mLearning environment. Persico *et al*. (2014) concurs by arguing that TAM was not modelled to include evaluating the learning required to use eLearning systems.

### 2.10.2 Technology Acceptance Model (TAM2)

TAM2 (Fig. 2.6) was developed by Venkatesh and Davis (2000) because of the limitations in the explanatory power of TAM. TAM2 also known as Extended Technology Acceptance Model (ETAM) seeks to further explain the motivation of users to use technology by exploring the original three factors mentioned above, and how the impact of those determinants changed over increasing use of the system (Lai, 2017).

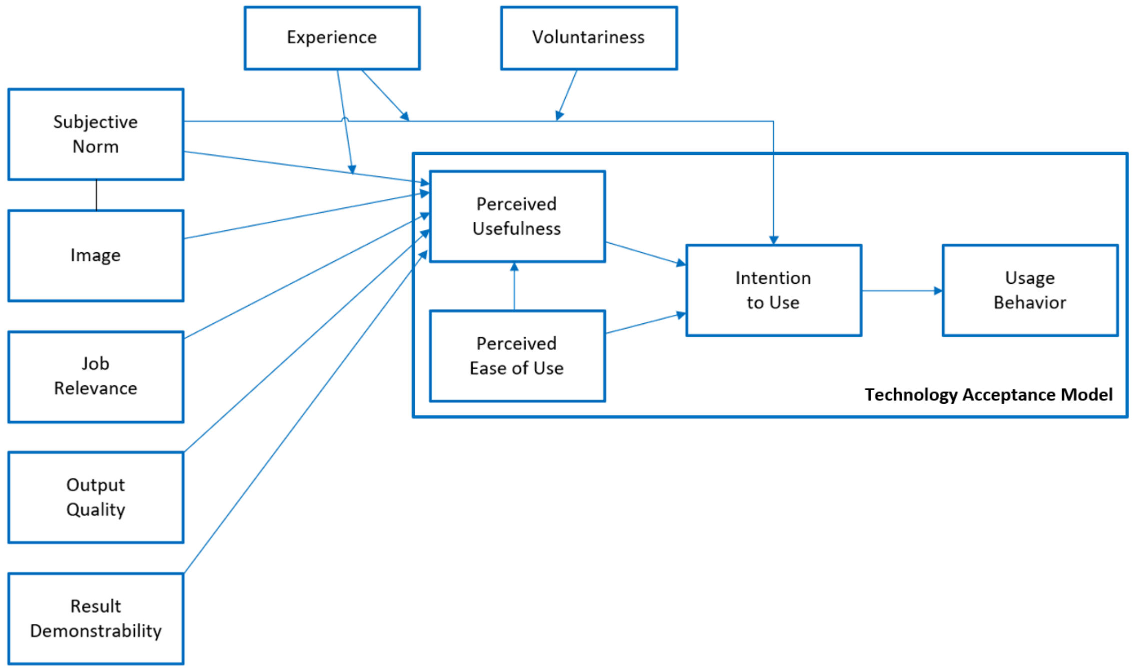



**Fig. 2.6**: The Theoretical Model of TAM 2 (Venkatesh and Davis, 2000)

### 2.10.2.1 Strengths

TAM2 performs well in both voluntary and mandatory environments (Bagozzi, 2007). These types of environments are determined by the individual's perception of the level of voluntariness of the use of the technology or innovation (Moore and Benbasat, 1991). In other words, to what degree is the use of the technology mandatory or the individual's free will.

### 2.10.2.2 Weaknesses

Despite the improvements made from the additional variables, explanatory power was still considered to be lacking. Bagozzi (2007) identified two critical gaps in the framework. The first, intention to use and actual use linkage. The second is 'the linkage between individual reactions to using information and intentions'(p. 246). According to Bagozzi, the two critical gaps in the framework are both uncritically accepted. Parsimony has been identified as both a strength and a weakness. However, the reason it is considered a weakness is because TAM2 does not fully explain decisions and behaviors across a wide range of contexts (Bagozzi, 2007). mLearning is a relatively new context and therefore based on arguments by Bagozzi (2007) regarding TAM2 inability to explain behaviours across a wide range of contexts, TAM2 was found to be unable to fulfil the current research aims.

### 2.10.3 The Unified Theory of Acceptance and Use of Technology (UTAUT) Model

Venkatesh *et al*. (2003) proposed a unified model, called the unified theory of acceptance and use of technology (UTAUT), which amalgamates elements across eight models (fig. 2.7). The eight models consist of the theory of reasoned action (TRA) (Fishbein and Ajzen, 1975), the technology acceptance model (TAM) (Davis, 1989), the motivational model (MM) (Davis, Bagozzi and Warshaw, 1992), the theory of planned behaviour (TPB) (Ajzen, 1991), the combined TAM and TPB (C-TAM-TPB) (Taylor and Todd, 1995), the model of PC utilisation (MPCU) (Thompson, Higgins and Howell, 1991; Triandis, 1977), the innovation diffusion theory (IDT) (Moore and Benbasat, 1991; Rogers 1995) and the social cognitive theory (SCT) (Bandura, 1986; Compeau and Higgins, 1995). The UTAUT model consists of four determinants of behavioural intention and usage, which include 1) performance expectancy, 2) effort expectancy, 3) social influence and 4) facilitating conditions. Additionally, there are four moderators of the central relationships also known as interactions, which are 1) gender, 2) age, 3) experience and 4) voluntariness of use (see Fig. 2.7). A further discussion on the four determinants (performance expectancy, effort expectancy, social influence, and facilitating conditions.) of behaviour intention is covered in the following sections.

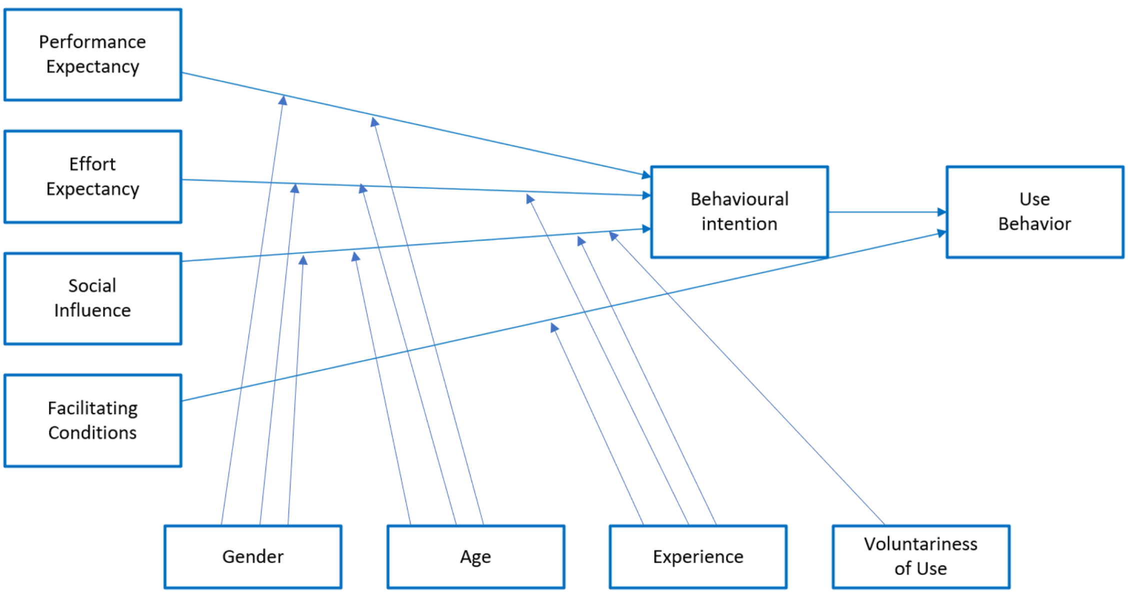



**Fig. 2.7**: The Theoretical Model of UTAUT (Venkatesh *et al*. 2003)

The UTAUT model in the current research has been extended to include self-directedness as an additional determinant based on literature by Williamson (2007). The term Self-directedness will be used interchangeably throughout this thesis with the term self-directed learning. The model in the current research uses only age and gender as moderators because the level of voluntariness is not an issue in this study as staff are aware that they have complete autonomy over whether they use the service or not. Additionally, unlike Venkatesh *et al*.'s (2003) study, the current study does not measure across different time periods. Thus, removing the need for the measurement of the moderating role of experience on three (Facilitating conditions, Social influence, and Effort expectancy) of the four key determinants of behavioural intention to use technology.

Venkatesh *et al*. (2003) provides definitions for each of the four constructs which the researcher of the current study has modified to incorporate mLearning and the SMG context. Performance expectancy suggests SMG staff will find it beneficial to apply mLearning as a knowledge acquisition solution. Thus, increasing their job productivity by accomplishing tasks more quickly and flexibly. There are five constructs pertaining to performance expectancy (PE), they are: perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT).

Venkatesh *et al*. (2003) defines effort expectancy as the extent to which the use of the information system is achieved with ease. Three constructs from three models denote the concept of effort expectancy: perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT). Effort expectancy postulates that SMG staff's acceptance of mLearning will depend on the extent to which the use of it will be achieved with ease and without the need to spend copious amounts of time understanding how to use mLearning. In addition, Rossett and Marshall's (2010) research found the use of mobile devices for learning was uncommon in current practice and was hardly considered for staff training albeit formal, non-formal or informal work-based learning. Therefore, because of this novel way of learning, it is assumed that effort expectancy will be a determinant of mLearning adoption.

Venkatesh *et al*. (2003) defines social influence as the extent to which an individual perceives that either senior level staff members or someone that can influence behaviour thinks they should use the information system. The construct social influence is represented as subjective norm in TRA, TAM2, TPB/DTPB and C-TAM-TPB, social factors in MPCU, and image in IDT.

Social influence in the context of SMG advances the notion of management or staff such as ICT champions influencing the behaviours of other staff. The purpose of management or ICT champions in this context is to raise the number of mLearning users to reach a critical mass point, leading to self-sustaining growth (Wenger *et al*., 2009).

Venkatesh *et al*. (2003) defines facilitating conditions as the extent to which an individual perceives the organisational and technical infrastructure's ability to provide support for the information system. The construct facilitating conditions is typified by three different constructs from five models: perceived behavioural control (TPB/DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT).

In the context of SMG, the construct facilitating conditions suggests that it is imperative that SMG needs to have the organisational and technological infrastructure readily available to staff to help resolve issues as and when they occur.

Based on arguments presented by Venkatesh *et al*. (2003) regarding the presence of both performance expectancy and effort expectancy constructs, facilitating conditions becomes nonsignificant in predicting behaviour intention.

According to Williamson (2007), individuals are capable of Self-direction.  Williamson believes it is the foundation of all learning be it formal or informal learning. Knowles (1975) argues that there is convincing evidence that individuals who are proactive learners tend to learn more things, and learn better, than individuals who are reactive learners, those passively waiting to be taught. 'They enter into learning more purposefully and with greater motivation. They also tend to retain and make use of what they learn better and longer than do the reactive learners.' (Knowles 1975: p. 14). Examples of self-directed learning relating to 'identifying human material resources for learning' are, reading self-designated books, articles, seeking advice from peers, participating in communities of practice (Paradise and Rogoff, 2009) or in the context of SMG, viewing educational YouTube videos and knowledge articles for the purpose of knowledge acquisition, etc.

From both a techno centric and andragogical viewpoint, aspects of mLearning can be considered as a type of self-directed eLearning via mobile devices. For example, both eLearning and mLearning are learner centred thus, self-directed learning (Behera, 2013). It is expected that a person's level of self-directedness of learning will have a positive influence on his or her behavioural intention to use mLearning as a knowledge acquisition intervention.

The use of the UTAUT model has been well documented, developed, reviewed, and used by numerous authors in many countries. It has been known to explain technological adoption in many research contexts and is presently being applied in the context of SMG and adapted to explain the factors affecting mLearning adoption. The UTAUT model and its constructs underpins this research as it provides explanations for many of the research questions in this study.

The UTAUT model is eighteen years old (at the time of writing) and has been used extensively in information systems and other fields (See Table 2.3 listing a comparison of UTAUT research). Researchers have integrated and extended the UTAUT model to study technological acceptance and use across a variety of settings (e.g., different user types, different organization types, different types of technologies, different tasks, different times, and different locations).

***Table 2.3*** Comparison of UTAUT Models

| Study | Dependent variable | Sample | Type of survey | Technology |
|---|---|---|---|---|
| Alaba, Abass and Igwe (2020) | Behavioural intention | 244 Students | Cross-sectional | mLearning |
| Chao (2019) | Behavioural intention | 1562 respondents | Cross-sectional | mLearning |
| Onaolapo & Oyewole (2018) | Usage behaviour | 186 university Students | Cross-sectional | mLearning |
| Moryson & Moeser (2016) | Behavioural intention | 1047 respondents | Cross-sectional | Mobile service |
| Guo (2014) | Behavioural intention | 359 respondents | Cross-sectional | Mobile service |
| Jackman (2014) | Behavioural intention | 600 undergraduate students | Cross-sectional | mLearning |
| Jambulingam (2013) | Behavioural intention | 351 university students | Cross-sectional | Mobile phone |
| Nistor, Gogus, & Lerche (2013) | Usage behaviour | 4589 respondents | Cross-sectional | Computer |
| Al-Sobhi *et al*. (2011) | Usage behaviour | 626 Citizens (Men) | Cross-sectional | E-Government Services |
| Wang *et al*. (2010) | Behavioural intention | 343 respondents | Cross-sectional | Mobile internet |
| Wang, Wu, & Wang (2009) | Behavioural intention | 330 Respondents with IT experience | Cross-sectional | mLearning |
| Kijsanayotin *et al*. (2009) | Usage behaviour | 1,187 Community health centres staff | Cross-sectional | Health Information Technology |
| Wills *et al*. (2008) | Usage behaviour | 52 professionals | Cross-sectional | Electronic Medical Record |
| Chiu and Wang (2008) | Continuance intention | 286 respondents | Cross-sectional | Web-Based Learning |
| Wu *et al*. (2008) | Usage behaviour | 394 professionals | Cross-sectional | 3G Mobile Communication |
| Al-Gahtani *et al*. (2007) | Usage behaviour | 722 knowledge workers | Cross-sectional | Information Technology |
| Bandyopadhyay & Fraccastoro (2007) | Behavioural intention | 502 respondents | Cross-sectional | Prepayment Metering Systems |
| Anderson *et al*. (2006) | Usage behaviour | 37 faculty members | Cross-sectional | Tablet PCs |
| Brown and Venkatesh (2005) | Behavioural intention | 746 households | Longitudinal | Technology |
| Benslimane, Plaisent, and Bernard (2004) | Individual performance | 136 corporate buyers | Cross-sectional | Web Systems for eProcurement |
| Lin *et al*. (2004) | Usage behaviour | 300 students | Cross-sectional | Instant Messaging |

Source: (Williams *et al*., 2015)

The aim of this model is to explain technological acceptance. It is also considered superior to previous theories explaining technology acceptance and use (Attuquayefio and Addo, 2014; Cheng *et al*., 2011). Hence, this study will be using this model to explain mLearning adoption as a just-in-time learning intervention at the SMG. Gender, experience, age, and voluntariness of use were identified as moderating variables in the original UTAUT; experience and voluntariness have been controlled for and therefore, removed from the adapted model. Since only a few mLearning adoption studies using the UTAUT model were found to investigate all the original UTAUT constructs (See Table 2.4 summarising the relationship among the UTAUT variables investigated) the current study will investigate many of the relationships.

***Table 2.4*** summary of relationships investigated in UTAUT studies

| **Study** | **PE-BI** | **EE-BI** | **SI-BI** | **FC-BI** | **FC-USE** | **BI-USE** |
|---|---|---|---|---|---|---|
| Alaba, Abass, and Igwe (2020) | Yes | Yes | No | Yes | X | X |
| Chao (2019) | Yes | Yes | X | X | X | X |
| Onaolapo & Oyewole (2018) | X | X | X | X | Yes | X |
| Moryson & Moeser (2016) | X | X | X | Yes | X | X |
| Guo (2014) | Yes | No | Yes | Yes | Yes | Yes |
| Jackman (2014) | Yes | Yes | No | Yes | X | X |
| Jambulingam (2013) | Yes | No | No | No | X | X |
| Nistor, Göğüş, & Lerche (2013) | Yes | Yes | No | X | Yes | No |
| Al-Sobhi *et al*. (2011) | No | Yes | No | X | Yes | No |
| Wang *et al*. (2010) | Yes | Yes | Yes | X | X | X |
| Wang, Wu, & Wang (2009) | Yes | Yes | Yes | X | X | X |
| Kijsanayotin *et al*. (2009) | Yes | Yes | Yes | X | Yes | Yes |
| Wills *et al*. (2008) | Yes | Yes | Yes | X | Yes | Yes |
| Chiu & Wang (2008) | Yes | Yes | No | No | X | X |
| Wu *et al*. (2008) | Yes | No | Yes | Yes | Yes | Yes |
| Al-Gahtani *et al*. (2007) | Yes | Yes | X | X | Yes | Yes |
| Bandyopadhyay & Fraccastoro (2007) | Yes | Yes | Yes | X | X | X |
| Anderson *et al*. (2006) | Yes | No | No | No | No | X |
| Brown & Venkatesh (2005) | No | No | No | X | Yes | Yes |
| Lin *et al*. (2004) | No | Yes | X | No | X | Yes |
| Venkatesh *et al*. (2003) | Yes | Yes | Yes | No | Yes | Yes |

Source: (Williams *et al*., 2015) **No**: non statistically significant relationship found. **Yes**: statistically significant relationship found. **X**: relationship not used in the study.

The current study will include an additional construct, self-directedness in this context. Subsequently, this study will examine the effects of this new construct on the behaviour intention to use mLearning for the purpose of acquiring just-in-time knowledge for museum staff. Thus, an adaptation of Venkatesh *et al*.'s (2003) model being tested in this study is shown in Fig 2.9. It will be used to address the following research question.

- What factors determine SMG employees' behavioural intention to adopt and use mLearning?

#### 2.10.3.1 Moderators

Moderating variables change the strength or direction of an effect between the exogenous variable and the endogenous variable (Bryman, 2012). In SEM, exogenous variables are those that do not depend on other variables whilst endogenous variables are dependent on other variables (Arbuckle, 2017). This relationship between exogenous variables, moderator variables and endogenous variables is diagrammatically illustrated in fig 2.8.

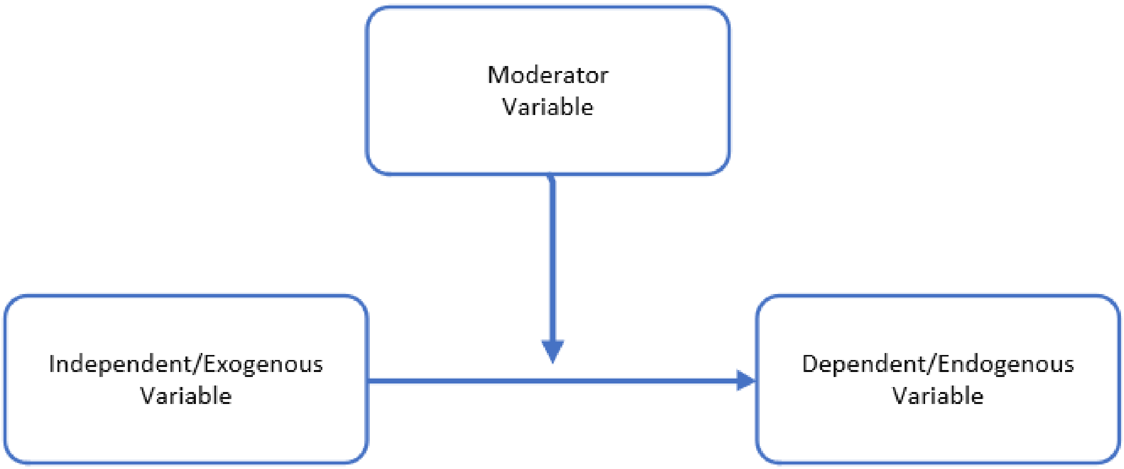



**Fig. 2.8:** Relationship of the moderator variable

Several scholars (Morris and Venkatesh, 2000; Venkatesh and Morris, 2000) theorised that gender and age have been shown to play moderating roles in the context of technological adoption. Moderating variables, gender and age were included in previous UTAUT research (see Table 2.5). Gender as a moderator has been included in only a few previous mLearning research that has adopted the UTAUT model to investigate determinants of mLearning (e.g., Al-Adwan *et al.*, 2018; Cheng *et al.*, 2011; Wang *et al.*, 2009). Table 2.5 presents a summary of UTAUT research over a 16-year period that has been carried out using moderator variables.

***Table 2.5*** Moderators used in UTAUT research

| Study | Gender | Age | Experience | Voluntariness of use |
|---|---|---|---|---|
| Chao (2019) | Yes | X | X | X |
| Al-Adwan *et al*. (2018) | Yes | No | X | X |
| Moryson & Moeser (2016) | Yes | Yes | Yes | X |
| Guo (2014) | Yes | X | X | X |
| Jambulingam (2013) | No | No | X | X |
| Cheng *et al*. (2011) | Yes | Yes | X | X |
| Wang *et al*. (2010) | Yes | X | X | X |
| Wang *et al*. (2009) | Yes | Yes | X | X |
| Al-Gahtani *et al*. (2007) | Yes | No | Yes | X |
| Bandyopadhyay & Fraccastoro (2007) | Yes | Yes | Yes | Yes |
| Anderson *et al*. (2006) | No | No | No | Yes |
| Brown and Venkatesh (2005) | Yes | Yes | X | X |
| Lin *et al*. (2004) | No | No | No | X |
| Venkatesh *et al*. (2003) | Yes | Yes | Yes | Yes |

Source: (Williams *et al*., 2015) **No**: has been found not to moderate the relationship among the constructs.

**Yes**: has been found to moderate the relationship among the constructs. **X**: not used in the study

Williams *et al*. (2015) review of UTAUT research found that several research that has used gender as a moderator has been found to affect decisions and attitudes towards the use of technology. Based on the UTAUT constructs, Performance expectancy is typically more salient to males as research on gender differences indicate males are usually more task-oriented than females (Minton and Schneider, 1980).

Drawing on previous research from the area of psychology which suggest that effort expectancy is more salient for females than for males. This notion of effort expectancy being a stronger determinant of an individuals' intention in females than males is supported by prior research (Venkatesh and Morris 2000; Venkatesh *et al*. 2000).

Miller (1976) suggests that females tend to be more receptive to others' opinions than males and therefore Social influence will be more salient to females than males when making an intention to use new technology. Furthermore, other scholars (e.g., Indrawati *et al*., 2010; Venkatesh *et al*., 2003; Wu *et al*., 2008) concurs with this notion that social influence affects females' intention to use new technology more than males.

Beck's (1983) research on cognitive therapy suggests evidence to support the notion that males are more likely to possess autonomous personality traits than females. As a result, it is anticipated that the effect of self-directed learning on mLearning acceptance will be moderated by gender such that the effect will be stronger for males than females.

Age as a moderator has been included in numerous previous UTAUT research but only a few mLearning research that has adopted the UTAUT model has included age as a moderator (e.g., Bandyopadhyay and Fraccastoro, 2007; Cheng *et al*., 2011; Wang *et al*., 2009). Williams *et al*.'s (2015) review of UTAUT research also found that several research that has used age as a moderator has been found to affect decisions and attitudes towards the use of technology. Venkatesh *et al*. (2003) reported that age was an important moderator within their UTAUT model. Performance expectancy is more salient to younger people as research on age differences and job-related attitudes (Hall and Mansfield, 1975; Porter, 1963) indicate younger workers place more value on extrinsic rewards than older workers (Venkatesh *et al*., 2003).

Drawing on previous research from the area of gerontology suggest that effort expectancy is more salient for older adults. This is because older adults have been found to not perform as well as younger people in divided attention tasks (Plude and Hoyer, 1986).

In addition, Rhodes' (1983) review of age-related differences in work attitudes and behaviours claims that as an adult's age increases so does their sense of involvement within an established social group. These findings suggest that older adults will place more salience on social influence than younger adults.

Wang *et al*.'s (2009) study on age and gender differences in mLearning adoption found that older individuals are more likely to display better self-management of learning attributes than younger individuals. Thus, self-directed learning will be more salient in older individuals then younger individuals.

In the context of mLearning and based on UTAUT literature, it is anticipated that the effect of facilitating conditions on mLearning adoption will not be moderated by gender and age.

Findings from Venkatesh *et al*. (2003) concluded that gender moderated the relationship between many variables such as PE-BIU, EE-BIU, and SI-BIU. In addition, age moderated the relationships between most of the variables such as PE-BIU, EE-BIU, SI-BIU and FC-USE.

Since only a few studies of mLearning and UTAUT were found to investigate the gender and age moderator variable in this context, this study will reduce the gap in knowledge and incorporate the moderator variables of gender and age for the purposes of examining its moderating effect towards the UTAUT constructs that determine intention to use mLearning for the purpose of acquiring just-in-time knowledge for museum staff. Thus, an adaptation of Venkatesh *et al*.'s (2003) model being tested in this study is shown in Fig 2.9. It will be used to address the following research question.

- To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?

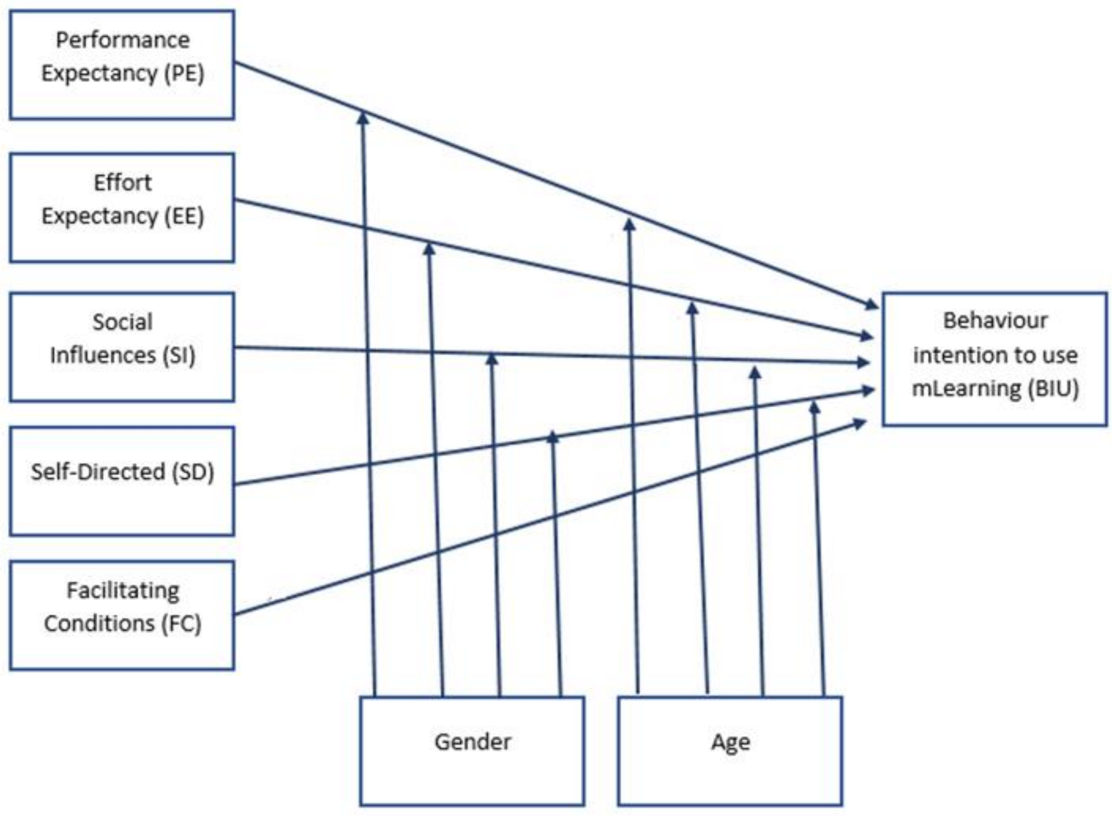



**Fig. 2.9**: The adaptation of the UTAUT Model (Venkatesh *et al*. 2003)

Previous UTAUT research (e.g., Al-Sobhi *et al*., 2011; Chen *et al*., 2008; Huser *et al*., 2010; Loo *et al*., 2009; YenYuen and Yeow, 2009; Yeow and Loo, 2009) have stated that not using moderators, was one of the limitations of their research. Therefore, moderators will be used in the current study to strengthen the current research.

#### 2.10.3.2 Extensions to the UTAUT model

Prior UTAUT research has extended the UTAUT model by adding moderator, exogenous or endogenous variables. Venkatesh *et al*. (2016) considers an extension to the original model if the study is an empirical study that included part of or the entire UTAUT as the baseline model and has extended that baseline with either new exogenous, endogenous or moderator variables. For example, both Wang *et al*. (2007) and Al-Adwan *et al*. (2018) study on mLearning included the exogenous variable Self-management of learning which in turn was found to be a determinant of behaviour intentions to use. Furthermore, Bandyopadhyay *et al*. (2007) research on Prepayment Metering System extended the UTAUT model by including the moderator variable, Income. This moderator variable moderated the relationship between social influence and behaviour intentions, effort expectancy and behaviour intentions, and performance expectancy and behaviour intentions. This moderator was found to be statistically significant in moderating the relationship in their study's UTAUT constructs. Additionally, Benslimane *et al*. (2004) research on Web Systems for eProcurement also extended the UTAUT model by including the endogenous variables, Web system usage and Individual performance. The UTAUT constructs performance expectancy, effort expectancy, and social influence were found to be determinants of the endogenous variable Web system usage. Web system usage was also found to be a determinant of Individual performance. The current study plans to extend the UTAUT model by including self-directed learning as an exogenous variable.

#### 2.10.3.3 Limitations of UTAUT research

Williams *et al*. (2015) review of UTAUT research found that the majority of limitations reported were single subject or gender biased samples such as majority female/male participants (Sumak *et al*., 2010; Wills *et al*., 2008). Another common limitation of UTAUT research was the use of students as research participants that were used to explore workplace issues (e.g., Al Awadhi and Morris, 2008; Carter and Schaupp, 2009; Im *et al*., 2008; Johnston and Warkentin, 2010; Luo *et al*., 2010; McLeod *et al*., 2009a, b; Sumak *et al*., 2010; Tsai *et al*., 2009; Wu *et al*., 2010; Zhang *et al*., 2010). Williams *et al*.'s (2015) research also found that some research did not use moderating variables (e.g., Al-Sobhi *et al*., 2011; Chen *et al*., 2008; Huser *et al*. 2010; Loo *et al*., 2009; Yeow and Loo, 2009; YenYuen and Yeow, 2009). The current research attempts to remedy these limitations by using SMG workforce as research participants to explore workplace issues. Furthermore, the current study uses moderators such as age and gender to examine if they affect behaviour intentions to use mLearning as a just-in-time knowledge acquisition tool at SMG.

There are no technology acceptance models that are without weakness or limitations, Alshammari and Rosli's (2020) review of Technology Acceptance Models and Theories found several drawbacks with the UTAUT model. One of which is the lack of consensus between the relationships in UTAUT especially when applied in different contexts. Another weakness of the UTAUT model that was found by Alshammari and Rosli (2020) was lack of parsimony due to the complex relationships among constructs as well as the moderating interactions among the constructs. Additionally, their research found that the UTAUT was inflexible when used in a non-western context. Specifically, a low explanatory power with the variance explained in the BIU construct when used in the Kingdom of Saudi Arabia, only 39.1% of the variances were explained by the UTAUT model. This notion is corroborated by research conducted by Thongsri *et al*. (2018) in Thailand that integrated the Uses and Gratifications Theory (UGT) model with the UTAUT model. They found that using the UTAUT model alone explained 42.1% of the variances of intention to use mLearning. Contrary to Alshammari and Rosli (2020) findings regarding the notion of low explanatory power of the UTAUT model in a non-western context, Mhina and Johar's (2018) research in Tanzania disproved this notion. Mhina and Johar (2018) research expanded the original UTAUT model by integrating the constructs, Perceived personal image, Hedonic motivation and Attitude found that their adaptation of the UTAUT model explained 73% behaviour intentions and 73% use behavior.

#### 2.10.3.4 UTAUT Explanatory power

Venkatesh *et al*. (2016) claims that UTAUT explained 77% of the variance in behavioural intention to use a technology and 52% of the variance in technology use. However, other researchers found discrepancies with this claim regarding the explained variance in behaviour intention to use a technology. They each observed lower explanatory powers; 59.3% (Thomas *et al*., 2013), 62.7% (Mardikyan *et al*., 2012), 34% (Cheng *et al*., 2011), 56.1% (Nassuora, 2012), 67% (Alharbi *et al*., 2017), 58% (Wang *et al*., 2009). The noted inconsistencies in the explanatory powers are perhaps due to the exclusion and inclusion of UTAUT constructs and moderators. Another reason for the discrepancies could be due to the variety of data analysis techniques carried out by the various scholars or the nature of the sample group. An example of the variety of analysis used in each study can be illustrated by comparing five authors' studies. Thomas *et al*. (2013) used Structural equation modelling and confirmatory factor analysis (CFA), Nassuora (2012) used Principal axis factoring, Wang *et al*. (2009) used Structural equation modelling and CFA, Mardikyan *et al*. (2012) used independent samples t-test, one-way ANOVA, and regression analysis. Cheng *et al*. (2011) used a mixture of descriptive statistical analysis, reliability analysis, CFA, and correlation analysis.

#### 2.10.3.5 UTAUT model validity and reliability

Regarding the validity and reliability of the UTAUT model, this has been confirmed by numerous authors (e.g., Al-Gahtani *et al*., 2007; Bandyopadhyay and Fraccastoro, 2007; Habboush *et al*., 2011; Nassuora, 2012; Teo, 2011; Thomas *et al*., 2012; van Raaij and Schepers, 2008; Wang and Shih, 2009; Wu *et al*., 2008).

#### 2.10.3.6 The Unified Theory of Acceptance and use of Technology (UTAUT2)

UTAUT2 (Fig. 2.10) was derived from the widely accepted UTAUT model (Venkatesh *et al*., 2003) and included the original five constructs and the addition of three other constructs, hedonic motivation, price value, habit, and the moderator, experience. Each of the newly added constructs will be discussed further. The original constructs performance expectancy, effort expectancy, social influence and facilitating conditions are discussed in detail in section *The Unified Theory of Acceptance and Use of Technology (UTAUT) Model*.

#### 2.10.3.7 Hedonic Motivation

Hedonic motivation is defined as the pleasure or fun derived from using a technology, numerous authors (e.g., Brown and Venkatesh 2005; Thong *et al* 2006; van der Heijden 2004) has found that pleasure from using a technology is an important determinant of technology acceptance and use. However, it is assumed that hedonic motivation will not apply to SMG staff for similar reasons as those found in Ain *et al*.'s (2016) research. Namely, mLearning in the current context is more task-oriented and SMG staff would not be seeking novelty in the system, only using it for knowledge acquisition activities. This means that although the construct Hedonic motivation is useful in other studies (Bae and Chang, 2012) it is rendered impractical for the current study.

#### 2.10.3.8 Price value

Individual consumers typically bear the monetary cost of using ICT, therefore the cost and pricing structure may present a significant impact on the consumers' decision to adopt or use technology (Venkatesh *et al*., 2012). Furthermore, in marketing literature the monetary cost is typically conceptualized together with the quality of the products or services (Zeithaml, 1988). Based on this conceptualisation, price value has a positive impact on behaviour intentions and use behaviour if the individual perceives that the benefits of using technology is greater than the monetary cost (Venkatesh *et al*., 2012). However, in the current research price value is not applicable to SMG staff as they are not the purchasers of the mLearning intervention being considered. Only the most senior management of the ICT department will bear the monetary cost of this novel learning intervention. Moreover, the purchase of the mobile devices is not solely for the purpose of using it for the mLearning intervention. Therefore, it is assumed that price value is irrelevant to this study and therefore not included in the current study.

#### 2.10.3.8 Habit

Limayem *et al*. (2007) defines habit as the extent to which individuals tend to perform behaviours automatically due to learning and repetition. On the other hand, Kim *et al*. (2005) defines habit as the ability to do things as an automatic response pattern. The distinction of the two conceptually similar definitions of habit lay in the perception. For example, Kim *et al.*'s (2005) perception is based on prior behaviour and Limayem *et al.*'s (2007) perception is based on the individual's belief that the behaviour is automatic. It can be assumed that the habit construct will not be applicable to SMG staff for similar reasons to those found in Ain *et al*.'s (2016) research. Such as, some staff may frequently use the KMS and mLearning for work and personal knowledge acquisition. However, this behaviour may not be considered habitual (Nilsen *et al*., 2012). Another reason habit may not be applicable to SMG staff is because this is a novel solution to just-in-time knowledge acquisition. Therefore, habit may not have been developed by many of SMG staff to use the ServiceNow™ knowledge articles for just-in-time knowledge acquisition. Thus, this construct will not be used in the current research. Venkatesh *et al*. (2016) suggests that old habits of using legacy systems could negatively impact the use of the new system. Consequently, inhibiting possible improvements to job performance. Venkatesh *et al*.'s (2016) suggestion can be transposed on the use of a mLearning system and may hinder the users learning of the new system. However, the perception of how easy it will be to learn the new system will be measured using the effort expectancy construct.

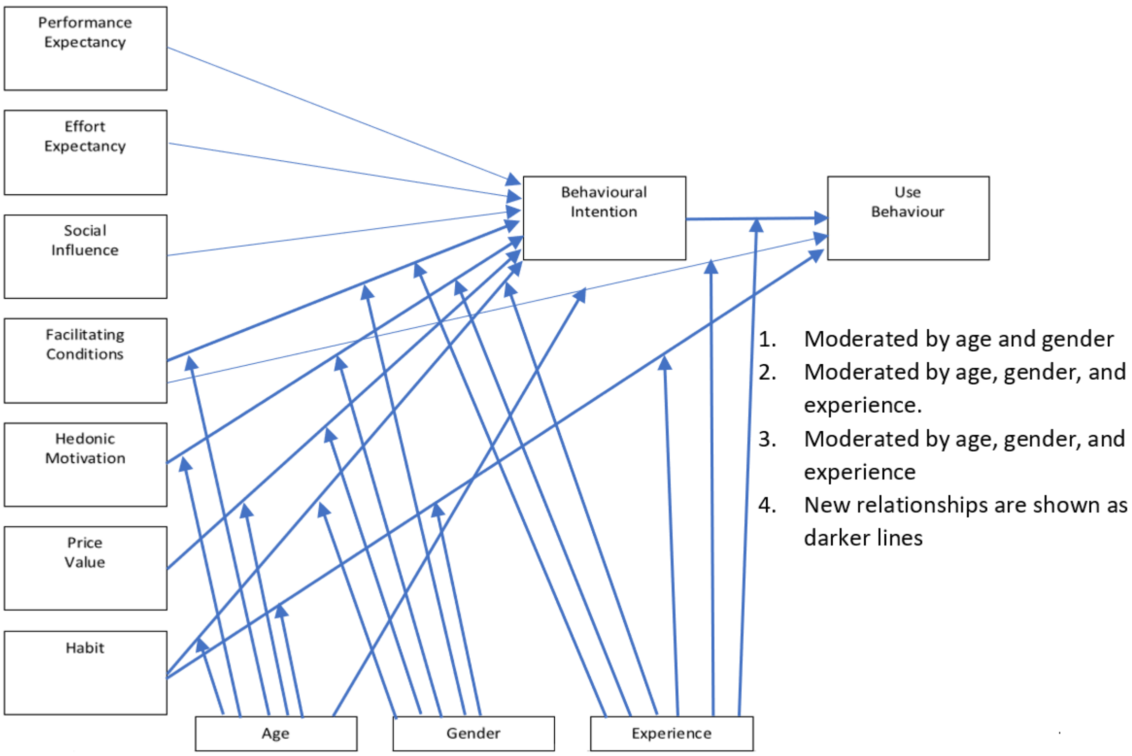



**Fig. 2.10**: The UTAUT2 Model (Venkatesh *et al*. 2012)

### 2.10.3.9 Strengths

Venkatesh *et al*.'s (2012) research found that compared to the original UTAUT, the extensions proposed in UTAUT2 yielded a substantial improvement in the variance explained in behaviour intention (56 percent to 74 percent) and Technology use (40 percent to 52 percent).

#### 2.10.3.10 Weaknesses

Ain *et al*. (2016) recommends that further studies are necessary to validate the UTAUT2 model in other contexts. Moreover, factors such as habit and hedonic motivation require more attention (Ain *et al*., 2016). Due to the above reasons, an adaptation of the original UTAUT model is going to be used in the current study to provide an understanding of mLearning adoption.

## 2.11 ICT Service desk and knowledge management

ICT service desk practice and knowledge management are relevant to this study because the Service Level Agreement (SLA) breaches being experienced by the service desk team and the wider SMG staff was the impetus for this study.  The overall ambition of employing mLearning as a just-in-time knowledge acquisition tool is to reduce the SLA breaches being experienced by staff. This will be achieved by embedding mLearning into SMG's current ICT service desk practice by using knowledge management tools to serve just-in-time knowledge to service users.  The overall ambition of this research is to reduce the gap in knowledge regarding mLearning and ICT service desk practice.

ICT Service Desk is a functional unit that contributes to a broader role that handles a plethora of Information Technology Service Management (ITSM) activities (Gallacher and Morris, 2012), most of which are beyond the scope of this study. This is because this study is only concerned with a limited aspect of the field. Namely, resolving ICT incidents especially those that can be resolved using mLearning to support service requests. Service requests are people facing roles and not technology facing roles (Gallacher and Morris, 2012). An example of one of many technology facing roles is the Enterprise Architect who is responsible for designing secure and resilient technology architectures that meet all the current and anticipated future IT requirements of the organisation (Steinberg, 2011).  An example of one of many people facing roles is service desk who is responsible for provisioning support through a single point of contact (Gallacher and Morris, 2012).  This will be the definition and scope with which ICT Service Desk will be referred to in the current study. Additionally, a brief discussion of ICT service desk practice's historical roots and its current practice will provide a context in which to describe ICT service desk practice in SMG and in this research. In addition, the following section will present a brief discussion of ITSM practice trends regarding the use of mobile devices to access SMG internal resources and applications.

There is plenty ITSM best practice literature that can be found in Information Technology Infrastructure Library (ITIL), Total Quality Management (TQM), Six Sigma, Business Process Management, and Capability Maturity Model Integration (CMMI) (Galup *et al*., 2009). However, there is a dearth of academic literature that delineates best practice regarding embedding mLearning into ITSM practice. The significance of this is that this research is unable to use established and validated frameworks to support the embedding of mLearning into ITSM practice. Having literature on embedding mLearning into ITSM practice would provide more factors to consider when evaluating the current use of mLearning in SMG and exploring mLearning adoption for the purpose of just-in-time knowledge acquisition. The current research aims to reduce the gap in this knowledge by examining the use of knowledge articles that can be adapted for mLearning use and incorporated into ICT service desk practice.

In ITSM practice literature, researchers postulate that ITSM has evolved from a technological centric practice to a field that focuses on managing IT operations and processes as a service (Gallacher and Morris, 2012; Galup *et al*., 2009). From the advent of IT operations, ICT help desk practice did not have much technology beyond the equipment that end users used. Subsequently, its main function was to help co-workers with common problems like hardware and operating system issues. This is considered by some authors (Galup *et al*., 2009; Thiadens, 2002) as the earliest practice of ICT help desk which goes as far back as the 1980's. Over the years, Service Desk practice has evolved into more than helping co-workers with common ICT problems and has become more integrated into business operations. Thiadens (2002) concurs by arguing that ICT Service Desk management has gone through three phases of development where it has progressed from simply coordinating its internal services to directing services towards an improved performance. However, the difficulty with this study is that it appears ambiguous as it does not clearly define the three phases, it only states that there were three stages. Therefore, it is difficult to determine the factors influencing the cause of the changes as these are not stated.

### 2.11.1 Current ICT service desk practice

The current role of ICT service desk seeks to facilitate the integration of business processes into the service management infrastructure (Adams *et al.*, 2009). In the context of SMG, the aim of ITSM is to augment IT services for the purpose of fulfilling business requirements and manage the IT infrastructure as well as aligning IT with the business objectives of SMG. In addition to actively monitoring and responding to incidents and user questions and requests, the ICT service desk provide the communications channel for the user community.

Furthermore, the service desk provides an interface for other activities such as customer change requests and software licensing (Gallacher and Morris, 2012). The system that is used to perform these tasks at SMG is ServiceNow™ which also has the functionality of a KMS. A discussion on KMS is appropriate for this study as the knowledge articles created in these systems are used as one form of learning intervention which helps to reduce the frequency of ICT support calls. Additionally, ServiceNow™ provides a software application that SMG staff can download to their mobile device for free to access the SMG knowledge articles. ServiceNow™ knowledge articles will be discussed in more detail in section *knowledge Management Systems (KMS)*.

### 2.11.2 ITSM trends and challenges

Bozga and Gheorghe (2015) study on the evolution of ITSM has identified an increasing trend with ICT departments making internal business applications accessible to employees via their mobile devices. The study has not stated whether the mobile devices are issued via the company or it is a Bring Your Own Device (BYOD) (Thompson, 2012). This information is crucial to the adoption of mLearning especially if staff are to use their personal mobile devices as it determines the level of security and data governance needed to be applied when accessing the SMG resources. It is anticipated that if SMG staff who use their own devices have to undergo stringent and convoluted processes to access SMG resources, this will inhibit mLearning adoption. Nevertheless, Bozga and Gheorghe’s findings are useful and congruent with the current SMG ICT department's practice. An example of this is the ability to access Mimsey (SMG’s collections database), SMG Intranet, Finance system, and two of SMG's network drives via Cisco's AnyConnect. Cisco's AnyConnect is a secure mobility client software that provides Virtual Private Network (VPN) access. Bozga and Gheorghe (2015) have advanced a move towards allowing staff access to the internal business has created a new field called Mobile Business Intelligence. There are numerous researchers (Amrutkar *et al*., 2011; Felt and Wagner, 2011) who have acknowledged security and data governance problems regarding BYOD. These challenges are currently unresolved especially when interconnecting staff's personal mobile devices with internal ICT management systems (Amrutkar *et al*., 2011; Felt and Wagner 2011). This is especially true for SMG staff despite the implementation of policies and procedures that audit and monitor equipment for typical use, BYOD means that these employees do not use standard issued SMG devices that comply with these policies and procedures, but instead choose their own devices to access the business resources (Tokuyoshi, 2013) and KMS.

### 2.11.3 Knowledge Management Systems (KMS)

KMS research is located in the area of knowledge management research (Alavi and Leidner, 2001; Harb and Abu-Shanab, 2019). KMS are concerned with the process of identifying, capturing, storing, disseminating, and leveraging the collective knowledge and experience in an organization to help the organization compete in its business environment (Alavi and Leidner, 2001; von Krough, 1999). Another intention of KMSs is to align organisational learning and strategic change (Chan and Garrick, 2003). KMS can be viewed from both a technical perspective or a socio-technical perspective (Meso and Smith, 2005). A techno-centric viewpoint is concerned with the types of technologies that support knowledge work and organisational learning (Harb and Abu-Shanab, 2019). A socio-technical viewpoint goes beyond just the technology and includes organisational infrastructure, culture, people, and knowledge (Harb and Abu-Shanab, 2019). In the current study, KMS is viewed from both perspectives. The current study considers the technology that supports organisational learning and decision making (Harb and Abu-Shanab, 2019). SMG uses a variety of software packages that perform these tasks throughout the various departments. Each department uses different types of KMSs because they offer different functionalities that suit the needs of the departments using them and the knowledge required for staff that work in those departments. Another reason why different departments use different types of KMSs is perhaps because of the lack of synergy between those departments and the business engagement team. However, the KMS that is of interest to this study and is used by the ICT service desk and many of SMG staff is ServiceNow™. ServiceNow™ is a web-based software solution that enables staff who have ICT related issues to solve them themselves rather than calling ICT service desk staff and getting them to resolve their issues. This is achieved by serving those staff who report their ICT related issues via the portal with a wiki style solution. This wiki style solution is a series of knowledge articles that have been created by a community of users, ICT service desk and ICT training staff with the aim of providing a step-by-step guide to resolving common problems. However, at SMG the feature that enables the creation of ServiceNow™ articles by the community of users has been disabled. Huang and Lin's (2008) study on factors influencing KMS usage, suggests that it is hard to make distinctions between contributors and seekers of knowledge as the same individual can play both roles at different points in time. Although this is true, in the context of SMG this study analyses KMS usage by examining usage logs. Thus, narrowly focussing on seekers' usage frequency rather than contributors or both.

The study of knowledge management is said to be a comparatively new field of research and practice according to numerous researchers (Handzic, 2015; Harb and Abu-Shanab, 2019). Conversely, there are knowledge management related studies conducted by Dwivedi *et al*. (2011) who investigated research trends related to knowledge management between 1974 and 2008 suggesting that this area of study is an established and well discussed area of study. Harb and Abu-Shanab's (2019) review of 2842 knowledge management studies found several topics were investigated between 1997 and 2018. Table 2.6 presents a summary of those topics along with the frequency to which they were published over a 21-year period. This 21-year period has been broken down into three time periods, 1) 1997- 2003, 2) 2004 – 2010 and 3) 2011 – 2018.

***Table 2.6*** Summary of Knowledge management related studies

| | First period (1997 – 2003) | Second period (2004 -2010) | Third period (2011 – 2018) |
|---|---|---|---|
| Knowledge discovery | 14 | 25 | 10 |
| Analytics | 0 | 6 | 2 |
| Big data | 0 | 0 | 137 |
| KM visualization | 4 | 18 | 30 |
| Data mining | 11 | 52 | 88 |
| KMS | 70 | 101 | 115 |
| Knowledge Management System | 43 | 167 | 127 |
| KM tools | 2 | 10 | 38 |
| Information technology | 44 | 74 | 82 |
| ICT/IT tools | 3 | 75 | 97 |
| Intellectual capital | 67 | 359 | 404 |
| Organization learning | 33 | 41 | 65 |
| Innovation | 121 | 420 | 929 |
| Knowledge worker | 61 | 70 | 82 |
| Knowledge economy | 25 | 64 | 40 |
| Tacit and explicit knowledge | 58 | 369 | 304 |
| Community of practice | 4 | 46 | 38 |
| Personal knowledge | 0 | 21 | 40 |
| Performance measures/balanced scorecard | 23 | 33 | 44 |
| Knowledge engineering | 8 | 3 | 9 |
| Online knowledge sharing | 0 | 3 | 3 |
| Knowledge sharing | 44 | 619 | 1119 |
| KM process | 2 | 14 | 33 |
| Knowledge exchange | 7 | 27 | 53 |
| Knowledge creation | 55 | 249 | 268 |
| Knowledge acquisition | 12 | 54 | 73 |
| Knowledge elicitation | 4 | 15 | 17 |
| Knowledge transfer | 41 | 424 | 413 |
| Knowledge generation | 1 | 25 | 11 |
| Knowledge application | 6 | 14 | 18 |
| Promote KM programs (reward, incentive, motivation, culture) | 119 | 515 | 508 |
| KM readiness | 6 | 8 | 63 |
| KM barriers | 23 | 111 | 159 |
| Industry | 59 | 231 | 214 |
| Knowledge city | 0 | 29 | 7 |

Source: (Harb and Abu-Shanab, 2019)

mLearning in the context of ITSM is a relatively new area for research and practice and there has only been a few studies investigating mLearning and knowledge management (Hayes, 2003; Zuga *et al*., 2006) or mLearning and knowledge management acceptance (Chen and Huang, 2010). The literature on the utilisation of mLearning in knowledge management environments is scarce (Stal and Paliwoda-Pękosz, 2017). In the current study, mLearning and knowledge management are merged to form a category of Mobile Knowledge Management (mKM) (Grimm *et al*., 2005). Furthermore, no research was found to investigate knowledge management usage and gender. Nor were there any research on ICT service desk usage and gender. Therefore, this presents an opportunity to fill this gap in knowledge regarding ICT service desk management. The current study examines the relationship between gender and reading knowledge articles as well as gender and reporting ICT incidents in the museum sector. Thus, the following research questions will be addressed.

- What are the relationships between gender and reading ServiceNow™ knowledge articles?
- What are the relationships between gender and reporting ICT incidents?

## 2.12 Reliability and Validity

Dimitrov (2002) states that in empirical research true scores cannot be directly ascertained. Hence, reliability is usually estimated by reliability estimates. Subsequently, internal consistency estimates were used to measure the 'different aspects of the same characteristics' (Utwin 1995, p. 21). Drost (2011) points out that internal consistency is concerned with the reliability of the test components as it measures consistency within the instrument and questions. Drost (2011) also argues that it does this with a view to measure 'how well a set of items measures a particular behaviour or characteristic within the test' (p. 111). Several scholars (Crano and Brewer, 1973; Green et al., 1977) refer to internal consistency as the degree of interrelatedness among the items.

### 2.12.1 Cronbach's alpha

Coefficient alpha is the most popular method of testing internal consistency (Dimitrov, 2002). This is a measure of correlating respondents' responses to a sub-group of questions on a questionnaire with the aim to measure consistency of the responses to the subgroup of questions (Saunders et al., 2016). Cronbach (1951) popularised coefficient alpha and acknowledged its utility hence why it is often referred to as Cronbach's Alpha. Coefficient alpha is useful for estimating reliability for item-specific variance in a unidimensional test (Cortina, 1993). However, Cronbach's Alpha does not measure unidimensionality or homogeneity as this is assumed. Homogeneity is a measure of how well, related but different items or survey questions measure the same construct. Unidimensionality is how well a single construct is measured on a scale by survey items (Cortina, 1993). Unidimensionality can be established by conducting a Confirmatory factor analysis (CFA) (Shelby, 2011). Cronbach's Alpha is a coefficient and like Kuder-Richardson, it can range from .00 to 1.0. where .00 means no consistency in the measure and 1.0 means that there is perfect consistency in the measure (Cronbach, 1951). However, from a computational point of view it is possible to have negative values (Vaske et al., 2017). There are numerous reasons why this would happen. One example is the items used to measure the UTAUT construct e.g., Performance Expectancy were coded in a different direction e.g., mixing "I would find mLearning useful in my work for knowledge acquisition" with "I would NOT prefer to use mLearning to solve IT related issues" then the high number on the Likert scale would mean different things for all the questions that measure the same construct. A further reason why negative values may occur is because all survey items do not measure the same underlying factor. This issue may be resolved by using CFA to test that all items measure the same underlying factor.

Nunally (1967) recommends coefficient alpha as the best estimate of reliability because most major sources of error are owing to the sampling of instrument contents. Alem *et al*. (2014) argues that for exploratory studies Internal consistency coefficient should be equal to or above 0.60. However, contrary to this, Nunally (1978) states that

> In the early stages of research . . . one saves time and energy by working with instruments that have only modest reliability, for which purpose reliabilities of .70 or higher will suffice' In contrast to the standards in basic research, in many applied settings a reliability of .80 is not nearly high enough. In basic research, the concern is with the size of correlations and with the differences in means for different experimental treatments, for which purposes of reliability of .80 for the different measures is adequate. In many applied problems, a great deal hinges on the exact score made by a person on a test… In such instances it is frightening to think that any measurement error is permitted. Even with a reliability of .90 the standard error of measurement is almost one-third as large as the standard deviation of the test scores. In those applied settings where important decisions are made with respect to specific test scores, a reliability of .90 is the minimum that should be tolerated, and a reliability of .95 should be considered the desirable standard. (p. 245 -246).

Cortina (1993) argues that Coefficient alpha is useful for estimating reliability when item-specific variance in a unidimensional test is of interest.

McDowell and Newell (1996) posit that the higher the coefficient alpha the higher the test-retest reliability will be. Therefore, indicating the questionnaires stability and the extent to which the same results are obtained on repeated administration of the questionnaire. Polit and Hungler (1995) recommends that 'Stability indexes are most appropriate for relatively enduring characteristics such as personality, abilities or certain physical attributes such as height' (p. 349). These characteristics were not captured in the current survey.

It is acknowledged, some scholars (Nunally and Bernstein, 1994) believe that due to the small sample size, there are limitations to the large standard errors associated with such a small sample. Therefore, the statistical tests will lack power, meaning that it is difficult to detect significant results. Thus, sample sizes can seriously influence the reliability of data analysis and the accuracy of results. Conversely, there are other authors (Fleiss, 1986) that suggest "sample sizes of 15 – 20 will be enough" (p. 8). Bonett (2002) concludes that "textbook recommendations of sample size requirements for reliability studies vary widely" (p. 339).

### 2.12.2 Discriminant validity

There are four commonly used approaches to conduct discriminant validity tests (Franke and Sarstedt, 2018). The first method of evaluating discriminant validity is the Fornell-Larcker (1981) criteria which tests the squared multiple correlation between items and constructs is greater than the squared correlation between constructs. The second, is the examination of cross-loadings. Gefen and Straub (2005) suggests that "discriminant validity is shown when each measurement item correlates weakly with all other constructs except for the one to which it is theoretically associated" (p. 92). The third is the Chi-Square difference test, constructs are analysed using two models. In the first model the constructs are correlated and in the second model the constructs are uncorrelated (Zait and Bertea, 2011). The fourth, recently introduced heterotrait-monotrait (HTMT) (Henseler *et al.*, 2015) which juxtaposes the indicator correlations between constructs with the correlations within indicators of the same constructs (Franke and Sarstedt, 2018).

According to Kline (2011) the threshold of 0.85 indicates that there are no discriminant validity issues. However, more lenient thresholds suggested by numerous authors (Gold et al., 2001; Teo et al., 2008) is .90. HTMT can be used in two different ways to assess discriminant validity. The first, as test criteria or the second, as a statistical test. In the case of the test criteria approach, if the HTMT is greater than the value of 0.85 (Kline, 2011), or the value of 0.90 (Gold et al., 2001), it shows the existence of discriminant validity issues. The second, test criteria, according to Henseler et al. (2015) is to test the null hypothesis (H0: HTMT ≥ 1) against the alternative hypothesis (H1: HTMT <1) and if the confidence interval contains the value of one, this indicates discriminant validity issues.

## 2.13 Structure Equation Modelling (SEM)

Gefen *et al*. (2000) recommends the use of SEM in both behavioural sciences and technological research. SEM has also been widely employed in numerous previous UTAUT research (Williams *et al*., 2015). Williams *et al*. (2015) research found that SEM was the most widely used analysis method for UTAUT research which was followed by regression analysis. Numerous UTAUT authors (e.g., Alaba et al., 2020; Bandyopadhyay and Fraccastoro, 2007; Wang et al., 2009) have reported using AMOS for the purpose of conducting statistical tests, such as CFA which is part of the SEM process.

Model-fit indices are used when conducting SEM and they report numerically how close the data collected matches a particular probability distribution (Hu and Bentler, 1999). Each of the indices have different strengths and weaknesses hence, the use of different types e.g., incremental/relative (IFI, TLI), absolute indices ($\chi^2/df$, GFI, RMR, SRMR) and those based on noncentrality parameter (RMSEA). For example, fit indices such as SRMR are less sensitive to variations in sample size and violations of normality assumptions (Anderson and Gerbing, 1984). Both RMSEA and CFI have the advantages of preferring parsimonious models (Diamantopoulos and Siguaw, 2000). However, according to Kenny and McCoach (2003), CFI is less effective when there are many indicators per factor. Nevertheless, goodness-of-fit tests was carried out in previous mLearning/mobile technology and UTAUT research for the purpose of examining the measurement and structural models (Alaba *et al*., 2020; Alharbi *et al*., 2017; Jambulingam, 2013; Wang *et al*., 2009).

## 2.14 Ethics, insider knowledge and professional roles

Floyd and Arthur (2012) propose that insider knowledge can be beneficial to the researcher as it provides a deeper understanding of the organisation which does not come from being an outsider. However, Drake (2010) points out that there is a danger of the researcher's inside knowledge being misleading as the researcher may make assumptions that do not resonate with their participants. Floyd and Arthur's (2012) research discuss the following themes, on-going personal and professional relationships with participants, insider knowledge, conflicting professional and researcher roles, and anonymity. See Appendix 13 for a further discussion on the researcher's positionality regarding the current research as an insider.

Floyd and Arthur (2012) suggest, there may be some conflicts between professional and researcher roles. They explain that a researcher needs to stand back and survey the evidence whereas a practitioner is actively engaged in the organisation. An example they present is the misinterpretations of other participants' actions and as a researcher not being able to inform about the misinterpretation without disclosing the other participants. In the context of Floyd and Arthur's (2012) research, the researcher had to allow the misunderstandings to continue rather than compromise confidentiality protocols.

## 2.15 Summary

This chapter presented a review of the common elements in related research areas such as TEL, dLearning, eLearning and mLearning. Secondly, it outlined the historical and evolution of contested definitions of mLearning and then presented a new working definition of mLearning that will inform the research moving forward.

Thirdly, this chapter presented a critical review of the relevant highly cited background literature on mLearning from both a pedagogical and technological centric perspective as well as the three most dominant mLearning research paradigms. This review was for the purpose of identifying trends and opportunities in the practical application of mLearning in a variety of settings, especially the workplace environment. Hong *et al*. (2011) suggests that only a few studies report the challenges faced by the adoption of mLearning in the milieu of the workplace. Therefore, this study will help to fill the gap in this knowledge.

The review of TEL, dLearning, eLearning, mLearning and theories related to technological acceptance models including TAM and Unified Theory of Acceptance and Use of Technology (UTAUT) has led to the identification of the variables used to structure the research for this study. Furthermore, the analysis of UTAUT literature was to assess the UTAUT and added construct self-directed learning which is conceptually the same as self-determined learning used by Wang *et al*. (2009) and Al-Adwan *et al*. (2018).

This chapter reviewed the historical and contemporary role of ITSM and literature on tools such as KMSs used to manage ICT support calls for the purpose of understanding contemporary ITSM practice and how mLearning can be embedded in ITSM practice.

Finally, this chapter provided a review of reliability and validity, data analysis techniques. Additionally, this chapter presented a review of Ethics with a focus on insider knowledge and professional roles.

The following chapter details the rationale underpinning the selected theoretical and methodological research approach in order to fulfil this study's objectives.

# Chapter 3. Methodology

The intention of this chapter is to provide a discussion of the adopted methodology in this study such as the research design, participants, instruments, data collection and data analysis used to achieve the research objectives as well as the underpinning justifications for the choice of methods used. This chapter also discusses the use and selection of software tools used to carry out the data analysis such as Analysis of Moment Structures (AMOS), Statistical Product and Service Solutions (SPSS), and Microsoft™ Excel. This chapter provides a critical overview of the specific methods of data collection and analysis whilst expounding on how they address the aims of the research. Additionally, an explanation is provided on how access to the participants was achieved and the sampling strategy employed in this study. Finally, this chapter presents a discussion on the researcher's responsibility to all stakeholders in the research and the adherence to the principles of appropriate and ethical research conduct.

## 3.1 Research design

Trochim (2006) refers to the research design as a glue that clamps the research project together. This research design describes how the research was conducted with the ambition to address the five research questions. Following the trends in the literature review, the research design this study is employing is a cross sectional, quantitative, survey, correlational, ex post facto (Campbell and Stanley, 1963; Crowl, 1993) with the aim of gathering and analysing nominal/ordinal/interval bivariate data. The reason this design has been adopted is based on the literature review of several previous UTAUT and mLearning research which has established that this approach is widely used. Furthermore, the data can be measured quantitatively and generalised to the population of SMG as opposed to opinion-related qualitative data (Bryman, 2012). In the literature reviewed, qualitative research has been found to be the least used approach when conducting research that uses the UTAUT model. Williams *et al*. (2015) reviewed 174 studies that used the UTAUT model and 102 of those used quantitative research methods. Additionally, they found that Survey was the most commonly used instrument for collecting data in UTAUT research. Kerlinger (1973) argues that ex post facto research is a systematic empirical inquiry in which the scientist does not have direct control of variables. Not having the ability to manipulate the variables is considered a disadvantage of ex post facto research by some researchers (Harris *et al*., 2006) because they believe that due to the lack of randomisation this may lead to internal validity issues. Harris *et al*. (2006) argues that there is a difficulty in measuring or controlling for important confounding variables. Thus, resulting in alternative explanations for apparent causal effect. However, Kerlinger (1973) states that inferences about relationships among variables are made from any determined variations between the studied variables (p. 344). In this study, there will be no manipulation of variables by the researcher, therefore, any determined differences will be ex post facto in nature. This means that they will stem from the differences in the results in the measurement efforts according to the variables from each case. Additionally, it would be unethical and against SMG's code of practice to prevent one group of employees' access to the various learning materials some of which is already available to all staff. The withholding of an intervention has also been acknowledged as an ethical issue by Harris *et al*. (2006). Therefore, ex post facto was the best choice of research design for this purpose.

The aim of adopting a cross sectional study was to collect data on the tools available to UK museum staff for reporting ICT incidents and just-in-time knowledge acquisition. Additionally, employing a cross sectional survey to explore the determinants that influence SMG's non-ICT staff's adoption of mLearning for just-in-time knowledge acquisition at one point in time. The limitation of using cross sectional analysis is the assumption that model parameters are constant over time and there is a tendency to not adequately address or investigate the change in the relationships among the variables (Bowen and Wiersema, 1999). However, the rationale for adopting a cross sectional study was for the purpose of studying a technological learning intervention that is not widespread at SMG, and for testing hypotheses with the ambition to address the current study's research questions. Thus, measuring the factors that may contribute to the wide-spread adoption of mLearning is adequate for this study. This study used a pre-existing structured UTAUT survey instrument to collect data and to fulfil the research objective of proposing a research model. Williams *et al*. (2015) review of

UTAUT research found that cross-sectional was the most widely used research approach for technology adoption studies.

The main limitation of using this strategy is that many authors (Abbott, 2004; Blumer, 1956; Esser, 1996) have criticized statistical quantitative methodology saying statistics uses worthless data, assigns meaning arbitrarily and denies context. Blumer's (1956) research on variable analysis describes the method of selecting variables for the purpose of studying phenomena as 'chaotic' (p. 683). Meanwhile, Esser (1996) argues that statistical models cannot play the role of an explanans. Abbott (2004) argues that if care is not taken when using this approach, it 'is easy to do [it] badly' (p. 10). There are also some critics that question the very notion of objectivity maintaining that meaning and reality are problematic (Snape and Spencer, 2003). Although some of these statements may be true to some degree, Yang (2010) makes a pertinent point that 'the function of a statistical model is to represent a theory behind [a phenomena]' (p. 32). Additionally, without the use of statistics, one could argue that social phenomena cannot be explained convincingly without it being properly measured.

## 3.2 Research purpose, question, objectives and hypotheses

### 3.2.1 Research purpose

The purpose of this study is to investigate if ICT service desk knowledge articles can be adapted and used as a just-in-time knowledge acquisition tool for the purposes of contributing to the effective management of ICT support calls at SMG. For example, to use ServiceNow™ knowledge articles as an mLearning intervention to reduce the number of logged ICT support calls that service desk staff need to resolve. If so, new and existing knowledge articles can be created and adapted to support mLearning for staff who work with portable devices (e.g., smartphones, tablets). This study also uses an adapted version of the Unified Theory of Acceptance and Use of Technology (UTAUT) to examine the determinants of mLearning adoption at SMG. mLearning as defined in the previous chapter is the provisioning of a learner-centred and flexible learning environment that enables knowledge construction, job skill development training, and performance support across a variety of locations and work performance contexts. This learning environment is ubiquitous and supported using mobile devices that enables direct access to learning materials and resources. The examination of ServiceNow™ report logs will be used to determine if knowledge articles played a part in reducing ICT support calls. The examination of mLearning adoption at SMG is an original valuable contribution to knowledge and practice as this adaptation of the UTAUT has never been used to assess novel technological adoption among staff in the museum sector. Fig 3.1 is a graphical representation of the proposed adaptation of the UTAUT model and hypotheses being advanced in this research. Furthermore, Fig 3.1 provides a graphical representation of the motivation behind the current research hypotheses generation (hypotheses 4 to 16). These hypotheses are based on research questions 4 and 5 they are elucidated in the following sections i.e., *Research question and objectives* and *Research hypothesis and associated research question*. Research questions 4 and 5 and the corresponding hypotheses are based on the review of UTAUT literature.

Additionally, it is anticipated that this research will assist senior management by way of supporting them to make informed decisions about novel technological adoption. For example, decisions about resource allocation and new ICT project implementation processes. This has the added benefit of enabling senior managers to set direction by exploiting opportunities and improving adoption and assimilation of new technologies.

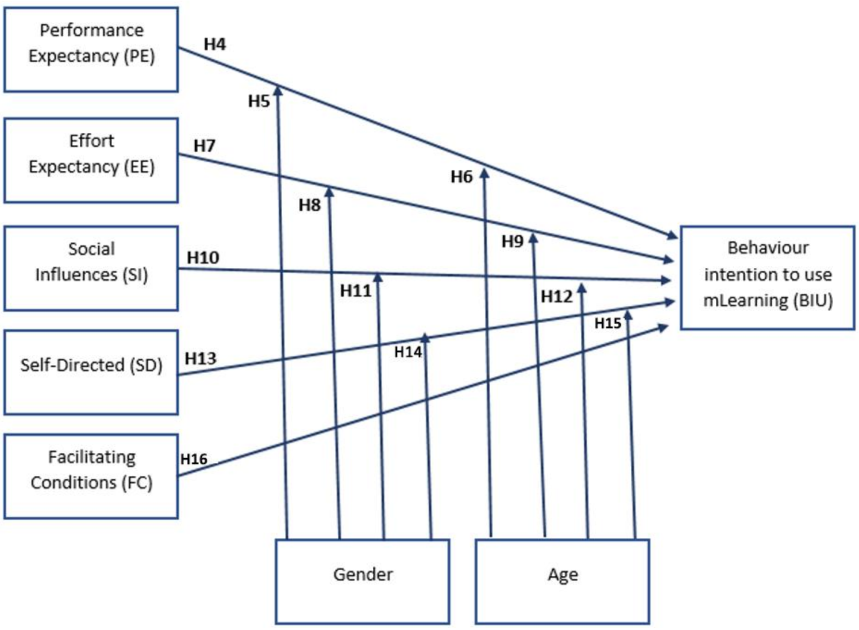



**Fig 3.1**: Adapted UTAUT Model with Self-Directed learning and hypotheses 4 to 16

### 3.2.2 Research question and objectives

This research will address the following research questions:

***RQ1:*** To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG?

***RQ2:*** What are the relationships between gender and reading ServiceNow™ knowledge articles?

***RQ3:*** What are the relationships between gender and reporting ICT incidents?

***RQ4:*** What factors determine SMG employees' behavioural intention to adopt and use mLearning?

***RQ5:*** To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?

In order to investigate the above five research questions effectively, this study was conducted in two phases. In the first phase of the study, data collection and analysis of YouTube videos views, ServiceNow™ reports and the creation and evaluation of the UTAUT questionnaire were done to address research questions one, two and three. This also included the proposal of three hypotheses to respond to those first three research questions. In the second phase, questionnaire items based on the UTAUT model was developed. Subsequently, data was collected and analysed from the UTAUT questionnaire and 13 research hypotheses were proposed to respond to research questions four and five.

First phase study's objectives:

- To analyse data from the tools available to SMG Staff that can be used for mLearning.
- To analyse ServiceNow™ SMG's Information Technology Service Management (ITSM) solution reports, categorizing support calls into training and non-training related groups.

- To analyse the ServiceNow™ reports and determine if the use of mLearning was used to resolve ICT support call issues.
- To measure the impact of mLearning on the frequency of ICT support calls on training related issues.

Second phase study's objectives:

- To examine various considerations in andragogical practice, i.e., Self-directed learning.
- To analyse questionnaire data and determine the use of mLearning in SMG.
- To analyse questionnaire data and determine factors contributing to mLearning adoption at SMG.
- To provide recommendations to the SMG's Senior Management team for improving the implementation and adoption of mLearning in the SMG in order to achieve operational objectives.

### 3.2.3 Research hypothesis and associated research question

To respond to research question 1 on the extent to which mLearning is currently being used for effective management of incoming IT support inquiries at the SMG, hypotheses 1, 2, and 3 were generated. To address research question 4 and 5 on the determinants of behavior intentions to use mLearning at SMG and if gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning at SMG, hypotheses 4 to 16 were generated based on the UTAUT model and literature.

**Is there a statistically significant relationship between gender and reporting ICT incidents?**

- Hypothesis 1: Gender and reporting ICT related incidents are independent of one and other.

**Is there a statistically significant relationship between gender and reading knowledge articles?**

- Hypothesis 2: Gender and reading knowledge articles are independent of one and other.
- Hypothesis 3: Gender and reporting an ICT incident related to knowledge articles are independent of one and other.

**What are the determinants of behavior intentions to use mLearning at SMG?**

- Hypothesis 4: Performance expectancy has a positive effect on behavioural intentions to use mLearning.
- Hypothesis 7: Effort expectancy has a positive effect on behavioural intention to use mLearning.
- Hypothesis 10: Social influence has a positive effect on behavioural intention to use mLearning.
- Hypothesis 13: Self-directed learning has a positive effect on behavioural intentions.
- Hypothesis 16: Facilitating conditions does not impact behavioural intentions.

**Does gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning at SMG?**

- Hypothesis 5: Performance expectancy influences behavioural intention to use mLearning more strongly for male staff than for female staff.
- Hypothesis 6: Performance expectancy influences behavioural intention to use mLearning more strongly for younger staff than for older staff.
- Hypothesis 8: Effort expectancy influences behavioural intention to use mLearning more strongly for female staff than for male staff.
- Hypothesis 9: Effort expectancy influences behaviour intention to use mLearning more strongly for older staff than for younger staff.
- Hypothesis 11: Social influence influences behavioural intention to use mLearning more strongly for female staff than for male staff.
- Hypothesis 12: Social influence influences behavioural intention to use mLearning more strongly for older staff than for younger staff.

- Hypothesis 14: Self-directed learning influences behavioural intentions to use mLearning more strongly for male staff than for female staff.
- Hypothesis 15: Self-directed learning influences behavioural intention to use mLearning more strongly for older staff members than for younger staff members.

## 3.3 Study phases

### 3.3.1 First phase

The first phase of the current study was conducted as a feasibility study in order to test various protocols such as data capturing and UTAUT model development. The testing of these protocols helped to inform aspects of the second phase of the current study. Aspects of this phase of the study will now be discussed here, such as the data collection and analysis of YouTube videos views, ServiceNow™ reports and the creation, pilot testing and evaluation of the UTAUT questionnaire with a few respondents. A more in-depth discussion about the results will be examined in chapter 5 and 6. The first phase of the study results were used to shape the main aspects of the study and its data collection. The specific aim of the first phase of the study was to carry out a series of feasibility tests to ascertain viability and reliability of the proposed methods used in the study. Lancaster *et al*. (2004) defined the objectives of conducting a feasibility study: to test the study protocol, the data collection, the randomisation procedure, the recruitment and consent procedures, the acceptability of the intervention and the feasibility of using selected outcome measures. Vogel and Draper-Rodi (2017) argue that 'the aim is not to test effectiveness as feasibility studies are not powered to assess effectiveness' (p. 2). Therefore, the feasibility study had two overall aims. 1) evaluate the data from the tools available to SMG staff used for just-in-time knowledge acquisition as well as the data from the tools used for reporting ICT incidents and 2) develop the instrument to be used to measure SMG staff's readiness and intention to use mLearning in the workplace for just-in-time knowledge acquisition. The term 'Readiness' is defined in the context of Parasuraman (2000) definition of Technology Readiness (TR) which refers to "people's propensity to embrace and use new technologies in order to accomplish goals in their home life and at work" (p. 308), with emphasis on the workplace environment.

### 3.3.2 Second phase

Once the first phase was successfully completed, the second phase of the study then followed and included the enhancements of the first phase of the study. For example, the second phase used the enhancements made to the UTAUT questionnaire. The specific aims and objectives of the second phase of the study was to analyse questionnaire data using a series of statistical approaches to determine the correlation among the variables. This was for the purpose of ascertaining contributing factors to mLearning adoption at SMG and also establish the current use of mLearning in SMG and in staff's personal and professional lives. The statistical approaches used in the second phase of this study included Exploratory Factor Analysis (EFA) and CFA. Further discussions about the results of these analysis will be examined in Chapter 5 and 6.

## 3.4 Data collection tools

### 3.4.1 YouTube videos views

Staff have access to YouTube videos on a private SMG ICT training channel created by SMG ICT training staff as a form of just-in-time knowledge acquisition tool. However, this was not extensively analysed using statistical techniques in the current study as the analytical tools available in YouTube are limited in functionality and accuracy. Despite the limitations, YouTube's analytics tools were used to gather information about the SMG YouTube channel's performance and to consider its impact on the creation of new ICT incidents. The purpose of using this tool was to help address the following research question:

***RQ1*: To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG?**

Criticism of using YouTube analytics tools are that they are 'almost inevitably exploratory and hence, even though they are likely to involve quantitative methods, are unlikely to be assessable through traditional hypothesis testing because the null hypothesis would not exist before the analysis' (Thelwall, 2017, p. 314).

### 3.4.2 ServiceNow reports

The ServiceNow™ portal provides a means for SMG staff to access just-in-time knowledge (via its KMS) and report ICT incidents. ServiceNow™ ICT incident reports and reports from knowledge articles were used as one of the data collection tools for the current study. The purpose of using ServiceNow™ reports was to analyse the data from the tools available to SMG staff that are used for reporting ICT incidents and the tools used for just-in-time knowledge acquisition. According to Dumais *et al*. (2014) the use of log files for collecting data has become common practice when examining a variety of human computer interaction behaviours. This is the reason why the ServiceNow™ reports were used in the current study as this study wanted to examine SMG staff behaviours and trends pertaining to viewing knowledge articles and reporting ICT related incidents. Furthermore, according to Harb and Abu-Shanab (2019) the use of questionnaires was the most prevalent data collection tool in quantitative knowledge management studies. The significance of Harb and Abu-Shanab's (2019) findings to the current research is that using log files for data collection presents a novel way to collect data which further expands the body of knowledge of KMS research.

Four objectives were investigated in the first phase of the study. Firstly, they were used to investigate if the frequencies for the sample records in terms of gender differs from the expected frequencies of the documented general population of SMG staff. Secondly, to examine whether gender plays a role in an individual's proclivity to read the knowledge articles or not. Thirdly, to explore whether gender plays a role in an individual's tendency to report an ICT incident to service desk or not. Finally, to identify incidents benefitting from a learning intervention such as a knowledge article created to support mLearning. Using these tools aided in addressing the following research questions:

***RQ2:* What are the relationships between gender and reading ServiceNow™ knowledge articles?**

***RQ3*: What are the relationships between gender and ICT incident reporting?**

#### 3.4.2.1 Incident reporting reports

ServiceNow™ incident reports are records of an ICT incident and are used by ICT operational staff to track the incident until it is resolved. The entire process is diagrammatically represented on Appendix 5. Once an incident has been reported, ICT staff can categorise the impact and urgency of the incident. All SMG staff can escalate, resolve, and report ICT incidents via email, the phone, or the ServiceNow™ Portal. If staff report an incident via the phone, email or in person, ICT Staff will enter the caller and incident details in the ServiceNow™ Portal. If staff report an incident via the ServiceNow™ Portal, the details are captured by the portal, and a report is created. All staff who report incidents are known to the system as Callers. Additionally, ICT service desk staff can assign incidents to appropriate ICT groups. For example, an incident can be assigned to the ICT Development and Engagement team as opposed to the ICT service desk staff. An example of this may be a training need that has been assigned to the ICT Development and Engagement team. A preliminary analysis of the ServiceNow™ incident reports showed that there was a total of 36,417 reported incidents between the time of ServiceNow's first use and the time of this analysis. These incidents increase every day by approximately 70 and are varied in nature, making it difficult to generate up to date and accurate data. It is acknowledged that from time-to-time errors will occur due to human data entry and this will affect, to a small degree, the accuracy of the data.

The Summary Description field is used by service desk staff to capture information about the incident. It was this field that was used to determine the nature of the incident. Although, it is acknowledged that the Summary Description field does not always accurately reflect the nature of the incident and is not easy to use as a filtered field, for example, filtering for specific types of incidents, i.e., training related. The Summary Description field does provide a general essence to the nature of the incident. Therefore, the Summary Description field helped to identify the nature of the incident. If the Summary Description field was considered vague to the researcher, further investigations were carried out by opening the incident and reading the communications thread within the report. Once the communications thread had been read to determine which type of incident it fell into, it was added to the corresponding filtered list e.g., training related. Approximately, 5% of the incident reports required this additional codification.

#### 3.4.2.2 Knowledge article views reports

An analysis of the ServiceNow™ knowledge articles report revealed that 155 knowledge articles were created and have collectively received 6280 views. A filter was applied displaying only knowledge articles that had been viewed within a six-month period. This yielded 4739 knowledge Article views. Numerous knowledge articles were viewed by system administrators. System administrators are the authors of the knowledge articles. The reason why they appear in the list is because once an article is created, typically, the creator will view the article for the purposes of quality control. Consequently, these views are captured by the system. There were also some anomalies, where Articles and User fields had blank entries. These anomalies could not be explained. Therefore, an additional filter was applied that excluded system administrators and blank entries in both the Article and User fields. An additional filter was applied that removed ICT operations articles which are knowledge articles created with the intention to assist ICT staff. These types of knowledge articles are not accessible to non-ICT SMG staff and are beyond the scope of the current study. Applying these filters yielded 1160 knowledge article views which were exported from ServiceNow™ into Microsoft Excel™ (see fig 3.2).

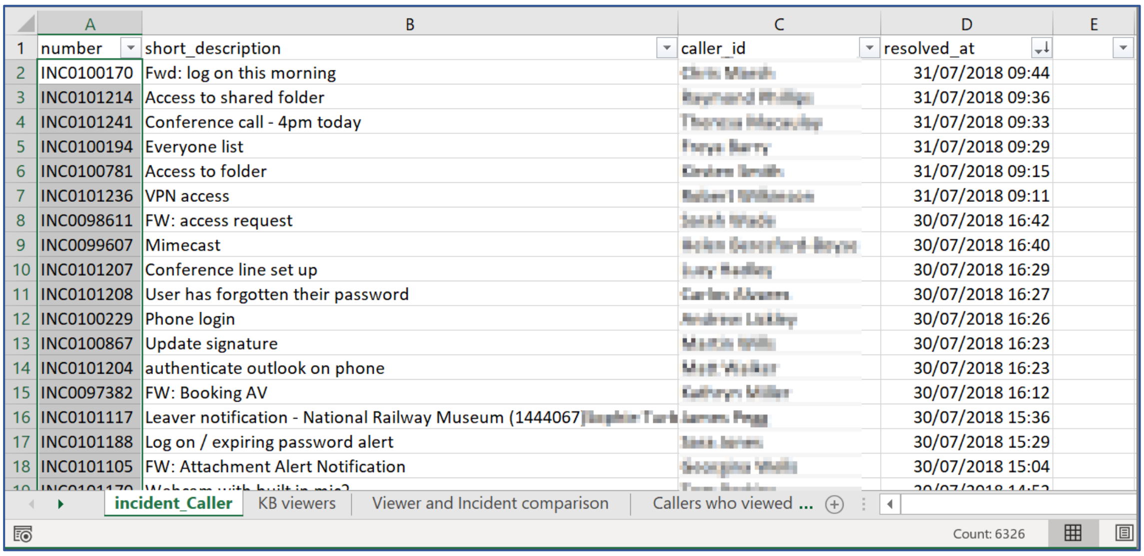
| | A | B | C | D |
|---|---|---|---|---|
| 1 | 01/03/2018 10:49 | KB0010018 | [illegible] | Remote Working |
| 2 | 01/03/2018 10:51 | KB0010018 | [illegible] | Remote Working |
| 3 | 01/03/2018 11:13 | KB0010029 | [illegible] | ITG003 - Cloud Services Key Use Guidance |
| 4 | 01/03/2018 13:44 | KB0010013 | [illegible] | How Can I Change / Reset my Password or Unlock my Account? |
| 5 | 01/03/2018 14:29 | KB0010029 | [illegible] | ITG003 - Cloud Services Key Use Guidance |
| 6 | 01/03/2018 14:30 | KB0010026 | [illegible] | ITG001 - Terms of Use Policy |
| 7 | 01/03/2018 15:07 | KB0010018 | [illegible] | Remote Working |
| 8 | 01/03/2018 15:44 | KB0010018 | [illegible] | Remote Working |
| 9 | 01/03/2018 16:02 | KB0010072 | [illegible] | How Can I Book a Loan Laptop? |
| 10 | 02/03/2018 10:08 | KB0010018 | [illegible] | Remote Working |
| 11 | 02/03/2018 10:10 | KB0010018 | [illegible] | Remote Working |
| 12 | 02/03/2018 10:32 | KB0010019 | [illegible] | How Can I Access my Email Remotely / Externally? |
| 13 | 02/03/2018 10:32 | KB0010018 | [illegible] | Remote Working |
| 14 | 02/03/2018 10:34 | KB0010307 | [illegible] | Signing in to Office 365 Outside of SMG |
| 15 | 02/03/2018 11:57 | KB0010041 | [illegible] | CISCO 'Meet Me' Conference User Guide |
| 16 | 02/03/2018 11:58 | KB0010041 | [illegible] | CISCO 'Meet Me' Conference User Guide |
| 17 | 05/03/2018 09:44 | KB0010307 | [illegible] | Signing in to Office 365 Outside of SMG |
| 18 | 05/03/2018 10:45 | KB0010277 | [illegible] | How to Insert a Contents Section in Word |

incident_Caller | **KB viewers** | Viewer and Incident comparison | Callers who viewed ...

Count: 1160

**Fig 3.2**: Knowledge article views report exported to Microsoft Excel™

6326 ServiceNow™ ICT incidents report (see fig 3.3) were also exported from ServiceNow™ to a Microsoft Excel™ where they were compared with the knowledge article views report. The intention was to compare knowledge article views with the incidents in ServiceNow™ to see if the person who viewed a knowledge article on a topic had subsequently contacted the service desk for further assistance.



| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | number | short_description | caller_id | resolved_at | |
| 2 | INC0100170 | Fwd: log on this morning | [illegible] | 31/07/2018 09:44 | |
| 3 | INC0101214 | Access to shared folder | [illegible] | 31/07/2018 09:36 | |
| 4 | INC0101241 | Conference call - 4pm today | [illegible] | 31/07/2018 09:33 | |
| 5 | INC0100194 | Everyone list | [illegible] | 31/07/2018 09:29 | |
| 6 | INC0100781 | Access to folder | [illegible] | 31/07/2018 09:15 | |
| 7 | INC0101236 | VPN access | [illegible] | 31/07/2018 09:11 | |
| 8 | INC0098611 | FW: access request | [illegible] | 30/07/2018 16:42 | |
| 9 | INC0099607 | Mimecast | [illegible] | 30/07/2018 16:40 | |
| 10 | INC0101207 | Conference line set up | [illegible] | 30/07/2018 16:29 | |
| 11 | INC0101208 | User has forgotten their password | [illegible] | 30/07/2018 16:27 | |
| 12 | INC0100229 | Phone login | [illegible] | 30/07/2018 16:26 | |
| 13 | INC0100867 | Update signature | [illegible] | 30/07/2018 16:23 | |
| 14 | INC0101204 | authenticate outlook on phone | [illegible] | 30/07/2018 16:23 | |
| 15 | INC0097382 | FW: Booking AV | [illegible] | 30/07/2018 16:12 | |
| 16 | INC0101117 | Leaver notification - National Railway Museum (1444067[illegible] | [illegible] | 30/07/2018 15:36 | |
| 17 | INC0101188 | Log on / expiring password alert | [illegible] | 30/07/2018 15:29 | |
| 18 | INC0101105 | FW: Attachment Alert Notification | [illegible] | 30/07/2018 15:04 | |



**Fig 3.3**: ICT incidents report exported to Microsoft Excel™

The purpose of this was to ascertain an approximation of staff members who have viewed the knowledge articles and found the articles beneficial or not. The criteria for evaluating the usefulness of the knowledge articles was based on the method(s) used to resolve the incident and the joint opinion of both the ICT Service desk manager and the researcher. Viewers of knowledge articles who had not raised a call with ICT service desk were also analysed and recorded. Additionally, an analysis of incidents where the callers had not viewed the knowledge articles had been carried out. In terms of ServiceNow™ reporting, the knowledge articles not only record the date/time they were viewed they also record the name of the person who viewed the article. If there were any knowledge articles that were viewed by a person and then the same person subsequently made an ICT service desk call, this information was compared and recorded in Microsoft Excel™.

### 3.4.3 Questionnaire

The questionnaire used in this research was developed based on the UTAUT model as described by Venkatesh *et al*. (2003). Its purpose in the current study was to measure and predict staff's intention to use mLearning in the workplace for knowledge acquisition. Using the data from the questionnaire helped to address the following research questions:

***RQ4*: What factors determine SMG employees' behavioural intention to adopt and use mLearning?**

***RQ5*: To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?**

#### 3.4.3.1 Questionnaire design

The questionnaire (Appendix 6) used in this study was developed to investigate staff's intention to use mLearning based on the unified theory and acceptance and use of technology (UTAUT) model (Venkatesh *et al*., 2003). Similarly, to the original UTAUT model, this model was used in the context of the workplace. However, it was modified to include self-directedness as an independent variable and the exclusion of moderator variables voluntariness of use and experience. Additionally, research outcomes, and several discussions to refine the items on the survey contributed to its development. Many SMG staff involved in reviewing the survey items for clarity and completeness were from various departments. Namely, ICT, Finance, People and Culture, and The Collection services department. All subsequent changes and ideas about making changes were floated and discussed with this committee. All members were empowered to recommend changes to the survey items. Areas of contention were resolved by group discussions. If a resolution was not met, the area of contention was put to a vote based on which option was closest to achieving the survey's objective. Members of the first phase of the study group returned a variety of responses mainly focusing on the survey items and the definition of mLearning used by the researcher to provide context and knowledge for the research participants (see Appendix 7). However, some of the members of this first phase of the study group only completed the survey without providing survey rater responses, whilst others provided both rater responses and completed the survey. Once the survey items were finalised, the questionnaire was created using Google Forms and disseminated to SMG staff via email to gatekeepers. The gatekeepers mainly consisted of the Heads of the Departments listed in the questionnaire. An additional option, 'Other' was added to the list of departments on the questionnaire for the purpose of accounting for newly created departments whilst the questionnaire was being created and distributed.

#### 3.4.3.2 Item analysis

It has been suggested that the validity of an instrument should be tested using a variety of approaches (Gould, 1994; Utwin, 1995). McDowell and Newell (1996) suggest that 'a variety of approaches should be used in testing any index, rather than relying on a single validation procedure' (p. 37). However, this was not possible in the first phase of the study due to the limited number of participants used to evaluate the survey. Therefore, in the first phase of the study, face validity was used to arrive at an overall judgement of the usefulness of the survey (Bannigan and Watson, 2009). Gould (1994) argues that 'the measurement tool must be understandable and perceived as relevant by the subjects to ensure their co-operation and motivation', (p. 99). Thus, a cross section of SMG staff from both management and non-management roles within the organisation from IT, Finance, People and Culture, and Collection services department were selected to explore their perceptions of the meaning of each item on the questionnaire. The rationale for selecting these staff members was to gain the subjective opinions of both ICT experts and non-ICT expert staff to estimate an items relevancy and whether it functioned as intended. Although, most of the participating staff have either used or created questionnaires, none have had previous experience of conducting expert reviews for other questionnaire-design projects. Due to time constraints and lack of resources, it would be impractical to search for SMG staff with such skills. Additionally, these staff will be limited in number and are likely to possess a high degree of specialist research skills which is not reflective of the heterogenous nature of the SMG workforce. When reviewing the questionnaire, Gray (2014) advises 'getting five or six people who are similar in key characteristics to the target audience' (p. 354).

#### 3.4.3.3 Survey evaluation

The aim of the questionnaire evaluation was to establish the survey's clarity and its wording, so that it was not bias, and it offered the desired information for recipients (Gray, 2014). This is essential to the current research because the questionnaire was created by the researcher based on previous research. Therefore, typically, the words researchers use to describe phenomena may not be understood in the same way by recipients in a consistent manner across different staff members. Ensuring clarity across different staff members was essential as the questionnaire would be created and disseminated in an online environment (Gaddis, 1998). Thus, once disseminated, there would be few opportunities for assistance with the interpretation and deduction of the items on the questionnaire. The staff selected for this task were asked to evaluate the questionnaire by going through each item on the questionnaire answering three open-ended questions about each of the survey items. These questions were based on Converse and presser's (1986) recommendations for examining the survey items and Presser *et al*.'s (2004) cognitive probes. Cognitive probing is a process to evaluate the extent to which questions are consistently understood and answered by individuals. The questions asked of the survey evaluation team were as follows:

- What does the [question/term] mean to you?
- Would you reword the question? If so, how?
- When you created your response, what was it that you had in mind?

Although these questions were key in revealing potential problems with the questionnaire, there is no empirical evidence to suggest that this kind of evaluation identifies major problems in the questionnaire (Presser *et al*., 2004). However, according to Presser *et al*.'s (2004) research only one study has unambiguously addressed the notion of item analysis pretesting and its benefits (Forsyth *et al*., 2004).

As a result of the survey evaluation carried out in the early stage of the current study, improvements were made to the instrument whilst keeping close to the original questions in Venkatesh *et al*.'s (2003) study. These improvements included but were not limited to, questions being reordered so that a preliminary question to establish whether respondents had any or much prior experience of mLearning. Definitions and examples of mLearning were added at the beginning of the survey to provide some understanding of mLearning as not all staff may know what mLearning is. Additionally, clarifying a distinction between staffs understanding of the definition of studying and learning. A full summary of the participants comments can be found in Appendix 7, some of which were used in the second phase of the study.

#### 3.4.3.4 Questionnaire Appraisal System (QAS)

Form appraisal was considered owing to its systematic approach to appraising a questionnaire. The Questionnaire Appraisal System (QAS) developed by Research Triangle Institute (RTI) for the purpose of evaluating draft questions was considered as it provides multiple ways to detect problems (Rothgeb *et al*., 2007). According to the instructions on how to use this tool, provided by Rothgeb *et al*., (2007), participants would have to check each question against a 27-item checklist circling a Yes/No box indicating whether the item is perceived to be problematic. In addition, if a yes is marked, the participant would have to enter notes about what they perceived to be problematic about the question. However, after discussing this option with some of the participants, it proved to be unfeasible. Staff were not motivated to partake in such an activity for numerous reasons, mainly, the perceived labour intensiveness of the tool, the time it would take to learn how the tool worked and the time constraint on participants evaluating the questionnaire.

#### 3.4.3.5 Questionnaire data collection

Once the survey items were evaluated by members of SMG staff (see Appendix 8 and Appendix 7) and finalised in the first phase of this study, the questionnaire (Appendix 6) was then created (in the second phase of the study) using an electronic form (i.e., Google form) and disseminated to both SMG staff and volunteers via emails to gatekeepers. This approach to disseminating the survey was adopted due to the difficulty in conducting random sampling for all potential mLearning users in SMG. Thus, the use of an exponential non-discriminative snowball sampling strategy (Etikan *et al*., 2015). Further discussions about this sampling strategy will be covered in section, *Sampling strategies*. Participation was not incentivised based on recommendations made by the ICT Senior management team. The questionnaire consisted of two SMG specific questions, three demographic questions, four internet connected mobile device usage questions and 37 reviewed UTAUT questions, totalling 46 questions.

The UTAUT constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) along with Self-Directed learning are measured by the items shown in Table 3.1. Each UTAUT subscale item is scored on a 5-point Likert scale (1) Strongly Agree, (2) Agree, (3) Neither Agree or Disagree, (4) Disagree, (5) Strongly Disagree, similar to the subscale items used in Thomas *et al*.'s (2013) UTAUT research. The UTAUT constructs along with Self-Directed learning are measured by the items shown in Table 3.1.

***Table 3.1*** Summary of the survey items that were validated

| Items | Source |
|---|---|
| 1 – 2 | SMG specific questions |
| 3 – 5 | Demographic questions |
| 6 – 7 | Use of Internet connected mobile devices |
| 8 -12 | Subscale 1: Performance Expectancy (PE) |
| 13 – 15 | Subscale 2: Effort Expectancy (EE) |
| 16 -17 | Subscale 3: Social Influence (SI) |
| 18 – 19 | Subscale 4: Facilitating Conditions (FC) |
| 20 -24 | Subscale 5: Self-Directed (SD) |
| 25 -28 | Subscale 6: Behaviour intention to use (BIU) |

Further review of the questionnaire (see Table 3.2) included an extension to the use of internet connected mobile devices questions. Additionally, an exploration of Self-directed learning was conducted and as a result a further 2 items were added to the survey to reflect four of the five broad areas of self-directed learning (Williamson, 2007). These attributes identified by Williamson (2007) are 1) Awareness, 2) Learning strategies, 3) Learning activities, 4) Evaluation and 5) Interpersonal skills. The areas included in the survey were 1) Awareness, 2) Learning strategies, 3) Learning activities and 4) Evaluation. It was decided that Interpersonal skills did not reflect the way mLearning is used in this context and therefore, omitted from the survey. A further seven questions were added to the Behaviour intentions to use construct to include the knowledge acquisition at work, knowledge articles, and the ServiceNow™ context.

***Table 3.2*** Summary of the final survey items

| Items | Source |
|---|---|
| 1 - 2 | SMG specific questions |
| 3 - 5 | Demographic questions |
| 6 - 9 | Use of Internet connected mobile devices |
| 10 -14 | Subscale 1: Facilitating Conditions (FC) |
| 15 – 22 | Subscale 2: Performance Expectancy (PE) |
| 23- 26 | Subscale 3: Effort Expectancy (EE) |
| 27 -32 | Subscale 4: Self-Directed (SD) |
| 33-35 | Subscale 5: Social Influence (SI) |
| 36 - 46 | Subscale 6: Behaviour intention to use (BIU) |

## 3.5 Survey reliability and stability tests

### 3.5.1 Instrument reliability and stability

Reliability is concerned with 'error in measurement' (McDowell and Newell 1996, p. 37) For example, how consistently or dependably does a measurement scale measure what it is intended to be measuring (Polit and Hungler, 1995). In the context of this study, the reliability tests were used to estimate how well the items on the survey measured the underlying UTAUT constructs. There are a variety of methods for measuring internal consistency such as Split-half technique, parallel forms (Lord and Novick, 1968), Kuder-Richardson formula 20 (KR-20) (Cronbach, 1951; Fiske, 1966; Hakstian and Whalen, 1976). However, in the current study, Coefficient alpha (known as Cronbach Alpha) was the method used to measure internal consistency.

### 3.5.2 Cronbach's alpha

Cronbach's alpha was used in both the first stage and second stage of the current study to measure the internal consistency of the current research questionnaire. Additionally, Cronbach alpha is widely used to assess the internal consistency (reliability) of a set of survey items (Bollen, 1989) and error factors associated with the use of different items of interest (Cortina, 1993).

The formula for Cronbach's alpha: $N^2$ is the square of the number of items/questions in the scale.

$$\frac{N^2 \times M(COV)}{SUM\ (VAR/COV)}$$

M(COV) is the mean inter-item covariance, and SUM (VAR/ COV) equals the sum of all the elements in the variance/covariance matrix (Cronbach, 1951).

In the first stage of the current study, the sample size was only for testing the feasibility of the research and not to draw general conclusions, the researcher is satisfied with the sample size used in the first phase of the study to determine the internal consistency of the survey (Bonett, 2002; Fleiss, 1986).

IBM Statistical Product and Service Solutions (SPSS) version 20 was used to perform the Cronbach Alpha calculations in both the first and second phases of the study for each of the UTAUT constructs. SPSS is a statistical package that is widely used by social science researchers for the purpose of statistical analysis (Field, 2009). Cortina (1993) suggests that 'when many items are pooled, internal consistency estimates are relatively invariant (i.e., large) and therefore somewhat useless'. It is for this reason why each of the constructs were not pooled but measured individually and their estimates recorded. Results from the Cronbach Alpha calculations for the second phase of the study are presented in *chapter 4* and discussed in more detail in *chapter 5*.

Confirmatory factor analysis (CFA) was performed in the second phase of this study as there were not enough respondents to carry out an effective CFA in the first phase of this study. Furthermore, the purpose of the first phase of this study was not to test hypotheses (Brown, 2014).

### 3.5.3 Discriminant validity

In the second phase of this study, discriminant validity tests were carried out to determine whether the constructs were measuring what they should be measuring

(Campbell and Fiske, 1959). The purpose for this is to ensure that the researcher is certain that the results confirming hypothesized structural paths exists and are not the result of statistical discrepancies (Farrell, 2010).

Although, the Fornell-Larcker criteria is commonly used in assessing discriminant validity and was used in the current study, there is almost no systematic examination of its effectiveness in assessing discriminant validity (Henseler *et al*., 2015). Thus, presenting uncertainty in the detection of discriminant validity (Yusoff *et al*., 2020). Therefore, Heterotrait-Monotrait (HTMT) was also used in the current study to assess discriminant validity. HTMT is an estimate of the correlation between the constructs. HTMT values are compared with a predefined threshold, if the value of the HTMT is higher than this threshold, there is evidence of discriminant validity issues. In the current study HTMT was used to assess discriminant validity by using the first method, the criteria method. A detailed discussion of HTMT can be found in *chapter 2*, section *Discriminant validity*

## 3.6 Participants

### 3.6.1 Participant letter

In the second phase of this study, informed consent was addressed by providing participants with an instruction sheet (Appendix 9) and a very brief introductory letter (Appendix 10) from both the researcher and the respective ICT Senior management team. The letter was emailed to each of the prospective participant's mailbox requesting their voluntary cooperation. The email and the attachments described the research and its importance, it also highlighted the support given from the Head of the respective department with regards to the time used to complete the survey and the candid nature of the data that would be captured. The introduction letter also assured participants that confidentiality would be adhered.

Additionally, participants were provided with contact details for the purpose of queries and or assistance completing the survey. This information could be used if issues arose that could not be resolved by the researcher or those assisting the researcher. The information given to participants reflected the degree of risk involved in the study. As this study involved only low levels of risk to the participants, the amount of information in the letters were relatively small. In addition to providing information about the research, participants were given time to think about the research and not coerced into participating immediately. Hence, staff were not pressurized to engage with the research.

In the event participants were unable to complete the form online themselves, they were, if they chose, able to receive support in the form of an assistant reading the survey questions and recording their answers. Each assistant involved was provided with training by the researcher on how to read survey questions and record participants' responses. This was for the purpose of minimising a biased approach to responding to the questions if the event arose where staff needed assistance responding to the questionnaire. This approach was adopted to prevent exclusion and foster a sense of empowerment among this category of participants.

Issues pertaining to participants' right to withdraw were addressed by informing them they were under no obligation to participate in the study. The introduction letter also emphasised their right to withdraw their data from the research at any stage. However, the letter carried a caveat, this would only be possible if the researcher is able to uniquely identify the respondents' survey response. Withdrawal from the research would not impede the level of support or service they received from the ICT department as the research is independent to the ICT provision. Participants were assured they will receive the same attitudes and services they would have done had they not joined the study in the first place. Based on a conversation with members of SMG's Corporate Information team who ensures that SMG are compliant with all relevant information legislation, concur that this approach was in line with information governance guidelines.

It is acknowledged that transparency is paramount to the research to counterbalance the experience of exploitation and alienation that may be felt by participants (Cokley and Awad, 2013). Thus, the participants' letter in the current study included the researcher's position within the organisation, goals, and aspects of the research process served to reduce the negative impact of power differences (Fassinger and Morrow, 2013).

### 3.6.2 SMG population

SMG employs approximately 1963 staff members and numerous volunteers (Science Museum Group, n.d. b). The population is all staff at the SMG. SMG consists of 5 museums located in 6 areas of England, one of the museums occupies two locations in the north of England (Science Museum Group, n.d. a). The exact number of volunteers registered are hugely inaccurate therefore unknown, this is because some volunteers may work only once and never again. Therefore, their name will remain in the Human Resource (HR) management information system, whilst others may work with SMG frequently. In this study, the population consists of SMG employees, contractors, and registered volunteer staff. These colleagues also have access to the ICT desk and its provisions.

### 3.6.3 Restriction to the population

Access to the SMG staff started with a discussion with members of the ICT Senior management team. In this initial discussion, unrestricted access to all the ServiceNow™ records was granted to the researcher. Initially, it was agreed that an all-staff global email would be sent with the necessary details and link to the online survey. However, after a discussion with a newly appointed senior manager of ICT, the researcher decided that the distribution of the survey to SMG staff would require a different strategy due to the culture of SMG. Constraints imposed by SMG's communications team restricts the sending of non-urgent global emails. It was also anticipated that if this type of email were permitted, it would be largely ignored by staff which means, a minimum sample size may not have been achieved. Although this sampling strategy is the best, based on the given constraints, using this approach limits the study's ability to capture an unbiased cross section of participants in terms of job role, level of IT skills, and use of service desk. Subsequently, it is problematic to determine accurately the margin of error. Consequentially, this could result in a lack of accuracy in the results of the various statistical tests.

### 3.6.4 Sampling strategies

In the second phase of the study, the researcher proposed to use both a probability sampling approach and a non-probability sampling approach. The use of the non-probability sampling approach was as a result of the constraints found during the first phase of the study, such as SMG's antipathy towards sending global emails. A probability sampling approach was used to randomly extract the sample from the ServiceNow™ reports and the report of read ServiceNow™ knowledge articles. The specific probability sampling approach employed was simple random sampling (Acharya *et al*., 2013). This method gives every participant in the population an equal chance of being selected. Furthermore, strengths of this approach are that it yields representative samples. However, criticisms of this approach are that it tends to have large sampling errors and is considered less precise at representing the population than the stratified approach (Daniel, 2012). Microsoft Excel™ was used in the current study to randomly generate numbers to derive the sample population. The rationale to use Microsoft Excel™ was because the dataset was too large to select data randomly using manual methods. Both samples from the ServiceNow™ reports and the report of read ServiceNow™ knowledge articles were selected from a six-month period from February 2018 to July 2018. Prior to pooling the data, the samples from both reports were screened and an in-depth discussion on how each of the samples used in this study were extracted from 6280 knowledge articles views, and 11,241 ICT incident report records is given in the *Data screening* section that follow. The sample size for the knowledge articles views were 1145, the sample size of the ICT incident report records was 1145 and the reports of ICT Incident related to knowledge article were 2728. Other probability sampling techniques were considered such as stratified random sampling. However, this approach requires having an exhaustive and definitive list of the entire population of SMG for the purpose of separating the population into mutually exclusive homogeneous strata (Daniel, 2012). Splitting the population into mutually exclusive subsets of the population would be difficult if the required information such as age is not readily available. In this case, age groups were difficult to acquire as Human Resources staff at SMG would not divulge this information and many staff would also be reluctant to give out this information unless anonymised as in the case of the questionnaire. Thus, making this sampling strategy less than ideal for the current research.

The specific non-probability sampling approach for the purposes of recruiting participants for the second phase of the study was an exponential non-discriminative snowball sampling strategy (Etikan *et al*., 2015). This is where each recruited participant recruits another participant. However, not every recruited participant is going to recruit other participants as it is entirely optional. Equally, not every recruited participant is going to partake in the research. The recruitment strategy used to recruit participants was performed in this way for example, ICT Service desk staff and Managers recommended the initial groups drawn from employees from across the 5 museums. The initial groups were asked to participate in the completion of the emailed survey and then redistribute the same email to others in their team, whilst informing them that participation is voluntary (see Appendix 10). Another strategy that was considered for distributing the research questionnaire was including it in the "all staff newsletter" which is sent out via email on a weekly basis. This strategy would have been the preferred approach as it would have given a more equal probability of staff being chosen for the research and would be in line with the People and Culture team's pulse survey distribution practice. It has been reported that this newsletter has a 60% open rate. However, senior management did not permit this approach. Other non-probability sampling approaches were considered such as purposive sampling. Purposive sampling requires the researcher to make a deliberate choice of what participants are used in the research based on pre-defined qualities that the participant possesses (Bernard, 2002; Etikan *et al*., 2016). However, unlike exponential non-discriminative snowball sampling, purposive sampling is typically used in qualitative research (Etikan *et al*., 2016). Therefore, purposive sampling was considered insufficient for the current research design.

Yang (2010) propounds that all sampling strategies 'aim to achieve two main objectives: 1) to represent the population structure accurately 2) to obtain a precise estimation of the value of any interested attribute of the population' (p. 42). Yang's (2010) assertion was the rationale for the current's studies sampling strategy which also considered the constraints faced by the researcher.

### 3.6.5 Participant profiles from ServiceNow incident reports

The population of the ServiceNow™ incident reports comprised of 31% Men and 69% Women. This data was compared with the documented total of people employed by SMG which is 1071 excluding agency and contracting staff as of 31st March 2017, of those, 62% were women and the remaining 38% were men (Science Museum Group, 2017). These totals are the most up to date documented figures available at the time of writing. The performance of a Chi-square goodness-of-fit test concluded that there were no statistical differences from the observed population data and the expected population data. This means that there were no statistical differences between the sample population and the actual population of SMG staff with regards to gender.

### 3.6.6 Knowledge articles read reports

The population of the readers of ServiceNow™ knowledge articles comprised of 35.3% Men and 64.7% Women. This data was compared with the documented total of people employed by SMG which is 1071 excluding agency and contracting staff as of 31st March 2017, of those, 62% were women and the remaining 38% were men (Science Museum Group, 2017). These totals are the most up to date documented figures available at the time of writing. The performance of a Chi-square goodness-of-fit concluded that there were no statistical differences from the observed population data and the expected population data. This means that there were no statistical differences between the sample population and the actual population of SMG staff based on gender.

## 3.7 Data screening

### 3.7.1 ServiceNow reports

The purpose of this data screening in the first stage of the study was to maximise the chances of collecting useful data. Abdulwahab *et al*., (2011) recommends conducting data screening at the initial stages of an analysis. They say that data screening is crucial to the quality and output of any quantitative research. Thus, in the first phase of the study, data screening was performed on the 36,417 ICT incident records that had been recorded from ServiceNow's inception at SMG. This analysis involved using numerous filters to remove several records as not all the 36,417 records were relevant for this study. The researcher made the decision to exclude incidents that fell into Network, Comms, Server, Backups and Storage categories. This was because of an analysis of the short description field and reviewing the nature of the incident. This involved opening the incident record based on the information in the short description and then reading both the caller's request and ICT service desk staff's resolution notes. For example, in the case of the incidents that fell under the Network category which consists of 1046 incidents. 278 incidents were randomly selected and reviewed. There is a more detailed discussion on this process in the following section, *ServiceNow reports data screening mechanism*. The reason why incidents were chosen randomly was as a result of the impracticality of opening and reading all the details of the 1046 incidents in this category as well as the other four categories. The reason why this was impractical was owing to the restrictions of time and cost. Therefore, after discussions with the ICT Senior management team at SMG (at the time of this analysis), the decision was made that it would be reasonable for the researcher to read the incidents of a random sample for each of the categories. These sample sizes allow generalisations to be derived about the cases in the population from which the sample had been selected (Saunders *et al*., 2016). The decision to use a sample size of 278 for the Network category was obtained from Saunders *et al*. (2016) table of sample sizes based on a 95% confidence level, 5% Margin of error and a population of 1,000. The researcher was satisfied to estimate the characteristics of the population to a 95% certainty (Saunders *et al*., 2016). The same process was carried out when examining the Comms, Server, Backup and Storage categories. Comms had 1093 incidents with a sample size of 278, Server had 202 incidents with a sample size of 132 and storage had 91 incidents with a sample size of 79. Overall, 767 incidents out of 2432 were reviewed to justify the exclusion of four categories from the study (see Table 3.3). However, it was acknowledged that there were a small number of records in each of the excluded categories that lent themselves to training or educational intervention that would benefit from being a mLearning intervention for museum staff. Subsequently, this number was due to mis-categorisation on the part of SMG ICT Service desk staff who received the incident.

These records were also excluded from the study as there was no simple way to append these records to the filtered list.

***Table 3.3*** Excluded ICT incident report categories

| Categories | Population | Sample size reviewed |
|---|---|---|
| Comms | 1093 | 278 |
| Server | 202 | 132 |
| Storage | 91 | 79 |
| Network | 1046 | 278 |

#### 3.7.1.1 ServiceNow reports data screening mechanism

Saunders *et al*. (2016) argues that 'random numbers allow you to select your sample without bias' (p. 226). This was the rationale for using Microsoft Excel™ and its RANDBETWEEN and VLOOKUP functions to generate the overall 767 random incidents that were going to be reviewed. The first step in the process was to export each of the filtered incident lists from ServiceNow™ and then import them in a new Microsoft Excel™ spreadsheet. The exported list (e.g., the Network category) was then sorted in ascending order of the date the incident was created. A new column was created where a number from 1 to 1046 was assigned to each of the incidents. This worksheet tab was used as the lookup table that was used to determine which incident record was to be viewed. Within the same workbook a new worksheet tab was created for the purpose of producing a list of 278 unique random numbers. This was achieved using Microsoft Excel™ 's RANDBETWEEN function. Once the list of random numbers was created it was then checked for duplicates which were removed and replaced with other unique random numbers between 1 and 1046. This was performed in line with Saunders *et al*. (2016) recommendation which is that repeated numbers are ignored and replaced. The number of duplicates replaced in this process was 28. The process of generating numbers was repeated until there was a column of 278 unique random numbers between 1 and 1046. Subsequently, this column was then sorted in ascending order of the random numbers. In the following two columns next to the unique random numbers, Microsoft Excel's VLOOKUP function was used to retrieve the Incident number and the short description information for the incidents that were to be reviewed. This process was carried out for each of the categories. For example, categories Network, Comms, Server, Backups and Storage. The only difference in the process between each of the categories was the number of unique random numbers that was generated.

### 3.7.2 Questionnaire data

Prior to performing the data analysis in the second phase of the current study, the data from the questionnaire was collated in a Microsoft Excel™ spreadsheet where it was screened for missing data, unengaged responses, outliers, and data normality. In the dataset there were no missing data. Five cases out of 123 cases were removed owing to unengaged responses, making a 96% response rate. The removal of unengaged responses was ascertained by calculating the standard deviation across the UTAUT constructs. Values less than 0.310517 were considered unengaged responses based on a review of each participants' response. Participants scoring less than 0.310517 were found to have responded with the same response for each of the UTAUT questions. Due to the types of questions across the UTAUT model, it is highly unlikely that an engaged respondent would provide the same response to all questions. This is demonstrated by the remaining responses. Thus, these cases (i.e., individual's response) were removed from the study by selecting the respondent and deleting their entire responses from the data because they were considered unengaged by the researcher. At this stage, the removal of outliers in the dataset typically applies to continuous variables. However, there were no continuous variables in the dataset. SPSS 20 was used to calculate Mahalanobis distance in the UTAUT construct with the aim to locate and remove outliers (Penny, 1996). The critical value was 69.3. which was compared to the Chi-square distribution (Garrett, 1989). Therefore, no cases were removed as the maximum value calculated for this dataset was 67.089. Garret (1989) states that using regression analysis procedures to locate outliers can be distorted by the same outliers being sought. Thus, the reason why Mahalanobis distance was calculated and compared to the Chi-square distribution table.

Assumptions of data normality need to be measured in order to successfully perform many statistical procedures namely, regression and correlation (Ghasemi and Zahediasl, 2012). This is because statistical tests like these and those required to perform CB-SEM are based on the assumption that the data follow a normal distribution (Jannoo *et al*., 2014). In the current study, data normality was examined by conducting a Skewness and Kurtosis test. If the Skewness and Kurtosis value of each scale ranges between ± 2.00 at $p < -0.01$, then the data are considered normally distributed (Field, 2009). The results of the analysis showed fairly normal distributions for the indicators of latent factors and all other variables were observed. However, mild Kurtosis was found in the following items PE1, PE2, EE1, EE3, SD5, BIU2 and BIU8 (see Appendix 11 for sub scale labels). The Kurtosis observed ranged from benign to 3.17. Whilst this violates strict rules of normality, it does fall below more lenient rules suggested by Sposito *et al*. (1983) who recommend 3.3 as the upper limit.

## 3.8 Data analysis

In the first phase of the current study, the ICT YouTube training videos were compared with ServiceNow™ incidents to see how many incidents had been created that corresponded with the skills covered in the videos. Overall, using these various approaches to reviewing ServiceNow™ incidents, knowledge articles and YouTube videos provided an extensive method of triangulation which gave the researcher the ability to study this phenomenon dynamically (Edwards *et al*., 2013) partially offsetting the low sampling validity of social web data (i.e., YouTube) by merging different types of information (e.g., ServiceNow™ ICT incidents report, knowledge articles report logs and YouTube videos) to discover deeper insights.

In the first part of the study, multigroup comparison tests were carried out using data from the ServiceNow™ reports. These multigroup comparison tests were performed via a Chi-square difference ($\Delta\chi^2$) test to test statistical significance of gender and reporting ICT incidents. In addition, Chi-square difference ($\Delta\chi^2$) tests were performed to see if there were statistical significance with gender and reading knowledge-based articles. Microsoft Excel™ was the software used to conduct these Chi-square difference ($\Delta\chi^2$) tests. The reason why Microsoft Excel™ was chosen to carry out these calculations is because the data from the ServiceNow™ reports were exported from the system to Microsoft Excel™ making it expedient to use the functionalities in Microsoft Excel™ to calculate the Chi-square difference test.

### 3.8.1 Structural Equation Modelling (SEM)

In the second phase of the study, the data captured from the survey were analysed using the covariance-based Structural Equation Modelling (CB-SEM) approach. SEM is a comprehensive statistical modelling technique used to specify CFA models, regression models and complex path models (Anderson and Gerbing, 1988). Hair *et al*. (2014) recommends that the application of SEM should only be performed if the research is developed based on strong theoretical basis. The current research used the UTAUT model (Venkatesh *et al*., 2003) and literature to identify the variables and specified the relationships among the variables. This was conducted for the purpose of fulfilling one of the many research objectives which is to analyse questionnaire data and determine factors contributing to mLearning adoption at SMG. Furthermore, SEM provides a suitable framework for statistical analysis, inclusive of several traditional multivariate procedures. These procedures include but are not limited to factor analysis, discriminant analysis and regression analysis (Hair *et al*., 2014). Thus, the reason why this statistical data analysis approach was used in the current study.

When conducting SEM analysis, Anderson and Gerbing (1988) recommend a two-step approach. The first step is the analysis of the measurement model and the second, is the analysis of the structural model. Each of these main two steps are supplemented with additional intermediate steps. Anderson and Gerbing's (1988) recommended approach was adopted in the current study. The more detailed steps are diagrammatically represented in Fig 3.4.

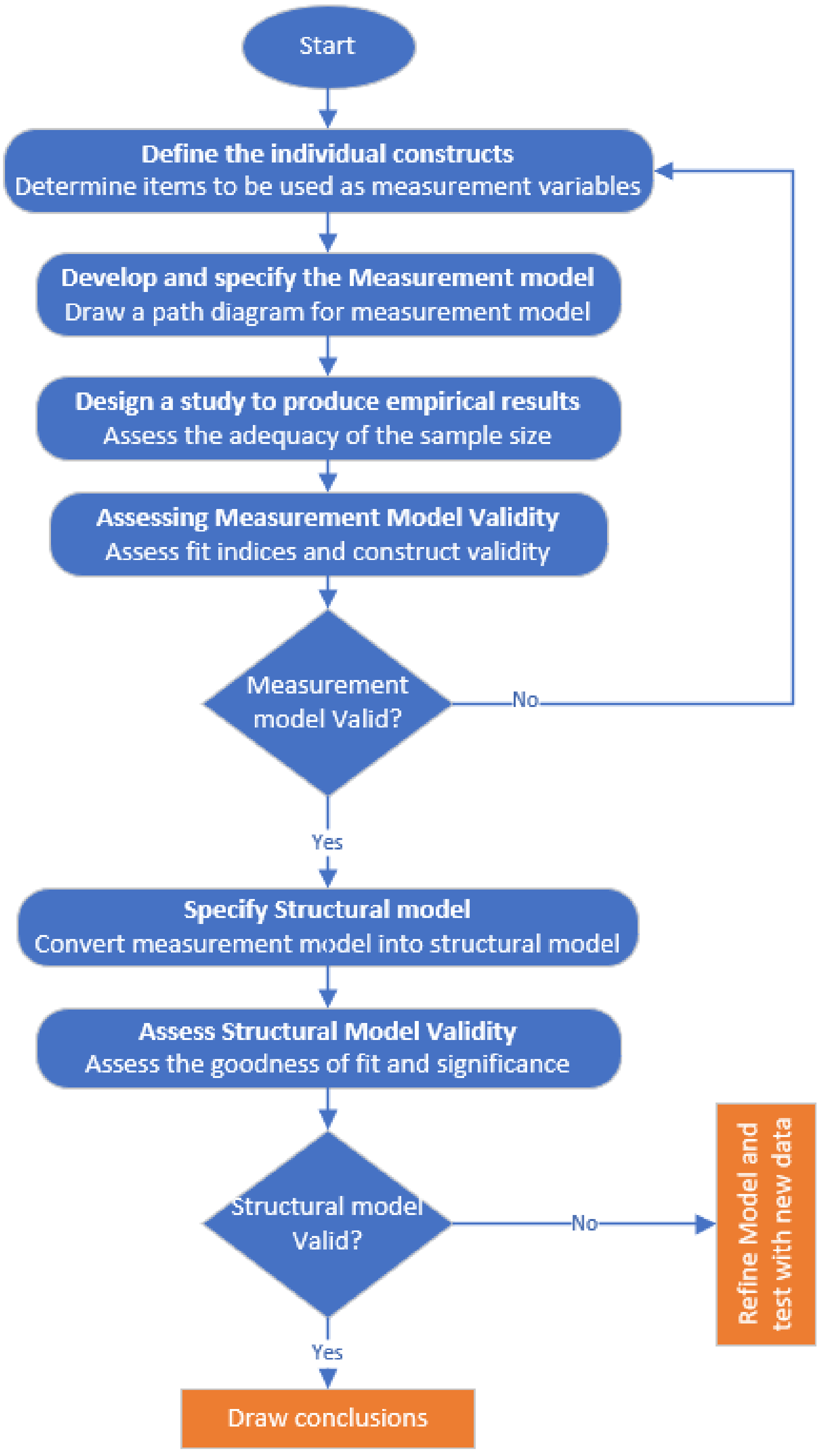



**Fig 3.4**: Significant steps in the SEM modelling

The first step involved an examination of the measurement model for reliability and validity. This examination included various other tests such as Kaiser-Meyer-Olkin and Barlett test of sphericity which tests the suitability of the data captured in the survey for factor analysis (Cerny and Kaiser, 1977). This test was conducted using the SPSS 20 software package. Another test was Common marker variable statistical technique that was used in this study to estimate Common Method Variance (CMV) (Lindell and Whitney, 2001). CMV happens when the survey used to collect data introduces a bias, hence variances (Lindell and Whitney, 2001). Consequences of this, is that the findings from the analysis is contaminated (Harman, 1960). Two survey items were identified as Marker variables post hoc. These survey items related to experience of using mobile phones for knowledge at home and at work and were identified because they had low correlations with other UTAUT model constructs as recommended by Lindell and Whitney (2001). The CMV test was carried out using the software package Analysis of Moment Structures (AMOS) version 25. AMOS is a widely used statistical software package used in social sciences for the analysis of SEM (Arbuckle, 2017). Williams *et al*. (2015) review of UTAUT research found that AMOS was the second most widely used analysis tool. Hence, why AMOS was used in this study to perform many of the statistical tests. Furthermore, SPSS and Microsoft Excel™ do not have some of the functionalities to easily perform the statistical tests that AMOS is able to achieve so easily. An examination of the Tolerance and Variance Inflation Factors (VIF) was also carried out to assess multicollinearity. This typically exist when two or more constructs or predictors are highly correlated in a regression model (Field, 2009). The Tolerance and VIF tests were performed using SPSS 20.

The examination of both the measurement and structural models was conducted in the current study and included the use of seven commonly used model-fit indices to assess the quality of the model's overall goodness-of-fit (Hu and Bentler, 1999). These indices are Chi-square mean/Degree of freedom ($\chi^2/df$), Goodness-of-fit (GFI), Incremental fit Index (IFI), Tucker Lewis Index (TLI), Comparative fit index (CFI), Root mean square error of approximation (RMSEA), Standard root mean square residual (SRMR). Table 3.4 summarises the goodness-of-fit indices used in the current study in both the evaluation of the measurement model and the structural model.

*Table 3.4* Summary of goodness-of-fit indices

| Goodness-of-fit indices | Acceptable value | Comments |
|---|---|---|
| **Parsimony fit indices** | | |
| $\chi 2/df$ | <3 | Value should be below 5.0 |
| **Absolute fit indices** | | |
| Goodness-of-Fit Index (GFI) | >0.80 | Values close to 0 signifies a poor model fit whereas values close to 1 reflects a perfect model fit |
| Root Mean Square Error of Approximation (RMSEA) | <0.08 | Values between 0.05 to 0.08 indicate a close model fit |
| Standardized Root Mean Square Residual (SRMR) | <0.10 | Values less than 0.05 indicates a good model fit |
| Comparative Fit Index (CFI) | >0.90 | Values close to 0 signifies a poor model fit whereas values close to 1 reflects a perfect model fit |
| **Relative Fit Indices** | | |
| Incremental Fit Index (IFI) | >0.90 | Values close to 0 signifies a poor model fit whereas values close to 1 reflects a perfect model fit |
| Tucker-Lewis Index (TLI) | >0.90 | Values close to 0 signifies a poor model fit whereas values close to 1 reflects a perfect model fit |

(Source: Hu and Bentler, 1999; Hair *et al*., 2006)

If the indices indicate poor model fit, then additional modifications of the model must be performed. In the second step of the two step SEM process, the assessment of the structural model was carried out to test the suitability of the UTAUT model and research hypotheses. In this case, the investigation is to see how well the data matches the underlying adapted UTAUT theory. Further use of the fit indices were used based on Hu and Bentler (1999) recommendation to minimize Type 1 error (the rejection of a true null hypothesis) and Type 2 error (non-rejection of a false null hypothesis) hence why this study used a combination of relative fit indexes, such as the CFI or IFI and absolute fit indexes such as SRMR or RMSEA.

Finally, in the second phase of this research, multigroup comparison tests were carried out via a Chi-square difference ($\Delta\chi^2$) test with constraint and unconstraint models (Savalei and Kolenikov, 2008). Model 1 is an unconstrained model whereby path estimates are calculated separately for each group (e.g., male and female). Whereas model 2 is a constraint model where path estimates are calculated as both groups are equal between the groups. This is for the purpose of examining the significance of moderation across the entire model (Byrne, 2004). Additionally, investigations into the individual paths using path analysis were carried out to determine causal relationships in the model (Stage *et al*., 2004). Moreover, the moderating effects of gender and age, the two moderators in this study were also investigated. AMOS 25 was used to conduct both the path analysis and the multigroup comparison test.

## 3.9 Ethics

Research ethics are integral aspects of reliability and trustworthiness in research. The researcher has a responsibility to all stakeholders involved to adhere to the principles of appropriate conduct (Saunders *et al*., 2016). Even, to the extent of whether the research impacts the participants directly, indirectly, or not at all. The researcher must perform research with integrity. Ensuring, to the best of their knowledge, there are no falsifications, misrepresentations, or misinterpretations (Saunders *et al*., 2016). SMG staff assisting with the research were signposted to where they could get information regarding the research. This helped to mitigate the chance of them inadvertently misleading research participants. Thus, avoiding dishonesty at all costs (Bryman, 2012).

At the beginning of this study, an application was made to the Humanities, Arts and Social Sciences Research Ethics Committee (HASSREC) of the University of Worcester for a proportionate ethical review and the application was approved (see Appendix 12).

The research undertaken complied rigidly to the assurances given in the application which is in accordance with the University of Worcester Ethics Policy. Additionally, this research adhered to the General Data Protection Regulations (GDPR) in accordance with the Information Commissioner's Office (ICO) (ICO, n.d.). Data for the mLearning adoption survey was collected using Google Forms. Subsequently, Google uses Hyper Text Transfer Protocol Secure/Transport Layer Security (HTTPS/TLS) to encrypt the data it transmits. In order to mitigate the risk of unauthorized access, Google uses their own data centres to store data rather than using the public internet (Data Center Knowledge, 2017). Consent was sought from participants (see Appendix 9) and their information was anonymised. Thus, none of the research participants could be uniquely identified nor have been associated with the information given in this research without obtaining permission first.

At this point, it would be useful to discuss how the researcher of this study managed ethical issues as an insider researcher for SMG. This is because these issues typically only arise after the completion of the ethical review application. The findings from Floyd and Arthur's (2012) research on external and internal ethical engagement examines the dilemmas and ethical issues confronting 'insider' researchers provides a useful framework to present this discussion. Floyd and Arthur's (2012) research is discussed further in Chapter 2, section, *Ethics and insider knowledge*. Having insider knowledge helped the researcher of the current study to gain access to gatekeepers because of the working relationship the researcher has with Heads of Departments.

In the current research, interviews or discussions were only pertaining to the development of the UTAUT instrument and not to other research participants. The relevance of this is because Drake and Heath (2008) discusses on-going personal and professional relationships with participants and the notion that insider researchers cannot unhear what has been told to them. Although this is worth considering when conducting interviews as a research method, the current research was not affected by this type of situation. Thus, the researcher's on-going personal and professional relationships were not affected by this condition. However, other difficulties arose pertaining to the perceived challenges that presented themselves when issues surfaced around reputational damage. These issues affected the researcher's personal relationship with some senior members of the management team. As the situation invoked feelings of indignation in the researcher because the entire research project was discussed with many members of the senior management team. However, after a series of communications with senior management it was found that the current research did not present a case for reputational damage and was encouraged to proceed with publication.

The researcher of the current study did not face issues such as those discussed by Hollway and Jefferson (2000) where probing questions during an interview created a destabilising effect on the research participant's psychological defences. This is because neither data collection methods involved physically interacting with research participants as participants were asked to complete an online form and the other data collection method did not involve verbally or physically interacting with participants.

In the current research, the researcher's critical stance was not weakened by the expected loyalty to the SMG as suggested in Floyd and Arthur's (2012) research. Additionally, the researcher in the current research took an objective role in the research as not to compromise any confidentiality protocols.

All data gathered including surveys, consent email replies and research notes etc. were stored securely and confidentially in the researcher's personal OneDrive folder which requires multi-factor login authorisation in order to access the information. Ensuring where possible, all relevant data and information was secure. However, Floyd and Arthur (2012) discuss the notion of the risk of research participants recognising each other. In the context of the current research, this issue can only be mitigated to a small degree because emails to participants were sent out via Heads of Departments who were informed about the confidential nature of this research. Some heads of departments chose to blind carbon copy (BCC) participants whereas others listed the participants' names in the To: section of the email. Thus, other staff members were aware of those in their department who had been invited to participate.

On completion of this research write up, all data collected for this research which is stored on the researcher's personal OneDrive folder is to be securely and permanently destroyed. Additionally, the data will not be held for longer than is statutorily permitted by the researcher.

## 3.10 Summary

This chapter described the rationale for the underpinning methodological perspectives of this study. It also outlines the research purpose, question, objectives, and hypotheses being tested in this study. This chapter reports the rationale for aspects of the first stage of the study that was conducted before the second stage of this research.

Two types of quantitative data collection methods and the subsequent analysis of available SMG tools used for reporting incidents and acquiring just-in-time knowledge were also explained.

Based on the technology acceptance literature, this chapter also presents a commentary of the process involved in the design and evaluation of the survey used to measure factors affecting mLearning adoption. This also included the processes involved in the initial phase of the study's reliability and stability tests. Additionally, this chapter explored the relationships between gender and reporting ICT related incidents, gender, and KMS usage. Furthermore, this chapter presented a rationale and definition of the UTAUT constructs with consideration to the moderators age and gender.

A justification for selecting the population and how access to the population was achieved and managed is stated and based on research methodology literature. This chapter also discussed data analysis and the consideration of various statistical tests. Finally, this chapter discussed the researcher's responsibility to all stakeholders (those involved or not) in the research and the adherence to the principles of appropriate and ethical research conduct.

The following chapter presents the findings from the analysis of the data from the tools available to SMG staff that are used for reporting ICT incidents, just-in-time knowledge acquisition and factors affecting mLearning adoption at SMG.

# Chapter 4. Results and Conclusions

The aim of this chapter is to report the findings from the first phase and second phase of the current study. The findings from the first phase of this study analysed the data from the tools available to SMG staff that are used for just-in-time knowledge acquisition and reporting ICT incidents which also includes the SMG ICT Training YouTube Channel. In the first phase of this study, data was gathered through ServiceNow™ reports and YouTube analytics.

This chapter also presents the findings from the statistical techniques used in the second phase of the study to analyse data collected from the modified UTAUT survey. Fig 4.1 provides an overview of how these statistical techniques used to analyse data are going to proceed in the current study. Furthermore, findings from the determinants that predict mLearning adoption at SMG will be presented. More specifically, this chapter expounds the following five outcomes:

1) The findings from the SMG ICT training YouTube Videos.
2) The findings from the Chi-square goodness-of-fit tests for the sample group in terms of gender and if it differs from the expected frequencies of the entire SMG workforce.
3) The findings from an examination of gender to see if gender plays a role in an individual's proclivity to read the knowledge articles or not.
4) The findings from an exploration of gender to understand if gender plays a role in an individual's tendency to report an ICT incident to the ICT service desk or not.
5) The findings from the investigation of factors affecting mLearning adoption at SMG based on the theories that underpin the UTAUT model.

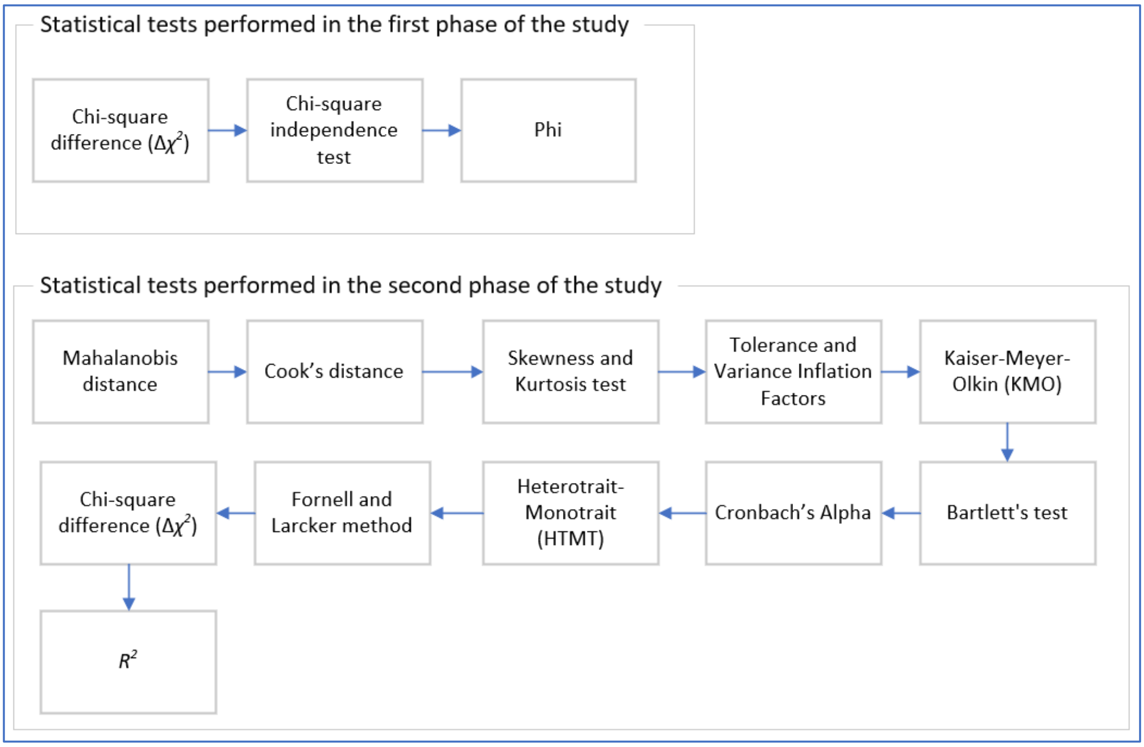



***Fig. 4.1*** Summary of statistical tests performed in the current study

## 4.1 Findings from the SMG ICT training YouTube Videos Views Data

The YouTube analytics tool was used to collect the data on SMG training video views for the purpose of analysing the SMG YouTube channel's performance and to consider its impact on incoming IT support inquiries at the SMG. Many of the knowledge articles available to staff for just-in-time knowledge acquisition have embedded links to videos on the private SMG Training YouTube channel. The analysis and subsequent findings help to provide some insight into the following research question.

***RQ1:*** To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG?

The YouTube analytics tool reported that of the 102 videos created, there had been 835 views from 26 October 2016 – 8 July 2018. Further investigation was performed to find out which devices were used to view the videos. Chart 4.1 shows the results of the analysis of YouTube analytics which showed that 91% of the videos were viewed on a computer, while 8.5% were viewed on a mobile phone. This left 0.5% that were viewed on a Tablet. One of the reasons why the SMG YouTube analytics was used as part of the analytical tools in this study is because 85 ServiceNow™ knowledge articles are linked to YouTube videos on the SMG ICT training YouTube channel. The use of YouTube analytics tool provides numerous useful metrics for analysing the performance of the channel, such as traffic source types, engagement, operating system, and geography. However, for this study to address the above research question it is important to see what devices are being used to access the just-in-time knowledge acquisition tools.

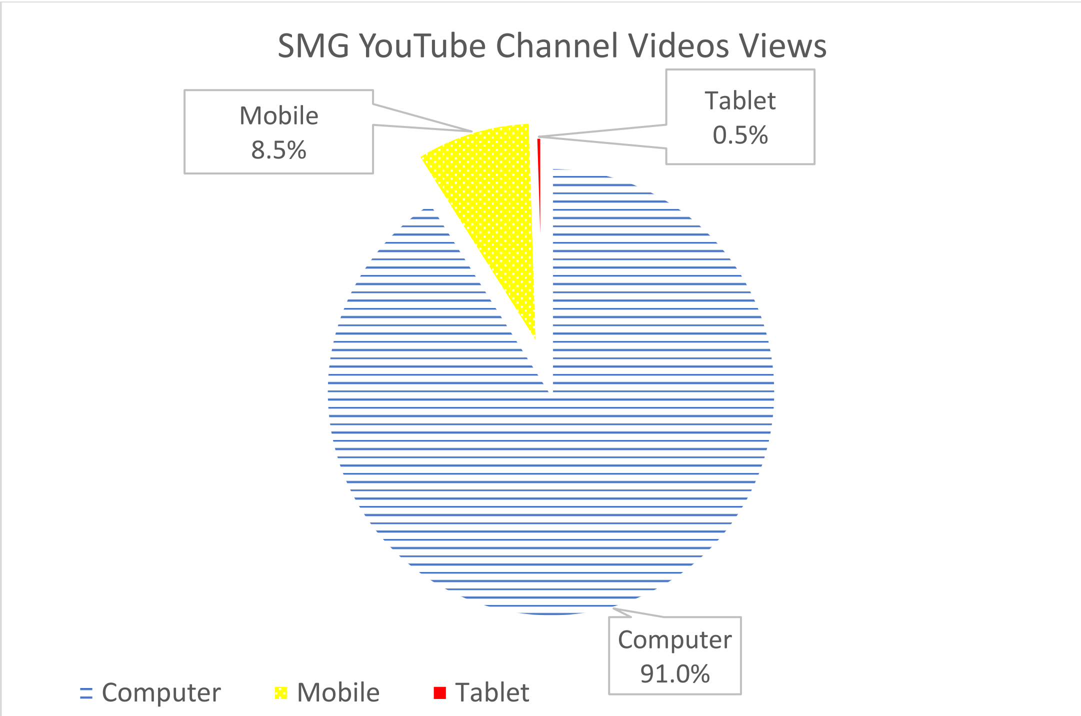



***Chart 4.1*** YouTube Channel video views (by devices)

## 4.2 Reported ICT incidents and corresponding knowledge article views

The current study investigates the reported ICT incidents and the corresponding knowledge article views using data collected from ServiceNow™ reports within a 6-month period. These data were collected in order to establish how the viewing of knowledge articles affects the management of ICT support calls. Chart. 4.2 shows the results of the analysis of the data from the ServiceNow™ knowledge article views, ICT incident reports. It was also observed that 71% of staff contacted service desk after viewing knowledge articles relating to the ICT incident that was reported, whilst 29% of staff contacted service desk staff without viewing knowledge articles. It is worth mentioning that these results are unique as there are no studies on the wider ITSM practice which have reported knowledge article views in relation to ICT incident reporting.

Based on both knowledge article reports and ICT incident reports, 799 out of 1125 individual callers contacted service desk without viewing knowledge articles.

Based on both knowledge article reports and ICT incident reports, 327 out of 1125 individual staff members viewed knowledge articles and subsequently contacted service desk for further assistance.

To provide context regarding the resolution of ICT incidents, both service desk staff and callers can resolve incidents. Callers can resolve their own incidents in two ways. Firstly, by contacting ICT service desk and informing them they no longer need their support or secondly, by simply not responding to follow up emails from the service desk team. Either way, the incident ticket is closed, and the incident is logged as resolved. Based on both knowledge article reports and ICT incident reports, 20 out of 1145 individual callers viewed knowledge articles and did not contact service desk for further assistance. Details on how the incident was resolved by the caller are not recorded in ServiceNow™ because SMG has not enabled the feature that allows callers to state or record how they have resolved their issues. This functionality is only enabled for ICT service desk staff. Based on a discussion with the ICT service desk manager, the consensus is that it is unlikely that enough staff will use this feature. The significance of these findings is that it provides insight into the behaviours of SMG staff specifically, how they currently use knowledge articles and its impact on the reporting of ICT incidents.

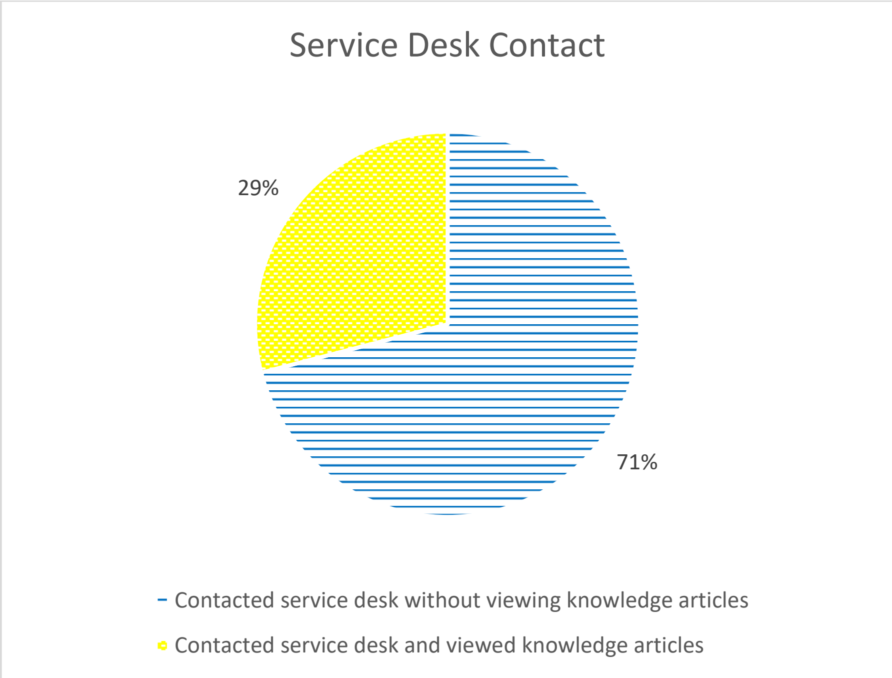



***Chart 4.2*** ICT Service desk contact

## 4.3 Reported ICT incidents benefiting from mLearning intervention

In order to determine the reported ICT incidents benefiting from a just-in-time learning intervention such as an mLearning intervention, the data from the ServiceNow™ incident report was analysed. The data were collected from ServiceNow™ reports within a 6-month period. Chart 4.3 shows the results of a review of 2728 reported ICT incidents of which 491 (18%) of them would have benefited from an mLearning intervention such as an adapted ServiceNow™ knowledge article made to display on a mobile device. These results indicate that 68 individual SMG staff members would have benefited from these interventions. The data also indicate 82% of the reported ICT incidents would not have benefited from an mLearning intervention.

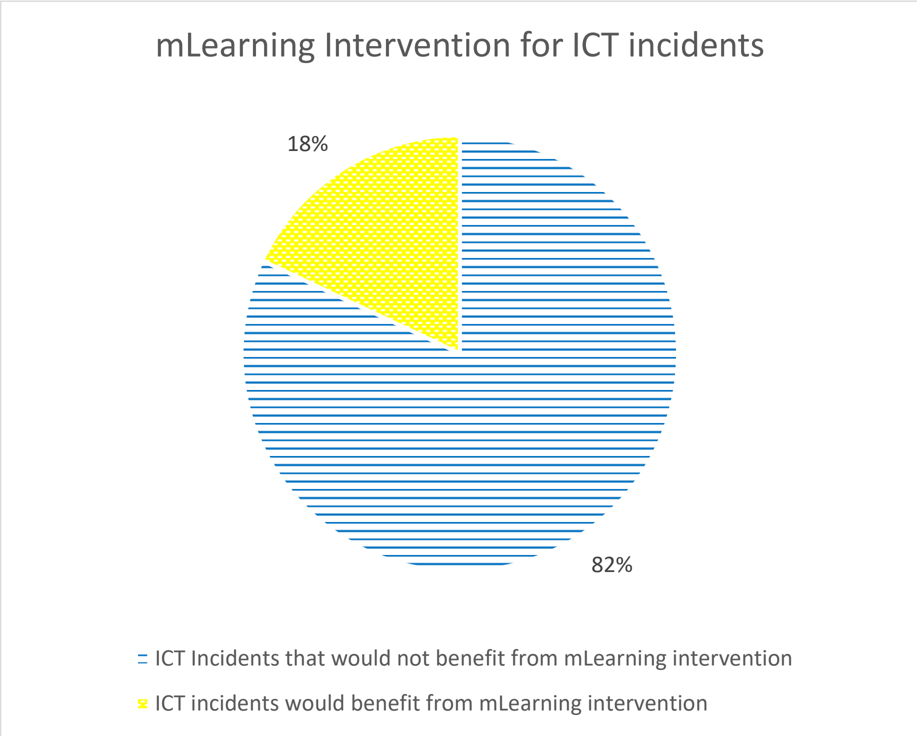



***Chart 4.3*** Percent of incidents benefitting from mLearning intervention

The analysis also found that 590 incidents reported by a caller were related to knowledge articles read by the caller while 2140 incidents reported were not related to the knowledge articles read by the caller. The significance of these findings is that some staff are reading knowledge articles but some of the knowledge articles are currently failing to provide the reader with the knowledge necessary to resolve the ICT incident themselves. However, there are knowledge articles that only provide information and awareness. Thus, not used to resolve ICT incidents. For example, remote working, ICT Cost Charging Guidance and ITG001 - Terms of Use Policy knowledge articles do not resolve ICT incidents. See Table 4.1 for a list of the ten most viewed knowledge articles where 7 of the 10 knowledge articles are for awareness. Categorising ServiceNow™ knowledge articles into training and non-training related groups gives a comprehensive indication of the types of knowledge articles that are currently viewed by SMG staff. The significance of these findings is that it will help with understanding the current trends in mLearning usage. Specifically, with regards to knowledge articles and how usage of the knowledge articles could be improved in future implementations.

***Table 4.1*** Top 10 most viewed knowledge article

| ServiceNow Knowledge Articles | Training (T)/non training (NT) Knowledge Articles | Number of individuals who viewed Knowledge Articles |
|---|---|---|
| Remote Working | NT | 132 |
| AnyConnect VPN | T | 71 |
| ICT Cost Charging Guidance | NT | 70 |
| CISCO meet me Conference User Guide | T | 52 |
| ITG001 - Terms of Use Policy | NT | 38 |
| User Software Installation and Approval | NT | 32 |
| ICT Policy | NT | 22 |
| Configuring Multi-Factor Authentication for Working Outside of SMG | T | 13 |
| How Can I Book a Loan Laptop? | NT | 13 |
| How to Contact ICT? | NT | 11 |

Based on the analysis of the data from a ServiceNow™ report that had recorded 7361 ICT incidents between 1st February to 31st July, 806 of those 7361 calls were identified as benefitting from a learning intervention such as, a knowledge article addressing the reported ICT incidents. According to the analysis, the 806 calls, collectively took 26 days for ICT Service Desk to resolve (based on ICT Service desk operating hours 07:00 – 18:30 Monday to Friday). Translating these findings into an approximation of Service Desk operational expenses, this would have cost SMG £5,259.00 for the 6-month period analysed. These costs are calculated based on an hourly paid ICT service desk staff member and the cost of the ITSM Service desk portal, ServiceNow™ (See Table 4.2). The cost excludes business applications, cloud hosting, datacentre hosting and WAN/LAN infrastructure costs.

***Table 4.2*** Approximation of Service Desk operational expenses

| Aspect | Annual Cost circa. | 26-Days Cost circa. |
|---|---|---|
| ITSM Service Desk Tool | £32,000 | £2,279.42 |
| ICT Operations Team Staff Salary | £498,000 | £2,979.58* |

*Individual ICT Service desk staff salary before deductions

In terms of the use of time required to resolve these ICT incidents, there is potential for SMG ICT Management to focus their staff's efforts on high value activities such as improving customer service skills among ICT Service desk staff, building automation capabilities, and upgrading servers and storage infrastructures. In terms of the cost to the caller (person reporting the ICT incident), there are monetary and productivity opportunities which they could have benefitted from as they would not have to wait for a resolution. Furthermore, the caller would have benefitted from the newly acquired ICT knowledge applicable to their role.

## 4.4 Gender, ServiceNow Incident reports and Knowledge articles read

Gender has been found in previous research work (Chen, 1986; Nsibirano, 2009; Shashaani, 1994) to influence the use of technology. This section explores ServiceNow™ ICT incident reports and knowledge articles read reports by gender, in order to address the following two research questions.

***RQ2:*** What are the relationships between gender and reading ServiceNow™ knowledge articles?

***RQ3:*** What are the relationships between gender and reporting ICT incidents?

All these questions are concerned with technological usage and its relationship with gender in SMG to determine if there is the presence of a digital divide among staff.

### 4.4.1 Gender, sample population and SMG population

In order to compare the sample population used in this study with SMG's workforce's actual population, the Chi-square test for goodness-of-fit, a nonparametric test was performed on one categorical variable, Gender. The formula for the Chi-square test for goodness-of-fit: $\chi^2$ is the Chi-Square Value.

$$\chi_c^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

$O_i$ is the Observed frequency, $E_i$ is the expected frequency and $c$ is the degrees of freedom.

The test makes claims about the population proportions e.g., comparing the sample population with the SMG workforce to determine if the proportion of male and female staff in each group are the same. Hair *et al*. (2010) suggested reporting the Chi-square

$\chi2$ value in determining the population proportions. The results from the Chi-square goodness-of-fit found that the observed frequencies do not differ from the expected frequencies for gender. $\chi2$ (df1, N= 1145) = 3.585, p = 0.058. If the p-value were less than the $\alpha$ 0.05 this would indicate there is statistically significant difference between the sample population and SMG's workforce's population size. However, since the p-value (0.058) is greater than the significance value (0.05) these results mean it cannot be concluded that the observed data are statistically different from the expected values. Therefore, the test failed to reject the null hypothesis. Table 4.3 shows the Chi-square goodness-of-fit results with both the observed and expected frequencies along with the residuals.

*$H_0$: The research sample size for gender and reading knowledge articles is consistent with SMG workforce population size*

*$H_a$: The research sample size for gender and reading knowledge articles is not consistent with SMG workforce population size*

***Table 4.3*** Chi-Square goodness-of-fit

| | **Observed** | **Expected** | **Residual** |
|---|---|---|---|
| Female | 741 | 709.9 | **31.1** |
| Male | 404 | 435.1 | **-31.1** |
| **Total** | **1145** | **1145** | |

### 4.4.2 Gender and reading knowledge articles

The Chi-square test for independence is a nonparametric test that is performed on two or more categorical variables (Fisher, 1922). In this study two variables were used, 1) Gender (male or female) and 2) if a staff member has read a knowledge article (Yes or No). Both independent t-tests and z-tests were considered unsuitable as these tests require one of the variables to be either an interval or ratio data type. The variables used in this test are both categorical.

The significance of the findings in this section is that the results help to address RQ2: **What are the relationships between gender and reading ServiceNow knowledge articles?** To address this question, the two hypotheses below were tested:

Hypothesis 1:

*$H1_0$: Gender and reading knowledge articles are independent of one and other*

*$H1_a$: Gender and reading knowledge articles are not independent of one and other*

The null hypothesis is that gender and reading knowledge articles are independent of one and other. The alternative hypothesis is that the two variables are associated, meaning, the difference between the expected and observed frequencies in the table cannot be attributed to sampling error. The observed and expected frequencies are presented below (Table 4.4), (Table 4.5).

***Table 4.4*** Gender and Reading knowledge articles (observed) Frequencies

| | N | Y | Grand Total |
|---|---|---|---|
| Female | 508 | 233 | **741** |
| Male | 290 | 114 | **404** |
| **Grand Total** | **798** | **347** | **1145** |

***Table 4.5*** Gender and Reading knowledge articles (expected) Frequencies

| | N | Y | Grand Total |
|---|---|---|---|
| Female | 516.43 | 224.57 | **741** |
| Male | 281.57 | 122.43 | **404** |
| **Grand Total** | **798** | **347** | **1145** |

The results of testing the hypothesis of independence are displayed in Table 4.6. The series of calculations performed in Microsoft Excel™ returned a Chi statistic (1.288) that was less than the Chi Critical value (3.841). With 1 degrees of freedom (*df*), it is clear that the value of the Chi statistic was low enough to fail to reject the null hypothesis. Therefore, concluding that there is not a relationship between gender and reading knowledge articles.

There is no statistically significant relationship between gender and reading knowledge articles, $\chi2$ (df1, N= 1145) = 1.288, p = 0.256. Meaning this happened by chance.

***Table 4.6*** Results from the test of independence (Gender and Reading knowledge articles)

| $\chi^2$ | *Df* | $\chi^2$ *Critical value* | p-value | α |
|---|---|---|---|---|
| 1.28839179256577 | 1 | 3.841 | 0.256 | 0.005 |

### 4.4.3 Gender and reporting ICT incidents

The nonparametric Chi-square test for independence was performed on this study's two categorical variables, 1) Gender (male or female) and 2) if a staff member has reported an ICT incident (Yes or No). Both independent t-tests and z-tests were also considered unsuitable, for the same reason as the previous section. The data used in this analysis were based on ICT incident reports.

These findings address RQ3:

**What are the relationships between gender and reporting ICT incidents?** To address this question the two hypotheses below were tested:

Hypothesis 2:

*$H2_0$: Gender and reporting ICT incidents are independent of one and other*

*$H2_a$: Gender and reporting ICT incidents are not independent of one and other*

It was observed that there is a statistically significant but weak relationship between gender and reporting an ICT incident, χ2 (df1, N = 1145) = 7.737, p-value = 0.005. Women (65.2%) were more likely to report an ICT incident than men (34.8%). SPSS 20 was used to calculate the *Phi coefficient ϕ* in order to estimate the strength of the relationship between the nominal variables, gender (male, female) and reporting an ICT incident (Yes, No). The formula for the *Phi coefficient ϕ:* $\phi_c$ *is a measure of association*

$$\phi = \sqrt{\frac{\chi^2}{N}}$$

N = Total number of subjects.

*Phi coefficient ϕ* has a range of 0 to 1. The interpretation of correlation coefficients varies among research areas. Thus, there are no absolute rules of thumb for the interpretation of their strength. However, based on the recommendations from Kotrlik and Williams (2003) it was reasonable to use Rea and Parker's (1992) rule of thumb shown below

(Table 4.7) for interpreting the *Phi coefficient ϕ* test result. The results returned that the effect size is negligible (.082). This indicates that whilst there is a statistically significant relationship between gender and reporting ICT incidents, the strength of the relationship is low.

***Table 4.7*** Phi coefficient values and interpretation

| Value | Interpretation |
|---|---|
| .00 and under .01 | Negligible association |
| .10 and under .20 | Weak association |
| .20 and under .40 | Moderate association |
| .40 and under .60 | Relatively strong association |
| .60 and under .80 | Strong association |
| .80 and under 1.00 | Very strong association |

The observed and expected frequencies of gender and reporting an ICT incident are presented below (Table 4.8), (Table 4.9).

***Table 4.8*** Report ICT Incident (observed)

| | N | Y | Grand Total |
|---|---|---|---|
| Female | 7 | 734 | **741** |
| Male | 13 | 391 | **404** |
| **Grand Total** | **20** | **1125** | **1145** |

***Table 4.9*** Report ICT Incident (expected)

| | N | Y | Grand Total |
|---|---|---|---|
| Female | 12.9 | 728.1 | **741** |
| Male | 7.1 | 396.9 | **404** |
| **Grand Total** | **20** | **1125** | **1145** |

The results of testing the hypothesis of independence are displayed in Table 4.10. The series of calculations performed in Microsoft Excel™ returned a Chi statistic (7.737) that was larger than the Chi Critical value (3.841). With 1 degrees of freedom (*df*), the value of the Chi statistic was high enough to support the rejection of the null hypothesis. Therefore, concluding that there is a relationship between gender and reporting ICT incidents.

***Table 4.10*** Results from the test of independence (Gender and Reporting ICT incidents)

| $\chi^2$ | *Df* | $\chi^2$ *Critical value* | p-value | α |
|---|---|---|---|---|
| 7.736780592171 | 1 | 3.841 | 0.005 | 0.005 |

### 4.4.4 Gender and reporting ICT incidents related to knowledge articles

The nonparametric Chi-square test for independence was performed on this study's two categorical variables, 1) gender (male or female) and 2) if a staff member has reported an ICT incident related to the knowledge articles read (Yes or No). The data used in this analysis was based on both knowledge article reports and ICT incident reports.

The findings in this section address the following two research questions:

***RQ2:*** What are the relationships between gender and reading ServiceNow knowledge articles?

***RQ3:*** What are the relationships between gender and reporting ICT incidents?

To address each research question, another question was formulated for the purpose of testing hypothesis 3: **Is there a statistically significant relationship between gender and reporting ICT incidents related to knowledge articles?** To answer this question the two hypotheses below were tested:

Hypothesis 3:

*$H3_0$: Gender and Reporting ICT incidents related to knowledge articles are independent of one and other*

*$H3_a$: Gender and Reporting ICT incidents related to knowledge articles are not independent of one and other*

The null hypothesis is that gender and reporting an ICT incident related to knowledge articles are independent of one and other. The alternative hypothesis is that the two variables are associated, meaning, the difference between the expected and observed frequencies in the table cannot be attributed to sampling error, if the expected frequencies are a function of the marginal totals for rows and columns independently of each other. The observed and expected frequencies are presented below (Table 4.11), (Table 4.12).

It was observed that there is no significant relationship between gender and reporting an ICT incident related to the knowledge article read, $\chi 2$ (*df*1, N= 2728) = 3.702, p = .054. Meaning this has happened by chance.

***Table 4.11*** Report ICT Incident related to knowledge article (observed)

| | N | Y | Grand Total |
|---|---|---|---|
| Female | 1474 | 431 | **1905** |
| Male | 664 | 159 | **823** |
| **Grand Total** | **2138** | **590** | **2728** |

***Table 4.12*** Report ICT Incident related to knowledge article (expected)

| | N | Y | Grand Total |
|---|---|---|---|
| Female | 1492.99 | 412.01 | **1905** |
| Male | 645.01 | 177.99 | **823** |
| **Grand Total** | **2138** | **590** | **2728** |

The results of testing the hypothesis of independence are displayed in Table 4.13. The series of calculations performed in Microsoft Excel™ returned a Chi statistic (3.702) that was less than the Chi Critical value (3.841). With 1 degrees of freedom (*df*), the value of the Chi statistic was low enough to support the failure to reject the null hypothesis. Therefore, this result indicates that there is no relationship between gender and reporting ICT incidents related to knowledge articles.

***Table 4.13*** Results from the test of independence (Gender and Reporting ICT Incident related to knowledge article)

| $\chi^2$ | *Df* | $\chi^2$ *Critical value* | p-value | α |
|---|---|---|---|---|
| 3.70197417191808 | 1 | 3.841 | 0.054 | 0.005 |

## 4.5 Findings from the UTAUT survey for mLearning adoption

This section presents the analysis of the data from the UTAUT survey that is adapted to reflect the factors affecting mLearning adoption at SMG. This survey was distributed among SMG staff, the findings address the following research questions.

***RQ4:*** What factors determine SMG employees' behavioural intention to adopt and use mLearning?

***RQ5:*** To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?

To address these two questions, the following 13 hypotheses were tested.

- *Performance expectancy has a positive effect on behavioural intentions to use mLearning*
- *Performance expectancy influences behavioural intention to use mLearning more strongly for male staff than for female staff*
- *Performance expectancy influences behavioural intention to use mLearning more strongly for younger staff than for older staff*
- *Effort expectancy has a positive effect on behavioural intention to use mLearning*
- *Effort expectancy influences behavioural intention to use mLearning more strongly for female staff than for male staff*
- *Effort expectancy influences behaviour intention to use mLearning more strongly for older staff than for younger staff*
- *Social influence has a positive effect on behavioural intention to use mLearning*
- *Social influence influences behavioural intention to use mLearning more strongly for female staff than for male staff*
- *Social influence influences behavioural intention to use mLearning more strongly for older staff than for younger staff*
- *Self-directed learning has a positive effect on behavioural intentions*
- *Self-directed learning influences behavioural intentions to use mLearning more strongly for male staff than for female staff*
- *Self-directed learning influences behavioural intention to use mLearning more strongly for older staff members than for younger staff members*
- *Facilitating conditions does not impact behavioural intentions*

### 4.5.1 mLearning adoption respondents

Sixty-eight (58%) of the staff were female, and fifty (42%) were male. Participants' age group were reported as follows: 3 (2%) <21; 41 (35%) 21 - 30; 36 (30%) 31 - 40; 23 (20%) 41 - 50; 15 (13%) >50.

The highest educational attainment among staff members was reported as 3 (3%) having attained a secondary school education; 5 (4%) Further Education (FE) College; 11 (9%) Higher Education (HE) College; 53 (43%) Bachelor; 46 (39%) Postgraduate.

All of the main departments of SMG were represented; 8 (7%) Collections Services; 6 (5%) Commercial Experience; 1 (1%) Curatorial / Library / Archives; 6 (5%) Development; 5 (4%) Directorate; 10 (9%) Exhibitions; 14 (12%) Finance / Procurement; 21 (18%) ICT; 9 (8%) Learning; 5 (4%) Marketing and Comms; 5 (4%) Masterplan, Estates & Design; 12 (10%) Operations (including Visitor Fundraising); 4 (3%) People & Culture; 6 (5%) Retail; 6 (5%) Other.

43 (36%) staff members had management responsibilities, leaving 75 (64%) that did not.

A large majority (114; 97%) of the participants reported they had used a mobile device at home with Internet access. 77 (65%) said they had used a mobile device at work, 70 (59%) of staff members reported that they used their mobile device to acquire knowledge or a skill, and 22 (19%) stated that they used their mobile device to access SMG knowledge articles or the ICT Training YouTube channel.

Table 4.14. outlines the general demographic and mobile usage overview of the 118 staff members whose responses from the mLearning adoption survey were usable.

*Table 4.14* *Demographic Information of Respondents*

| Characteristic | Frequency | | Percentage | |
|---|---|---|---|---|
| **Gender** | | | | |
| Male | 50 | | 42% | |
| Female | 68 | | 58% | |
| **Age** | | | | |
| <21 | 3 | | 2% | |
| 21 – 30 | 41 | | 35% | |
| 31 – 40 | 36 | | 30% | |
| 41 – 50 | 23 | | 20% | |
| >50 | 15 | | 13% | |
| **Educational attainment** | | | | |
| Bachelor | 53 | | 45% | |
| FE College | 5 | | 4% | |
| HE College e.g., foundation degree, Access, HND, HNC | 11 | | 9% | |
| Postgraduate | 46 | | 39% | |
| Secondary School | 3 | | 3% | |
| **Department** | | | | |
| Collections Services | 8 | | 7% | |
| Commercial Experience | 6 | | 5% | |
| Curatorial / Library / Archives | 1 | | 1% | |
| Development | 6 | | 5% | |
| Directorate | 5 | | 4% | |
| Exhibitions | 10 | | 9% | |
| Finance / Procurement | 14 | | 12% | |
| ICT | 21 | | 18% | |
| Learning | 9 | | 8% | |
| Marketing and Comms | 5 | | 4% | |
| Masterplan, Estates & Design | 5 | | 4% | |
| Operations (including Visitor Fundraising) | 12 | | 10% | |
| Other | 6 | | 5% | |
| People & Culture | 4 | | 3% | |
| Retail | 6 | | 5% | |
| **Management responsibilities** | | | | |
| Yes | 43 | | 36% | |
| No | 75 | | 64% | |
| **Mobile device usage** | **Yes** | | **No** | |
| Use of Mobile device at work | 77 | 65% | 41 | 35% |
| Use of Mobile device at home | 114 | 97% | 4 | 3% |
| Used to acquire knowledge or skill | 70 | 59% | 48 | 42% |
| Used to access SMG knowledge articles or ICT Training YouTube Channel | 22 | 19% | 96 | 81% |

## 4.6 Data screening

### 4.6.1 Multivariate outliers

Multivariate outliers are data points that deviate from patterns exhibited by much of the data (Hair *et al*., 2006). In other words, they are presented as unusual scores on at least two variables. These types of outliers can distort the accuracy and outcome of statistical analysis (Zimmerman, 1994). Outliers occur for several reasons. One of which can be erroneous data entry, causing data to contain extreme cases. A Cook's distance analysis was carried out before conducting the evaluation of the measurement model to determine if any multivariate influential outliers existed. The Cook's distance analysis uses a data-driven approach to highlight data points that deviate from patterns exhibited by the majority of the data (Hair *et al*., 2006). The Cook's distance formula is:

$$D_i = \frac{\sum_{j=1}^{n} \left(\widehat{y}_j - \widehat{y}_{j(i)}\right)^2}{ps^2}$$

$D_i$ of observation (for $i$ = 1,..., n) is defined as the sum of all the changes in the regression model when observation $i$ is removed from it. $\widehat{y}_{j(i)}$ is the fitted response value obtained when excluding $i$, and $s^2 = \frac{\mathbf{e}^\top \mathbf{e}}{n-p}$ is the mean squared error of the regression model.

In this analysis, there were no observed cases of a Cook's distance greater than 1. Most cases were less than 0.280, indicating no presence of influential outliers.

## 4.7 Evaluation of the measurement model

The first step in the SEM process is to assess the measurement model. The measurement model is the process of assigning numbers to variables based on a given set of rules that are used to assign numbers to the variable in a way that accurately represents the variable (Afthanorhan, 2014; Hair *et al*., 2006). Evaluating the measurement model includes carrying out an EFA or CFA. The primary purpose of EFA and CFA is to explain relationships among several observed variables (also known as measured variables) using a smaller number of unobserved variables (also known as latent variables or factors) (Hair *et al*., 2006). Fig 4.2 illustrates an example of a generic CFA diagram with two latent factors (unobserved variables/factors) and six observed variables, depicted as rectangles. Each of the unobserved variables/factors are reflected via three observed variables (also known as indicator variables). The arrow between the two unobserved variables shows that the factors are covaried among themselves. Each of the observed variables have their own error terms which are also known as indicator errors. The indicator errors are represented by a small circle with the letter 'e'.

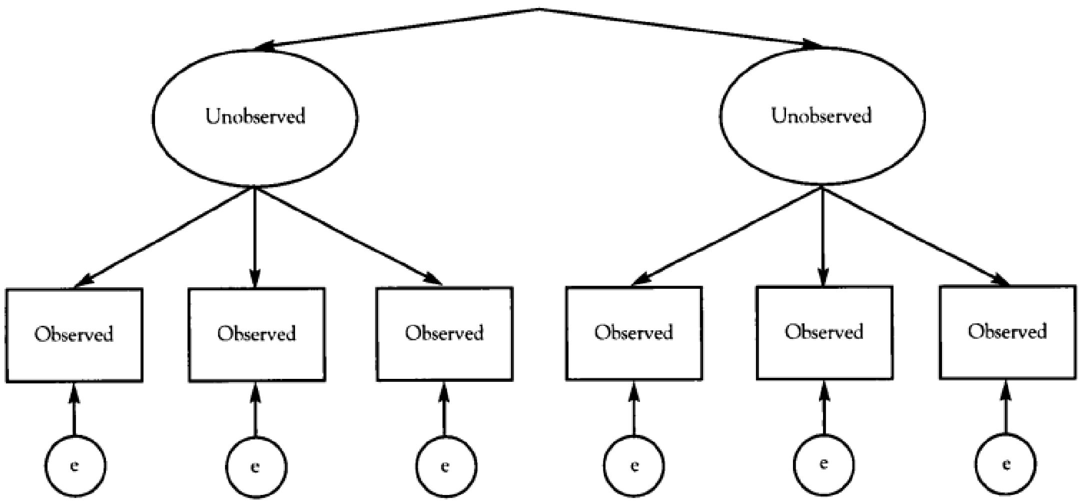



**Fig. 4.2:** Generic confirmatory factor analysis diagram, e = error terms

The main difference between EFA and CFA is that EFA is exploratory and measures variables without imposing any a priori theory to the items belonging to the underlying constructs. Conducting an EFA was not necessary in the current study because the UTAUT model is known and well established, meaning that a priori existed. However, EFA using Maximum likelihood factor extraction method was used in the current study to derive an adequate pattern matrix (see Table 4.17). This is because a maximum likelihood estimation procedure aims to locate factors that maximises the likelihood of producing a correlation matrix based on multivariate normal distribution data (Mabel and Olayemi, 2020). The formula for the Maximum likelihood factor extraction method is:

$$l(\mu, \mathbf{L}, \boldsymbol{\Psi}) = \frac{np}{2} \log 2\pi - \frac{n}{2} \log |LL' + \Psi| - \frac{1}{2}(X_i - \mu)'(\mathbf{LL}' + \boldsymbol{\Psi})(X_i - \mu).$$

Where ***L*** is the matrix of factor loadings and Ψ, is the diagonal matrix of specific variances. The Maximum likelihood factor extraction method procedure involves the estimation of μ, the matrix of factor loadings ***L***, and the specific variance Ψ, from the log likelihood function.

During this analysis, a new latent factor was discovered and subsequently added to the research after the hypotheses were defined. The new latent factor was named USE, this was based on a common theme of the observed variables. The overall assessment of the measurement model was carried out using EFA and CFA. The software used to perform the assessment was SPSS 20 and Analysis of Moment Structures (AMOS) 25. These software were used to examine discriminant validity and convergent validity. Discriminant validity is the degree to which measures of constructs that theoretically should not relate, are unrelated (Cronbach and Meehl, 1955). For example, a theoretical measure of social influence should not be positively correlated with the self-reported ability to use a tool with ease. Conversely, convergent validity is the degree to which measures of constructs that theoretically should relate, are related (Campbell and Fiske, 1959). For example, a theoretical measure of performance expectancy should be positively correlated with the self-reported ability to use a tool to increase job productivity. Convergent validity is dependent on three indicators: 1) the reliability of each construct, 2) the item reliability of each measure (standard loadings), 3) the average variance extracted (AVE). AVE is defined as the sum of the squared loadings divided by the numbers of indicators. The formula for the AVE is:

$$\mathrm{AVE} = \frac{\sum_{i=1}^{k} \lambda_i^2}{\sum_{i=1}^{k} \lambda_i^2 + \sum_{i=1}^{k} \mathrm{Var}(e_i)}$$

$k$ = the number of items, $\lambda_i$ = the factor loading of item $_i$; and $\mathrm{Var}(e_i)$ is the variance of the error item $_i$ (Fornell-Larcker, 1981).

AVE was used in the current study to measure the convergent validity. An AVE value of 0.50 indicates that the construct explained more than half of the variance of its indicators (Fornell-Larcker, 1981). Conversely, an AVE of less than 0.50 indicates that more error remains in the items than the average variance explained by the constructs.

According to Hair *et al*. (2013) an AVE value equal to or greater than 0.50 is acceptable. Based on the values obtained for the AVE for all constructs in this study, convergent validity was achieved for the measurement model. Constructs are considered to have convergent validity when the composite reliability (CR) exceeds the criterion of 0.70 and the AVE is above 0.50 (Hair *et al*., 2006). Based on the results of the evaluation of the measurement model, convergent validity was achieved as CR values for all constructs were above 0.7 and all AVE values for each construct were above 0.5. Cronbach's Alphas for each of the constructs were also above the 0.7 threshold as specified in Table 4.15 which shows the standardised factor loadings, the AVE, CR, and the Cronbach's Alpha values.

To achieve convergent validity and reliability during the EFA, sixteen items (FC1, FC5, FC6, SD4, SD5, SD6, PE1, PE2, PE3, PE5, BIU2, BIU3, BIU4, BIU6, BIU7, BIU9) were removed due to low loadings, cross loadings and optimising the reliability analysis (see Appendix 11 for label definitions). Gorsuch (1983) considers zero loadings as values that fall between -0.10 and +0.10. Loadings between these values were supressed in this study's pattern matrix. According to Kline (2002) significant standard loadings based on 100 participants are loadings of 0.30 or higher. Thus, the results support the convergent validity of the scales. Additionally, all Alpha values are above the 0.7 threshold thus exhibiting good reliability (Nunnally and Bernstein, 1994).

*Table 4.15*. Results for the Measurement model

| Constructs | Items | Standardised loading | CR | AVE | Alpha |
|---|---|---|---|---|---|
| Performance Expectancy | PE4 | 0.78 | 0.835 | 0.628 | 0.829 |
| | PE6 | 0.85 | | | |
| | PE7 | 0.75 | | | |
| Effort Expectancy | EE1 | 0.89 | 0.898 | 0.688 | 0.900 |
| | EE2 | 0.80 | | | |
| | EE3 | 0.87 | | | |
| | EE4 | 0.76 | | | |
| Social Factors | SI1 | 0.89 | 0.927 | 0.809 | 0.927 |
| | SI2 | 0.95 | | | |
| | SI3 | 0.88 | | | |
| Facilitating Conditions | FC2 | 0.88 | 0.870 | 0.700 | 0.853 |
| | FC3 | 0.99 | | | |
| | FC4 | 0.59 | | | |
| Self-Directed | SD1 | 0.75 | 0.834 | 0.628 | 0.823 |
| | SD2 | 0.89 | | | |
| | SD3 | 0.73 | | | |
| Behavioural Intention | BIU1 | 0.91 | 0.948 | 0.821 | 0.943 |
| | BIU5 | 0.89 | | | |
| Use | BIU8 | 0.87 | | | 0.931 |
| | BIU10 | 0.93 | | | |
| | BIU11 | 0.97 | | | |

CR: Composite reliability, AVE: Average variance extracted, Alpha: Cronbach Alpha
See Appendix 11 for Items label

### 4.7.1 Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity

As part of the EFA, Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity tests were carried out using SPSS 20 to determine the suitability of the data captured in the UTAUT survey for factor analysis. The KMO test measures the sampling adequacy of the variables in the UTAUT model by measuring the proportion of variance among variables that have common variance (Cerny and Kaiser, 1977). For example, test results showing large numbers of partial correlations typically mean widespread correlations resulting in a problematic factor analysis. The formula for the KMO test is as follows:

$$KMO = \frac{\sum\limits_{j\neq k}\sum r_{jk}^2}{\sum\limits_{j\neq k}\sum r_{jk}^2 + \sum\limits_{j\neq k}\sum p_{jk}^2}$$

$r_{jk}$ Is the correlation between one variable and another variable. $p_{jk}$ is the partial correlation.

The results of the KMO test in the current study was 0.905 (see Table 4.16). This result means that the data achieved sampling requirements, thus the data was good enough to carry out the factor analysis.

Kaiser and Rice's (1974) rule of thumb as shown below, was used for interpreting the statistical test result:

- Between 0.90 to 1.00 marvellous
- Between 0.80 to 0.89 meritorious
- Between 0.70 to 0.79 middling
- Between 0.60 to 0.69 mediocre
- Between 0.50 to 0.59 miserable
- 0.49 and below, unacceptable

Bartlett's test of sphericity compares the Pearson correlation to the identity matrix to investigate if there is a redundancy between variables that can be summarised with fewer factors. If the test result is less than 0.05 significant levels, this indicates that the data are suitable to carry out a factor analysis. The formula for the Bartlett's test of sphericity is as follows:

$$\chi^2 = \frac{(N-k)\ln(S_p^2) - \sum_{i=1}^{k}(n_i - 1)\ln(S_i^2)}{1 + \frac{1}{3(k-1)}\left(\sum_{i=1}^{k}(\frac{1}{n_i-1}) - \frac{1}{N-k}\right)}$$

Where $N = \sum_{i=1}^{k} n_i$ and $S_p^2 = \frac{1}{N-k}\sum_i (n_i - 1)S_i^2$ is the pooled estimate for the variance (Bartlett, 1937).

In the current study the significant value of the test result was 0.000, indicating that the data are suitable for carrying out a factor analysis. Table 4.16 displays the results of the KMO and Bartlett's test of sphericity tests for this study. The results from both tests indicate that the data were appropriate for factor analysis.

***Table 4.16*** KMO and Bartlett's test results

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy | | 0.905 |
| Bartlett's Test of Sphericity | Approx. Chi-square | 2354.828 |
| | *Df* | 231 |
| | Sig | .000 |

### 4.7.2 Factor extraction methods

During the EFA, factor extractions were performed. A Factor extraction forms part of the Factor analysis procedure in both an EFA and CFA (Jung, 2013). One of the ways factor extraction is performed is by using an iterative algorithm to weight correlations among variables by the inverse of the uniqueness of the variables (Kolenikov and Bollen, 2012). SPSS uses seven widely used types of factor extraction methods. Existing methods are Maximum likelihood, Principal components, Generalized least squares, Unweighted least squares, Principal axis factoring, Alpha factoring, and Image factoring. Maximum likelihood is one of the most popular factor extraction methods (Fabrigar *et al*., 1999; Jung, 2013) and was used in the current study's EFA. Another reason why Maximum likelihood was used in the current study is because Mabel and Olayemi's (2020) study found that Maximum likelihood outperformed the other extraction methods when the data were normally distributed, the samples sizes were small with a small number of variables. This assertion was corroborated by Fabrigar *et al.* (1999) who argues that when data is relatively normally distributed, Maximum likelihood is the best option because "it allows for the computation of a wide range of indexes of the goodness of fit of the model [and] permits statistical significance testing of factor loadings and correlations among factors and the computation of confidence intervals." (p.277). The dataset in the current study is considered small therefore based on the arguments by several authors (Costello and Osborne, 2005; Fabrigar *et al.*, 1999), using the Maximum likelihood extraction method would be optimal for the current study's dataset. Additionally, Maximum likelihood is the estimation method selected by default when using AMOS to perform CFA (Arbuckle, 2017). Although, Maximum likelihood factor extraction methods are susceptible to ultra-Heywood cases (Kolenikov and Bollen, 2012), using other factor extraction methods such as PCA was found to be unsuitable for this dataset. This was because the dataset in the current study did not violate the assumption of multivariate normality. If the data in the current study violated the assumption of multivariate normality, Fabrigar *et al.* (1999) recommends the use of PCA.

Furthermore, Costello and Osborne (2005) believe that optimal results will be achieved by the use of a true factor analysis extraction method such as Maximum likelihood.

### 4.7.3 Rotation methods

Rotation methods are an attempt to relate calculated factors to theoretical objects (Yang, 2010). Rotations are performed differently depending on whether the factors are believed to be correlated (oblique) or uncorrelated (orthogonal) (Yang, 2010). SPSS offer five methods of rotation, three of those are (orthogonal) varimax, quartimax, and equimax, and two are (oblique) promax and direct oblimin (Vogt, 1993). Once a rotation is completed it creates a pattern matrix. A pattern matrix is a regression calculation where the standardized observed variable is expressed as a function of the factors. The loadings are the regression coefficients (Gorsuch, 1983). The columns represent the number of factors that has been extracted from the rotation. The number of rows represents the number of observed variables that load on a factor. Table 4.17 displays the outcome of the pattern matrix in the current study based on the extraction of seven factors using the Maximum likelihood factor extraction method and the Promax rotation method which were employed in this study using the SPSS 20 software.

***Table 4.17*** Pattern Matrix

| | Factors | | | | | | |
|---|---|---|---|---|---|---|---|
| Items | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| *EE3* | *1.031* | | | | | | |
| EE2 | .851 | | | | | | |
| EE4 | .738 | | | | | | |
| EE1 | .668 | | | | | | |
| *SI1* | | *1.095* | | | | | |
| SI2 | | .946 | | | | | |
| SI3 | | .816 | | | | | |
| FC3 | | | .957 | | | | |
| FC2 | | | .945 | | | | |
| FC4 | | | .598 | | | | |
| SD2 | | | | .960 | | | |
| SD3 | | | | .685 | | | |
| SD1 | .334 | | | .677 | | | |
| BIU8 | | | | | .945 | | |
| BIU7 | | | | | .725 | | |
| BIU10 | | | | | .657 | | |
| *PE6* | | | | | | *1.035* | |
| PE7 | | | | | | .419 | |
| PE4 | | | | | | .411 | |

| | | |
|---|---|---|
| BIU1 | | .944 |
| **BIU2** | **.414** | **.502** |
| BIU5 | | .393 |

Extraction Method: Maximum Likelihood.
Rotation Method: Promax with Kaiser Normalization.
Rotation converged in 7 iterations.
Italicised: Heywood cases. Bold: Cross loadings
See Appendix 11 for list of Item labels

### 4.7.4 Communality and Heywood cases

A communality is the degree to which an item correlates with all other items on a factor (Yang, 2010). Higher communalities such as those greater than 0.4 are better as they tend to load significantly on a factor. If communalities for a particular variable are low (between 0.0-0.4), then that variable may struggle to load significantly on any factor. Item BIU5 was a low loading and could potentially be removed from the pattern matrix providing it does not negatively impact the other factor loadings. However, removing this item caused the pattern matrix to become messy. It is for this reason why item BIU5 was not removed from the pattern matrix. The results illustrated in Table 4.17 showed most of the item loadings were higher than 0.50 indicating satisfactory convergent validity among the observed variables and their respective constructs.

However, if a communality equals 1, the situation is referred to as a Heywood case, and if a communality exceeds 1, it is an ultra-Heywood case. An ultra-Heywood case implies that some unique factor has negative variance, indicating that something is problematic. Heywood cases were found in 3 items (EE3, SI1, PE6) on the pattern matrix (see Table 4.17). However, factor extraction methods such as Maximum likelihood are susceptible to ultra-Heywood cases. Several authors (Fabrigar *et al*., 1999; Reio and Shuck, 2015) suggest that EFAs are often messy. Numerous authors (Kolenikov and Bollen, 2012) suggest that it is not advisable to let the underlying statistics drive the theoretical model as this may cause the unnecessary removal of observed variables and constructs. Thus, resulting in theory that is directed by statistics, instead of theory driven research. Accordingly, Haywood cases have not been removed in this study as it may lead to a less clean EFA pattern matrix. Removing these items may lead to construct coverage issues (Kolenikov and Bollen, 2012). Hence, why these items were not removed from the pattern matrix.

### 4.7.5 Low loadings and Cross loadings

The results in Table 4.17 illustrates that most of the items loaded onto the factors following extraction. A moderately clean factor structure in which convergent validity are evident by the high loadings of items EE2, EE4, EE1, SI2, SI3, FC3, FC2, FC4, SD2, SD3, SD1, BIU8, BIU7, BIU10, BIU1. These items have loadings greater than 0.5, making them acceptable loading scores resulting in satisfactory convergent validity among the observed variables and their respective constructs. However, in Table 4.17 there were 3 items with low loadings, PE4, PE7and BIU5. These low loadings present themselves as limitations in this study because they inflate the unexplained variance in the measurement models (Thomas, Singh and Gaffar, 2013). Poor loadings suggest there is too much conceptual inconsistency between the survey items representing the construct (Child, 2006). Removing these items caused the pattern matrix to become unstable.

There were no major cross-loadings between factors. For example, a primary loading should be at least 0.200 larger than secondary loading (Child, 2006). In this EFA there was only one loading that violated this rule (BIU2). This item loaded on both behaviour intention to use, and effort expectancy. The removal of this item was considered, however removing this item caused the pattern matrix to become less clean. Furthermore, Hair *et al*. (2014) claims that the elimination of items solely on statistical bases can adversely affect the construct measures' content validity. Hence why the item BIU2 remained.

### 4.7.6 Confirmatory measurement model

The confirmatory measurement model shown in fig 4.3 was created using AMOS 25 to investigate whether the data fit the hypothesized measurement model, which is based on the UTAUT theoretical model. Initially based on the EFA pattern matrix shown in Table 4.17., items were removed (BIU7) and replaced with (BIU4, BIU11) to remedy model fit discrepancies. These model fit discrepancies caused the RMSEA values to inflate above the 0.08 threshold, indicating a badness-of-fit (Kline, 2010). Additionally, the same model fit discrepancies caused the GFI values to fall below the 0.8 thresholds indicating poor model fit. The removal of item BIU7 and replacement of items BIU4 and

BIU11 ensured that the model satisfied the recommended RMSEA and GFI thresholds. These thresholds are recommended by Hu and Bentler, (1999) and Baumgartner and Homburg (1995). Thus, suggesting that the current model was confirmed with its data. A poor model fit results in the rejection of the model because the model has not been confirmed with its data (Rakotoasimbola and Blili, 2018). When a model has been rejected there is an increased risk of Type 1 (rejection of a true null hypotheses) and Type 2 (rejection of a false null hypotheses) errors.  Rejection of the model means the results from the SEM path analysis are dubious and have not been empirically confirmed (Rakotoasimbola and Blili, 2018). Thus, making the explanatory power of the model questionable.

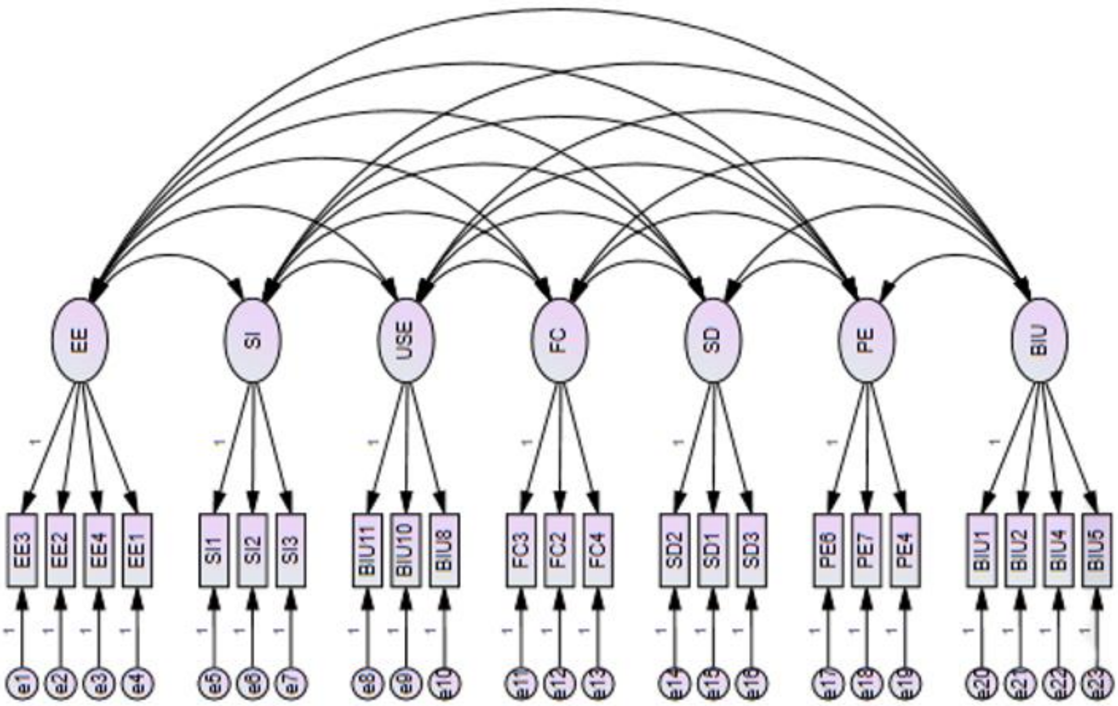



**Fig. 4.3**: Seven-Factor Confirmatory Measurement Model: Performance Expectancy (PE); Effort Expectancy (EE); Social Influence (SI); Facilitating Conditions (FC); Self-Directed (SD); Behavioural Intention (BIU); Use (USE), Key: e = error terms; rectangle box = survey item; oval = latent factor/unobserved variable

### 4.7.7 Discriminant validity

Discriminant validity refers to the extent to which the measurement model used in studies capture what they intend to measure (Campbell and Fiske, 1959). The assessment of discriminant validity in this study was performed using the Fornell and Larcker (1981) method which states that the square root of the AVE for each construct must be compared with the inter-factor correlations between that construct and all the other constructs. If the AVE is higher than the squared inter-scale correlations of the construct, it shows good discriminant validity (Gefen *et al*., 2000; Hair *et al*., 2006). However, in the current study as illustrated in Table 4.18, the square root of the AVE for EE is less than its correlation with BIU and the square root of the AVE for PE is also less than its correlation with BIU. Therefore, according to Gefen *et al*. (2000) this measurement model is exhibiting some poor discriminant validity. This means that some constructs are correlated with others that are designed to measure theoretically different concepts. Henseler *et al*. (2015) provide two recommendations for handling discriminant validity problems in variance-based structural equation modelling. They recommend 1) keeping the problematic constructs and eliminating the items that have low correlations with other items measuring the same construct. 2) Merging the problematic constructs and replacing them with the new (merged) construct if theoretically plausible. Table 4.18 shows the results of the discriminant validity test using the Fornell and Larcker (1981) criterion.

***Table 4.18*** Discriminant Validity of the UTAUT Measurement Model

| | Effort Expectancy | Social Factors | Use | Facilitating Conditions | Self – Directed | Performance Expectancy | Behavioural Intention |
|---|---|---|---|---|---|---|---|
| Effort Expectancy | **0.830** | | | | | | |
| Social Factors | 0.614*** | **0.900** | | | | | |
| Use | 0.779*** | 0.615*** | **0.926** | | | | |
| Facilitating Conditions | 0.291** | 0.549*** | 0.300** | **0.837** | | | |
| Self-Directed | 0.580*** | 0.367** | 0.477*** | 0.292** | **0.793** | | |
| Performance Expectancy | 0.658*** | 0.783*** | 0.688*** | 0.510*** | 0.482*** | **0.793** | |
| Behavioural Intention | 0.840*** | 0.792*** | 0.824*** | 0.465*** | 0.495*** | 0.842*** | **0.906** |

The square root of the average variance extracted is inserted diagonally and printed in bold. Off diagonal elements are the shared variance

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

Besides assessing discriminant validity using Fornell and Larcker (1981) criterion and Barclay *et al*. (1995), and Chin's (1998) proposal that loadings should be greater than all cross-loadings, this study also assessed discriminant validity using Gold *et al*. (2001) and Teo *et al*. (2008) Heterotrait-Monotrait (HTMT) 0.90 threshold as a criteria test. The formula for HTMT is:

$$\underbrace{\mathrm{HTMT}_{ij} = \frac{1}{K_i K_j}\sum_{g=1}^{K_i}\sum_{h=1}^{K_j} r_{ig,jh}}_{\substack{\text{average}\\ \text{heterotrait–}\\ \text{heteromethod}}} \div \underbrace{\left(\frac{2}{K_i(K_i-1)}\cdot\sum_{g=1}^{K_i-1}\sum_{h=g+1}^{K_i} r_{ig,ih}\cdot\frac{2}{K_j(K_j-1)}\cdot\sum_{g=1}^{K_j-1}\sum_{h=g+1}^{K_j} r_{jg,jh}\right)^{\frac{1}{2}}}_{\substack{\textit{geometric mean of the average monotrait–heteromethod}\\ \textit{correlation of construct } \xi_i \textit{ and the average}\\ \textit{monotrait–heteromethod correlation of construct } \xi_j}}.$$

Using this method, discriminant validity was fulfilled according to the $\mathrm{HTMT}_{0.90}$ more liberal thresholds of discriminant validity. All values were below the 0.90 threshold. Thus, suggesting the model achieved good discriminant validity. However, using Gaskin and James' (2019) HTMT Plug-in for AMOS, the results found that BIU and USE constructs were statistically indistinguishable (see Table 4.19).

***Table 4.19*** Discriminant Validity using Heterotrait-Monotrait matrix

| | EE | SI | **USE** | FC | SD | **PE** | BIU |
|---|---|---|---|---|---|---|---|
| EE | - | | | | | | |
| SI | 0.587 | - | | | | | |
| USE | 0.795 | 0.619 | - | | | | |
| FC | 0.295 | 0.546 | 0.323 | - | | | |
| SD | 0.609 | 0.396 | 0.524 | 0.318 | - | | |
| PE | 0.659 | 0.791 | 0.728 | 0.554 | 0.536 | - | |
| **BIU** | 0.833 | 0.801 | **0.850** | 0.494 | 0.547 | **0.850** | - |

Values highlighted in bold indicate discriminant validity problems according to the $\mathrm{HTMT}_{0.85}$ criterions

Henseler *et al.*'s (2015) simulation study compared Fornell-Larcker criterion and the examination of cross-loadings as ways of evaluating discriminant validity. They found that using $\mathrm{HTMT}_{0.90}$ criterions with a sample size of 100 detected discriminant validity problems in 98.50% cases. Their research found that HTMT approaches to detecting discriminant validity outperformed the other approaches, e.g., Fornell-Larcker criterion and the examination of cross-loadings. Therefore, the current research will use the findings from the HTMT test to determine discriminant validity.

### 4.7.8 Common Method Variance (CMV)

Survey methods have the potential to introduce excessive variance that can alter research findings. There are numerous ways this can be introduced. For example, a participant's positive or negative attitude or motivation towards the research subject can influence their responses to varying degrees. Additionally, the survey's complexity and format can influence the participant's responses. Another way excessive variance can be introduced to self-reported survey results is when participants respond to survey items in a consistent fashion (Padsakoff and Organ, 1986). Thus, the purpose of testing for common method variance (CMV) is to estimate to what degree such biases exist. There are several tests that can be used to test CMV, the three most popular post hoc techniques are 1) Harman Single Factor (Harman, 1960), 2) Common Latent Factor and 3) Common Marker Variable. Common marker variable statistical technique was used in the current study to estimate such variance. During the creation of the survey, no marker variables were created. Subsequently, no data was collected for this purpose. However, Lindell and Whitney (2001) recommend using variables with low correlations between observed variables as measures for the latent method variable. The current study used multiple uncorrelated measures from the study e.g., Mobile_at_home and Mobile_at_work to create a Mobile marker variable (see fig 4.4). The results show that the constrained and unconstrained models are invariant. This means that the common method variance test failed to detect the presence of any specific response bias affecting the model. Table 4.20 shows the common method variance test results.

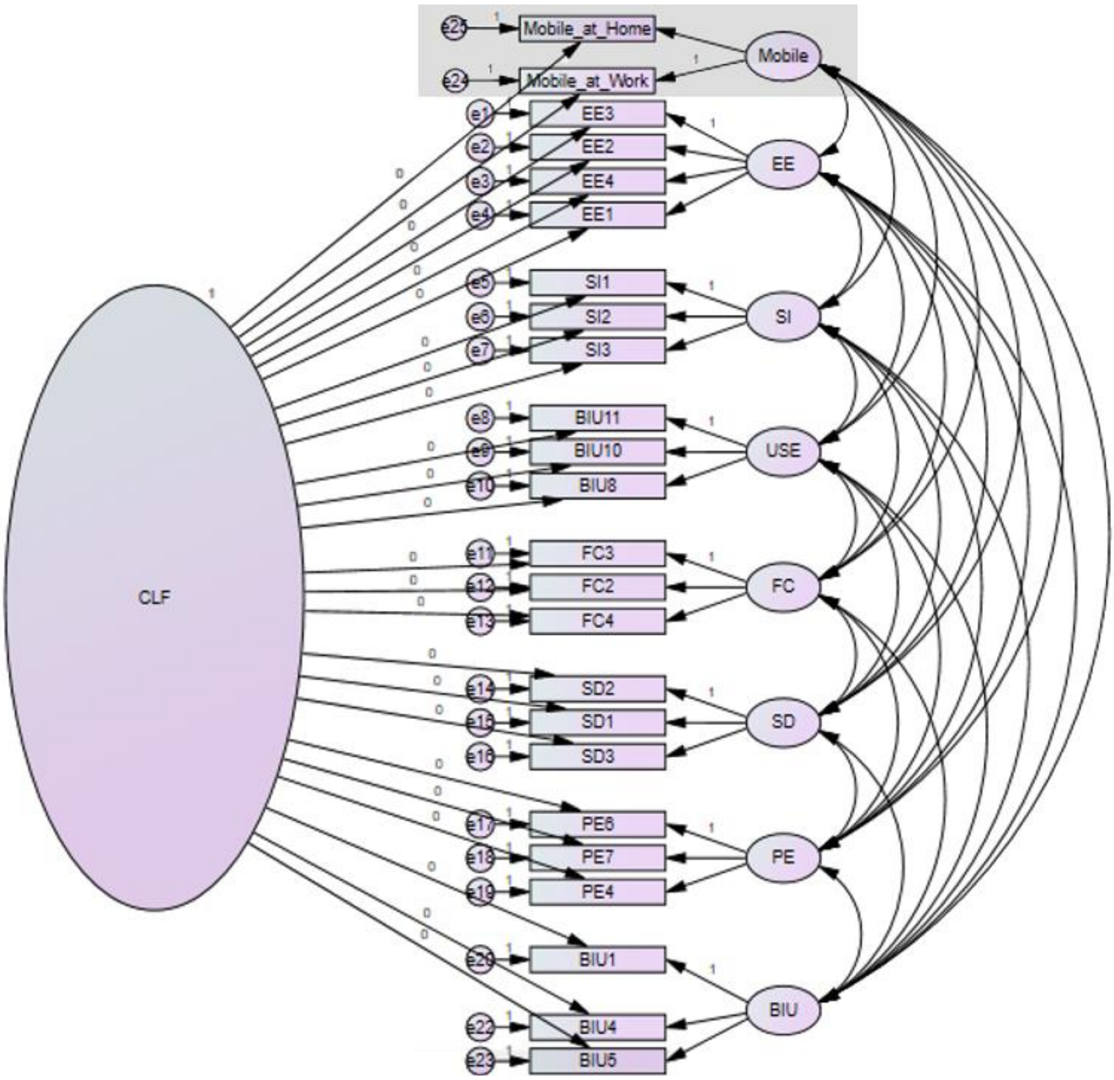



**Fig. 4.4**: Seven-Factor Confirmatory Measurement Model with Common Marker Variable highlighted

***Table 4.20*** Common method variance test results

| | $\chi^2$ | *df* | **Delta** | **P-value** |
|---|---|---|---|---|
| Unconstrained Model | 384.489 | 224 | χ2 = 0.000<br>df = 0 | 1.000 |
| Zero Constrained Model | 384.489 | 224 | | |

### 4.7.9 Multicollinearity

An examination of the Tolerance and Variance Inflation Factors (VIF) was carried out to assess multicollinearity. This typically exists when two or more constructs or predictors are highly correlated in a regression model (Field, 2009). The multicollinearity does not exist in a regression model when the Tolerance value is greater than 0.1 and the VIF value is less than 10 (Field, 2009). The formula for the VIF is:

$$\mathrm{VIF}_i = \frac{1}{1 - R_i^2}$$

Where $R_i^2$ is the coefficient of determination of the regression equation.

The results of the Tolerance and VIF indicated that all Tolerance values were greater than 0.1, and the VIF values for all UTAUT constructs were less than 5 which is far below the threshold of 10 (see Table 4.21). Thus, the assumption of the absence of multicollinearity was met.

***Table 4.21*** Multicollinearity Test

| | **Tolerance** | **VIF** |
|---|---|---|
| Effort Expectancy | .354 | 2.829 |
| Social Influence | .251 | 3.978 |
| Facilitating Conditions | .624 | 1.603 |
| Self-Directed | .550 | 1.818 |
| Performance Expectancy | .215 | 4.644 |

## 4.8 Model fit

Model fit refers to the model's ability to reproduce the underlying data (Hu and Bentler, 1999). The aim is to derive a good model fit which means that the model is reasonably consistent with the data. A good model fit in SEM is typically required before interpreting the causal paths of the structural model. In this study, tests of the measurement model, and structural model (discussed in the following section, i.e., *Evaluation of the Structural Model*) were conducted to ascertain Goodness-of-fit. Seven common model-fit measures were used to assess both the measurement model and structural model’s overall goodness-of-fit. These are Chi-square mean/Degree of freedom (*χ2/df*), IFI, TLI, CFI, RMSEA, SRMR. According to Hu and Bentler (1999), an acceptable threshold value for the SRMR fit index is less than 0.10 which is an indication that the data are a close model fit. A TLI threshold value greater than 0.90 means that the data are a close model fit. A CFI threshold value greater than 0.90 indicates the data are a close model fit. An IFI threshold value greater than 0.90 is an indication that the data are a close model fit. A GFI threshold value greater than 0.80 suggests the data are a close model fit. Overall, the results of the proposed measurement model showed an adequate fit: ($\chi 2/df$ 1.646, GFI .804, IFI .948, TLI .934, CFI .947, RMSEA .075, SRMR .053). Table 4.22 shows the minimum acceptable thresholds for the various Goodness-of-fit indices according to Baumgartner and Homburg (1995) and Hu and Bentler, (1999).

***Table 4.22*** Fit indices for measurement and structural models

| Goodness-of-fit indices | Acceptable value | Measurement model | Structural model |
|---|---|---|---|
| $\chi 2/df$ | <3 | 1.646 | 1.691 |
| GFI | >0.80 | 0.804 | 0.817 |
| IFI | >0.90 | 0.948 | 0.945 |
| TLI | >0.90 | 0.934 | 0.932 |
| CFI | >0.90 | 0.947 | 0.944 |
| RMSEA | <0.08 | 0.075 | 0.078 |
| SRMR | <0.10 | 0.053 | 0.058 |

*Recommendations based on Hu and Bentler, (1999); Baumgartner and Homburg (1995)*

## 4.9 Evaluation of the structural model

In the previous sections, the first steps in SEM were performed and the results reported. This included several validity, reliability, and goodness-of-fit tests conducted through the evaluation of the measurement model. These tests were carried out for the purpose of satisfying the prerequisites of the measurement model analysis. In this section, the second steps of SEM are performed, and the results are reported. The second step in SEM is to assess the structural model which includes testing the theoretical hypotheses and the relationships between the latent constructs. This was assessed using AMOS 25 software. The previous seven common model-fit measures used for the measurement model were used to assess the structural model's overall goodness-of-fit. Overall, the results of the proposed research model showed an adequate fit: ($\chi^2/df$ 1.691, GFI .817, IFI .945, TLI .932, CFI .944, RMSEA .078, SRMR .0582). These results are similar to the results attained from the assessment of the measurement model. Table 4.22 shows the minimum acceptable thresholds for the various Goodness-of-fit indices. These results provide evidence that the model fit the data adequately. Thus, able to proceed with testing the model hypothesis constructed for mLearning adoption in the current study.

### 4.9.1 Path analysis

Investigating the determinants and the moderators age and gender involved using AMOS 25 to perform path analysis. Path analysis is a type of multiple regression that can estimate the magnitude and significance of causal relationships between variables (Stage *et al*., 2004). Fig 4.5 shows the path diagram created with AMOS 25 that represents the structure of the SEM model used to evaluate the structural model in this research. This structural model was created after the affirmative validation of the CFA model which is diagrammatically shown in Fig 4.3. The path diagram in Fig 4.5 displays six exogenous latent factors (Effort expectancy, Social influence, Facilitating conditions, Self-Directedness, Performance expectancy, Behaviour intention) represented by the large circles. Five exogenous latent factors are covaried among each other. This covariance is depicted by the curved arrows. There are two endogenous latent factors (Behaviour intention, Use behaviour) which are not covaried because they are endogenous latent factors. Each latent factor has its associated manifest indicators, for example the exogenous factor EE has four associated manifest indicators, EE1, EE2, EE3, EE4. These are depicted as rectangles. Each of the indicators have their associated indicator errors e.g., e1, e2, e3, e4. These indicator errors are illustrated as small circles. The straight arrows between each of the exogenous latent factors and the endogenous latent factors indicate the direction of the causal paths.

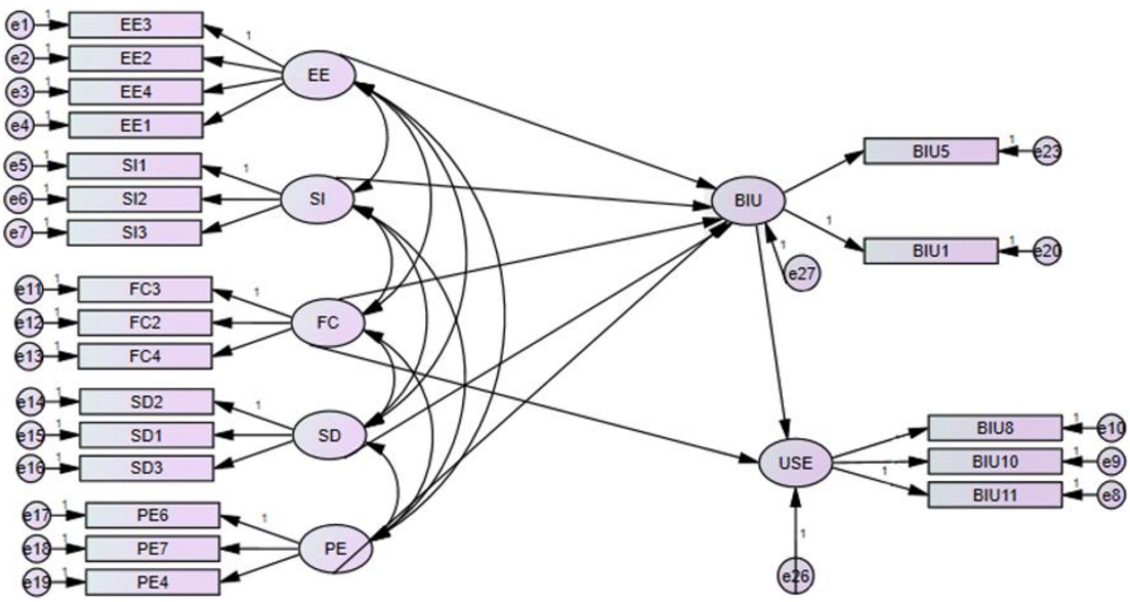



**Fig. 4.5:** Causal Measurement Model

#### 4.9.1.1 Exogenous and Endogenous variables of mLearning adoption

The path coefficients which indicate the estimates of the five hypothesized relationships among the six constructs (PE, EE, SI, SD, FC and BIU) were obtained from the structural model analysis and is listed in Table 4.23. To be statistically significant, t-values should be greater than 1.96 at 0.05 confidence levels (Garson, 2016). The results show that among the five predictors (PE, EE, SI, SD, and FC), EE exhibited the most substantial positive effect on BIU (with t-value of 5.590) in the model. This is followed by PE with t-values of 3.244 which is then followed by SI with t-values of 2.160. FC was found to have a statistically significant positive effect on BIU with t-values of 1.822 at 0.10 confidence level. However, FC was found to have a statistically significant negative effect on USE with t-values of -2.690. SD was found not to be statistically significant with t-values of -0.504. Therefore, these results indicate that hypotheses H4, H7 and H10 are fully supported. Indicating, that factors PE, EE, SI, and FC positively and significantly influenced BIU mLearning at SMG. These findings address RQ4.

**What factors determine SMG employees' behavioural intention to adopt and use mLearning?**

***Table 4.23*** Structural Model Results

| Path/Hypothesis | Beta | t-value | Hypothesis testing results |
|---|---|---|---|
| PE → BIU (H4) | 0.347** | 3.244 | Supported |
| EE → BIU (H7) | 0.460*** | 5.590 | Supported |
| SI → BIU (H10) | 0.199* | 2.160 | Supported |
| SD → BIU (H13) | - .032 | -0.504 | *ns* Not supported |
| FC → BIU (H16) | 0.109† | 1.822 | Not supported |
| FC → USE | -0.206 | -2.690 | Negative relationship |
| BIU → USE | 0.960 | 10.659 | Supported |

Model fit indices: $\chi^2/df$ 1.691., GFI 0.817, IFI .945, TLI .932, CFI .944. RMSEA .078, SRMR = .0582

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001 *ns* non-significant

### 4.9.2 Moderating effect of gender and age

This study continued to examine gender and age to investigate whether there were significant differences between the groups or if the effects of the UTAUT constructs can be generalised across the groups. Prior to investigating the moderating effects on the individual paths, a global multigroup comparison test was carried out via a Chi-square difference ($\Delta\chi^2$) test with constraint and unconstraint models. The formula for the Chi-square difference ($\Delta\chi^2$) test:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i}$$

This was for the purpose of examining the significance of the moderator variable (gender) on the following independent/exogenous variables (PE, EE, SI, and SD) and the dependent/endogenous variable (BIU) using Gaskin and Lim's (2018) Multigroup Plug-in for AMOS 25. This multigroup test followed the steps suggested by Byrne (2004) which is to test for validity of the hypothesized model across the two different groups e.g., male and female. Then test for invariance of the fully constrained model across the two different groups e.g., male and female. Finally, test for invariance of the unconstrained model across the two different groups e.g., male and female. The p-value of the Chi-square difference ($\Delta\chi^2$) test was found to be significant. Therefore, establishing that the model differs across the groups (male staff and female staff), Table 4.24 lists the results. These results suggest that further investigation into the individual paths is warranted to determine the extent of the different moderating effects based on gender.
The results of the analysis of gender and age differences listing the path coefficients and their significance are outlined in Tables 4.24 and 4.26, respectively. The path coefficient listed in Table 4.25 indicates the moderating effects of the gender moderator on the dependent/endogenous variable (BIU). The significance of these results addresses RQ5: **To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?**

***Table 4.24*** Global test results (Male and Female staff)

| | $\chi^2$ | *df* |
|---|---|---|
| Unconstrained | 650.016 | 342 |
| Constrained | 663.960 | 349 |
| Difference | 13.944 | 7 |
| P-Value | 0.052 | |

The path coefficient which indicates the estimates of the hypothesized interactions among the five constructs were also obtained from the structural model analysis listed in Table 4.25. The results indicate the moderating effect of gender on the independent/exogenous variables (PE, EE, SI and SD) assumed to be a cause on the dependent/endogenous variable (BIU) assumed to be an outcome. Based on the Beta values of Gender PE showed that it was stronger for female staff (0.651***). EE showed that the moderating effects were stronger for male staff (0.749***). SI revealed that the moderating effects were stronger for male staff (0.382*). Finally, SD was found to be non-significant. The results indicate that hypotheses H5, H8, H11 and H14 were not supported in the current study. The moderating effects on constructs FC and USE were not reported or hypothesized in this study.

***Table 4.25*** Structural Model Results (Moderators Male and Female)

| Path (Hypothesis) | Male Beta | Female Beta | Result/Interpretation |
|---|---|---|---|
| PE → Gender → BIU (H5) | -0.173 | 0.651*** | Not supported. Stronger for female staff than male. |
| EE → Gender → BIU (H8) | 0.749*** | 0.442*** | Not supported. Stronger for male staff than female staff |
| SI → Gender → BIU (11) | 0.382* | - 0.037 | Not supported. Stronger for male staff than females |
| SD → Gender → BIU (H14) | 0.056 | -0.146 | Not supported. No difference |

† $p < 0.100$ * $p < 0.050$ ** $p < 0.010$ *** $p < 0.001$ (Levels of significance)

Participants were divided into two groups: the older group consisted of ages greater than 30 years (63%) and the younger group with ages less than or equal to 30 years (37%). These age thresholds were based on research conducted by Wang et al. (2009) who also used the UTAUT model and divided their respondents into two groups: the older group with ages greater than 30 years and a younger group with ages less than or equal to 30 years. In Venkatesh et al.'s (2003) research they failed to define precisely what constitutes older and younger staff. Therefore, the use of research on age and employment (Warr and Pennington, 1993) provided a useful benchmark to divide the current research participants in to older and younger groups. Dividing the participants into 4 groups was also considered as it would present some interesting results. For example, drawing comparisons among subgroups of age grouping and discovering if there are any differences between and among groups. However, due to the limited number of participants in each group AMOS 25 was unable to carry out the required calculations. Thus, it was expedient to divide the participants into two groups. The multigroup comparison test was first carried out via a Chi-square difference ($\Delta\chi^2$) test with constrained and unconstrained models to investigate the significance of multigroup comparisons across the entire model using AMOS 25. This multigroup test also followed the steps suggested by Byrne (2004). This resulted in the p-value of the Chi-square difference ($\Delta\chi^2$) test being significant, indicating that the model differs across the different groups (older and younger staff). Table 4.26 summarises the global test results. These results suggest that further investigation into the individual paths is necessary to determine the different moderating effects based on age.

***Table 4.26*** Global test results (older and younger staff)

| | $\chi^2$ | *df* |
|---|---|---|
| Unconstrained | 587.915 | 338 |
| Constrained | 617.858 | 345 |
| Difference | 29.943 | 7 |
| p-Value | 0.000 | |

The path coefficient which indicates the estimates of the moderating effect of age on the hypothesized relationships among the five constructs (PE, EE, SI, SD and BIU) were obtained from the structural model analysis and is listed in Table 4.27. Based on the Beta values of age, PE showed that the moderating effects were stronger for older staff (0.426***). EE showed that the moderating effects were stronger for older staff (0.501***). SI revealed that the moderating effects were stronger for younger staff (0.895***). Finally, SD was found to be stronger for younger staff members (0.256*) than older ones. The results indicate that hypotheses H6, H12 and H15 were not supported in this study. However, H9 was supported. The moderating effects of age on constructs FC and USE were not recorded or hypothesized in this study.

*Table 4.27* Structural Model Results (Moderators Younger staff and Older staff)

| Path (Hypothesis) | Older Beta | Younger Beta | Results/Interpretation |
|---|---|---|---|
| PE → Age → BIU (H6) | 0.426*** | 0.240 | Not supported. stronger for older staff than younger staff |
| EE → Age → BIU (H9) | 0.501*** | 0.248 | Supported. Only significant for older staff |
| SI → Age → BIU (H12) | 0.097 | 0.895*** | Not supported. Stronger for younger staff than older staff |
| SD → Age → BIU (H15) | -0.082 | 0.256* | Not supported. Stronger for younger staff than older staff |

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001 (Levels of significance)

Fig 4.6 presents the entire structural equation model results displaying the beta values for each of the hypothesized paths (listed in Tables 4.22, 4.24 and 4.26). These include the moderators (listed in Tables 4.24 and 4.26). The values within the black boxes represents female staff beta values and the white boxes are male staff beta values. Values in the heavily dotted box represents the younger staff beta values and the lightly dotted box represents the older staff beta values.

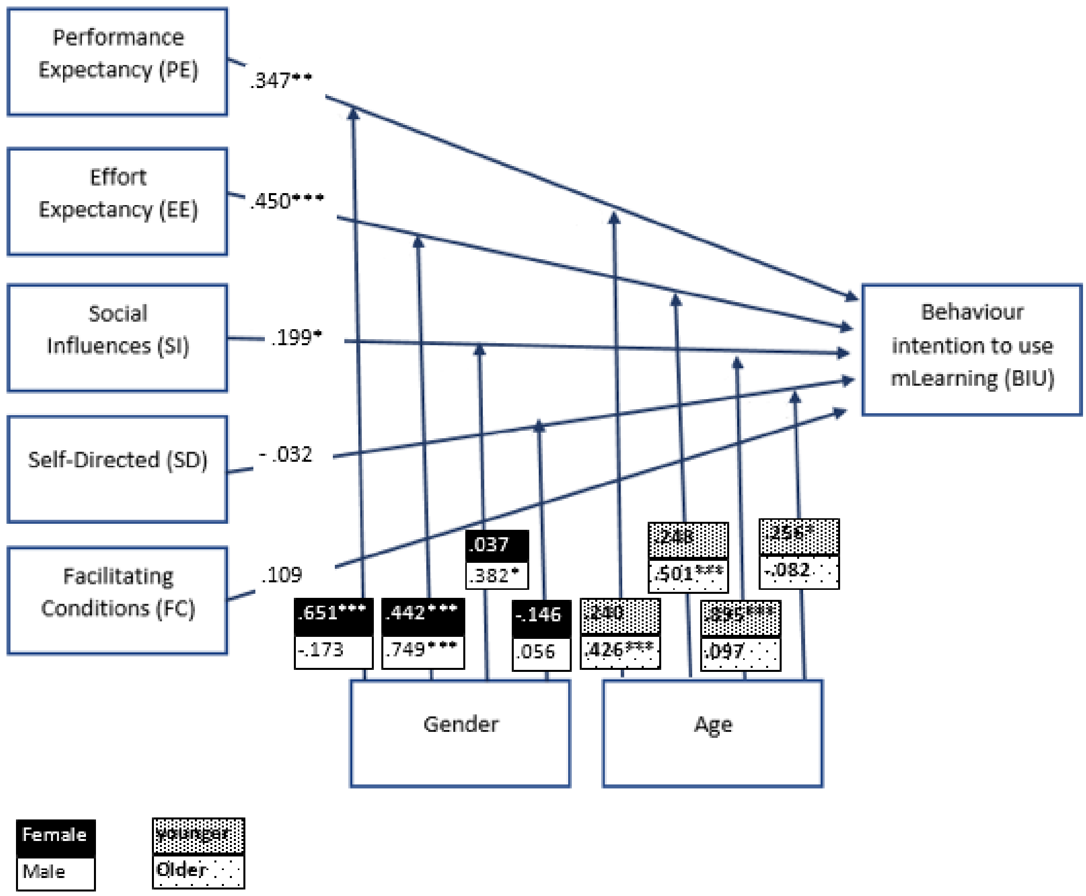



**Fig. 4.6**: Structural Equation Modelling results

### 4.9.3 UTAUT model explanatory power

Finally, regression models use $R^2$ statistic to measure the proportion of the variance for a dependent variable that is explained by the independent variable (Hair *et al*., 2014). $R^2$ values range from 0.0 to 1.00 and are typically represented as percentages, e.g., 0% to 100%. $R^2$ values equal to or greater than 0.75 are considered as substantial, those equal to or greater than 0.50 but below 0.75 are considered moderate and those that are around 0.25 are considered weak (Hair *et al*., 2014). The formula for the $R^2$ statistic is:

$$R^2 = 1 - \frac{RSS}{TSS}$$

Where $R^2$ is the coefficient of determination, *RSS* is the sum of squares of residuals and *TSS* is the total sum of squares.

In this study, the variables PE, EE, SI, SD, FC were the independent variables and BIU was the dependent variable. BIU also acted as the independent variable for the dependent variable, Use behaviour. Table 4.28 presents a summary of all the hypotheses that were advanced in the current study. The $R^2$ value of the behavioural intention was 0.875 and that of the USE was 0.683. Translating these values into explanatory power, behavioural intention was 87.5% whilst use was 68.3%. This means that the explanatory power of this model is greater than Venkatesh *et al*. (2003) research reporting 70% explanatory power.

***Table 4.28*** Summary of the results of all the hypotheses.

| Hypothesis | Result/Interpretation |
|---|---|
| H1 | Not supported. Gender and reporting ICT are not independent of one and other |
| H2 | Supported. Gender and reading knowledge articles are independent of one and other |
| H3 | Supported. Gender and reporting an ICT incident related to knowledge articles are independent of one and other |
| H4 | Supported. Performance expectancy has a positive effect on behavioural intentions to use mLearning |
| H5 | Not supported. Stronger for female staff than male staff. |
| H6 | Not supported. Stronger for older staff than younger staff |
| H7 | Supported. Effort expectancy has a positive effect on behavioural intention to use mLearning |
| H8 | Not supported. Stronger for male staff than female staff |
| H9 | Supported. Only significant for older staff |
| H10 | Supported. Social influence has a positive effect on behavioural intention to use mLearning |
| H11 | Not supported. Stronger for male staff than female staff |
| H12 | Not supported. Stronger for younger staff than older staff |
| H13 | Not supported. Self-directed learning has been found to be nonsignificant |
| H14 | Not supported. No difference |
| H15 | Not supported. Stronger for younger staff than older staff |
| H16 | Not supported. Facilitating conditions does impact behavioural intention to use mLearning |

## 4.10 Summary

The goal of this chapter was to report the findings from the analysis of the data from the tools available to SMG staff for just-in-time knowledge acquisition and reporting ICT incidents. It is acknowledged that the results of the analysis of SMG ICT training YouTube video views would not be as comprehensive as in the other sections of this chapter e.g., *Findings from the UTAUT survey for mLearning adoption*. This is because YouTube analytics provides the user with limited tools to perform in depth analysis. For example, YouTube analytics does not record information about the individuals who have viewed the video and if they have viewed it more than once. Additionally, the results from this analysis will not be as accurate as the analysis in the other sections of this chapter because YouTube occasionally runs algorithms that causes video view statistics to be reduced (Dsouza, 2016). Despite these limitations, the significance of these findings addressed the following research question.

**To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG?**

The findings from the analysis of the data from the tools available to SMG staff for just-in-time knowledge acquisition and reporting ICT incidents addressed the following research questions.

**What are the relationships between gender and reading ServiceNow knowledge articles?**

**What are the relationships between gender and reporting ICT incidents?**

Using Chi-square goodness-of-fit test, it has been established that there is no statistically significant relationship between gender and reading knowledge articles. The findings have shown that there is a significant but weak relationship between gender and reporting an ICT incident. These findings have established that female staff were more likely to report an ICT incident than male staff. Additionally, there is no significant relationship between gender and reporting an ICT incident related to the knowledge article read.

This chapter also presented the findings from the Structural Equation Modelling (SEM) analysis which is typically used to specify CFA models, regression models and path models. Seven common fit indices ($\chi 2/df$, GFI, IFI, TLI, CFI, RMSEA, SRMR) were used to determine how well the model fit with the data captured. The results concluded that all minimum acceptable thresholds for the various Goodness-of-fit indices were met.

Findings from the current research concluded that convergent validity was achieved based on three indicators. The first being the reliability of each construct. All alpha values were above the 0.7 threshold thus exhibiting good reliability. The second being the item reliability of each measure (standardised factor loading). Each of the standardised loadings were above the 0.30 threshold. Finally, the AVE. All AVEs were above the 0.5 threshold.

Findings from the analysis of discriminant validity using Gold *et al*. (2001) and Teo *et al*. (2008) Heterotrait-Monotrait (HTMT) 0.90 threshold as a criteria test found that the model achieved good discriminant validity. However, using Gaskin and James' (2019) HTMT Plugin for AMOS, found that BIU and USE constructs were statistically indistinguishable.

The findings from this analysis revealed the factors affecting mLearning adoption at SMG, based on the theories that underpin the adapted UTAUT model. These findings addressed the following research questions.

**What are the determinants of behavior intentions to use mLearning?**

**Does gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning?**

In order to ascertain the determinants of behaviour intentions to use mLearning at SMG and the moderating effects of gender and age, this study used an adapted UTAUT model and proceeded to analyse the data captured from 118 survey recipients. The survey was based on Venkatesh *et al*. (2003) UTAUT theoretical model. SEM was used to test the theoretical model and hypotheses advanced in this study. To test the theoretical model, and hypotheses in this study, a range of measurement tools (KMO, Maximum likelihood, AVE, Cronbach alpha, Common Marker Variable, Tolerance and Variance Inflation Factors, Path analysis, Multigroup analysis, $R^2$ statistics) were used to evaluate both the measurement model and the structural model.

The results, based on the beta and t-values of the constructs PE, EE and SI were found to be determinants of BIU at SMG. Surprisingly, based on the beta and t-value of the construct FC, FC was also found to be a statistically significant determinant of BIU with an alpha of 0.10. The beta and t-value of the construct SD, SD did not significantly predict behaviour intention to use mLearning. Interestingly, construct EE had the highest beta and t-value meaning it contributed the most positive affect on the outcome variable, BIU. This was then followed by the construct PE. The least contributing factor to predict behaviour intention to use mLearning at SMG was FC.

Based on the Beta values used to measure the moderating effects of gender, the construct PE showed that it was stronger for female staff. EE showed that the moderating effects were stronger for male staff. SI revealed that the moderating effects were stronger for male staff. Finally, SD was found to be non-significant. In addition, based on the Beta values of the moderating effects of age, the construct PE showed that the moderating effects were stronger for older staff. EE showed that the moderating effects were stronger for older staff. SI revealed that the moderating effects were stronger for younger staff. Finally, SD was found to be stronger for younger staff members.

This study aimed to advance 16 hypotheses. The first three were used to derive the results from an analysis of the data from the tools available to SMG staff that are used for just-in-time knowledge acquisition and reporting ICT incidents. The final 13 were used to determine factors and moderators that affect behaviour intentions to use mLearning at SMG. Starting with the first three hypotheses, based on the Chi-square difference test, H2 and H3 were supported while H1 was not supported.

The results from the SEM analysis of the UTAUT Model found that regarding the determinants of behaviour intentions to use mLearning at SMG, hypotheses H4, H7, H9 and H10 were supported in this study.

The results indicate that hypotheses H5, H6, H8, H11, H12, H13, H14 and H15 pertaining to the two moderators (gender and age) were not supported in this study.

H16 was not supported because it was hypothesized that FC does not impact behavioural intentions. However, it was found to be a statistically significant determinant of behaviour intentions to use mLearning at SMG. Despite this, FC was not hypothesized as affecting USE in the current study, it was tested in the overall evaluation of the structural model. This test reviewed that FC had a negative relationship to USE. BIU to USE indicates that BIU has a large influence on the construct USE.

The following chapter presents a discussion of the findings from this chapter and the original contribution to the body of knowledge pertaining to mLearning, UTAUT and its implications to ICT Service desk practice.

# Chapter 5. Discussion

This chapter provides an evaluative discussion of the findings from the analysis of data from the tools available to SMG staff that are used for just-in-time knowledge and ICT incident reporting such as ServiceNow™ reports. This is for the purpose of addressing research questions 1, 2 and 3. The second phase of this study utilised the modified UTAUT model to address research questions 4 and 5. More specifically, it examines how this study addressed its primary goals. This chapter also outlines the unique contributions to ICT Service desk management practice, mLearning in the work environment and the use of the UTAUT model and its moderators to investigate the determinants of mLearning adoption in the museum context. This discussion is broken down into the two phases in which this study was carried out. Section 5.1 presents a discussion on the findings from the analysis of the data from the tools available to SMG staff that are used for just-in-time knowledge acquisition and reporting ICT incidents. Section 5.2 presents a discussion of the results of the modified UTAUT model used to examine the determinants that predict mLearning adoption at SMG. In sections 5.1 and 5.2 there are also discussions about the comparisons and contrasts that were drawn between what the research found and what the literature suggested would be expected. Section 5.3 concludes this chapter.

## 5.1 Analysis of data from just-in-time knowledge acquisition SMG tools

The primary goals of the first phase of the research were to investigate the data from the tools used by SMG staff for just-in-time knowledge acquisition for the purposes of contributing to the effective management of ICT support calls at SMG. Additionally, this phase of the research examined ICT incident reporting. The primary research aim was achieved by the following research objectives:

- To analyse data from the tools available to SMG staff that can be used for mLearning.
- To analyse ServiceNow SMG’s Information Technology Service Management (ITSM) solution reports, categorizing support calls into training and non-training related groups.

- To analyse ServiceNow reports to determine if the use of mLearning could resolve support call issues.
- To measure the impact that using mLearning has on the frequency of ICT support calls relating to training issues.

This section discusses the findings from the first 3 research questions which were derived from the first phase of the current research.

- ***RQ1:*** To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG?
- ***RQ2:*** What are the relationships between gender and reading ServiceNow™ knowledge articles?
- ***RQ3:*** What are the relationships between gender and reporting ICT incidents?

This discussion explains findings from the analysis of the ITSM solution incident reports and the reports from the knowledge articles. These findings are valuable as they help to fill the gap in knowledge about the relationship between gender and the usage of the ICT Service desk provisions that have not been previously reported. These insights contribute to ServiceDesk management practice at SMG. Moreover, these insights can contribute to ServiceDesk management practice in general. This knowledge can be beneficial to other organisations within or outside of the culture and heritage sector as it will help management explore relationships between gender and ICT usage within their organisations.

***RQ1:*** To what extent is mLearning currently being used for the effective management of incoming IT support inquiries at the SMG?

2728 reported ICT incidents have shown that knowledge articles had been viewed and continue to be viewed by some SMG staff. This is evidence to suggest that the use of knowledge articles at SMG is valuable to staff. This research presents a case for the ICT Service desk management team to review the current stock of knowledge articles so that some can be decommissioned, and new ones created. This insight would also be useful to other organisations who use knowledge articles for the acquisition of knowledge as it confirms that they are beneficial to staff. Therefore, the knowledge articles should be kept up to date and relevant so that they can be effective in reducing IT support inquiries. It was observed that out of 2728 reported incidents, 491 (18%) of them would have benefited from an mLearning intervention such as an adapted knowledge article (See Chart 5.1). Additionally, this research presents a case for an upgrade of the current ICT Service desk portal. Many of these modern ICT Service desk portals have added features such as intelligent bots and features that better support mobile devices. Thus, presenting an opportunity to drive up knowledge article usage and reducing incoming ICT Service desk calls pertaining to ICT training related incidents. These findings are significant as they contribute to the broader context of ICT Service desk management practice by providing data driven insights. These findings are useful to other organisations using an ITSM portal for the purposes of knowledge management and ICT incident reporting because the insights from this study have been empirically tested.

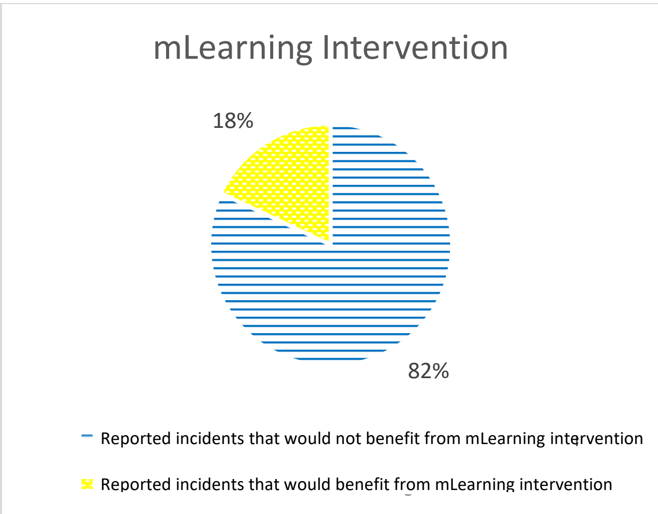



***Chart 5.1*** Percent of incidents benefitting from mLearning intervention

***RQ2:*** What are the relationships between gender and reading ServiceNow™ knowledge articles?

Based on 1145 individuals (female: 741, 64.7%; male: 404, 35.3%) who read knowledge articles, (see Chapter 4,) results from Table 4.6 which lists the results from the test of independence carried out via a Chi-square difference ($\Delta\chi^2$) test used to examine the relationship between gender and reading knowledge articles. See Chart 5.2 for percentage of staff who read knowledge articles. The p-value was 0.256 with an α of 0.005, the Chi-square statistic (1.28839179256577) was less than the Chi-square critical value (3.841) with 1 *df.* This suggests that there is not a statistically significant relationship between gender and reading knowledge articles. This means that neither gender perceive this type of knowledge sharing negatively and therefore both male and female staff members at SMG are equally likely to read knowledge articles if the information is useful.

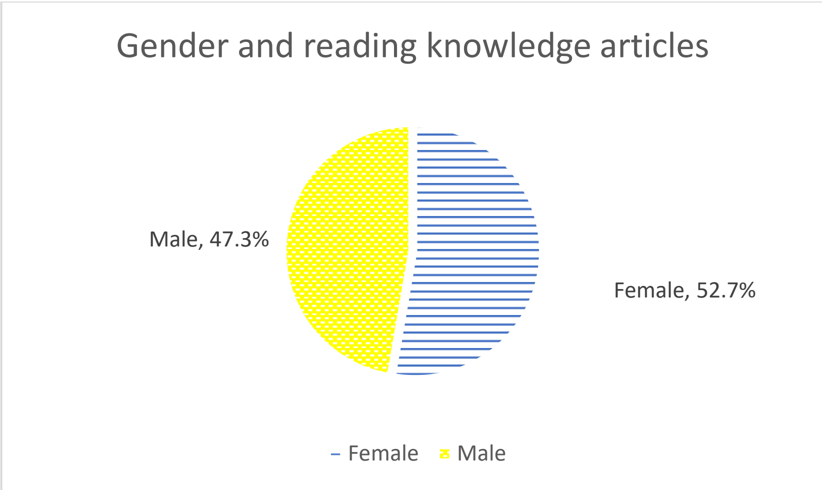



***Chart 5.2*** Percent of staff reading knowledge articles (by gender)

This finding is supported by Lin and Huang's (2008) research on determining the key factors affecting KMS usage in IT. Their research found that despite having more male than female participants in their study, there were no significant difference between male and female KMS usage. However, these findings are contrary to the findings of Connelly and Kelloway's (2003) research which propounds that female employees perceive knowledge sharing culture differently than their male counterparts. In their research, female participants were found to require more positive social interaction culture before they would perceive knowledge sharing as positive. Equally, findings from Abukhait *et al*. (2019) whose research on knowledge sharing and innovative behaviours observed that females were cautious and less likely to share knowledge with others. Therefore, perceiving knowledge sharing negatively. However, their research also showed that empowered females were more willing to engage in knowledge sharing.

Meaning that if the environment is positive, they are more likely to perceive knowledge sharing positively. In the current research, there is no significant relationship between gender and reading knowledge articles. The potential impact of these findings on ITSM practice at SMG is that there is not much need to target a specific gender when communicating the benefits of knowledge articles usage to SMG staff. Moreover, regarding the wider context of the discipline, if there are enough knowledge articles that provide guidance on resolving ICT issues, ICT Service desk staff would be able to spend less time resolving training related issues. The time saved can be used on value adding activities such as improving ICT Service desk staff customer service skills or resolving network and software related issues. This insight would also be useful to other organisations who are exploring gender relationships and reading knowledge articles. The knowledge in the current research will help management in those organisations to find possible solutions for exploring and finding explanations for gender relationships and reading knowledge articles.

***RQ3:*** What are the relationships between gender and reporting ICT incidents?

Based on 1145 individuals (female: 741, 64.7%; male: 404, 35.3%) captured who reported ICT incidents, (see Chapter 4,) results from Table 4.10 which lists the results from the test of independence carried out via a Chi-square difference ($\Delta\chi^2$) test used to examine the relationship between gender and reporting ICT incidents. See Chart 5.3 for percentage of staff who reported ICT incidents. The p-value was 0.005 with an $\alpha$ of 0.005, the Chi-square static (7.736780592171) was greater than the Chi-square critical value (3.841) with 1 *df*. This suggests there is a statistically significant relationship between Gender and reporting ICT incidents. This means that male staff members at SMG are more likely to attempt and resolve ICT related issues than female staff members at SMG. Therefore, males are less likely to need to report ICT incidents to ICT Service desk staff unless they perceive the incident to be necessary to report or unable to solve the problem themselves.

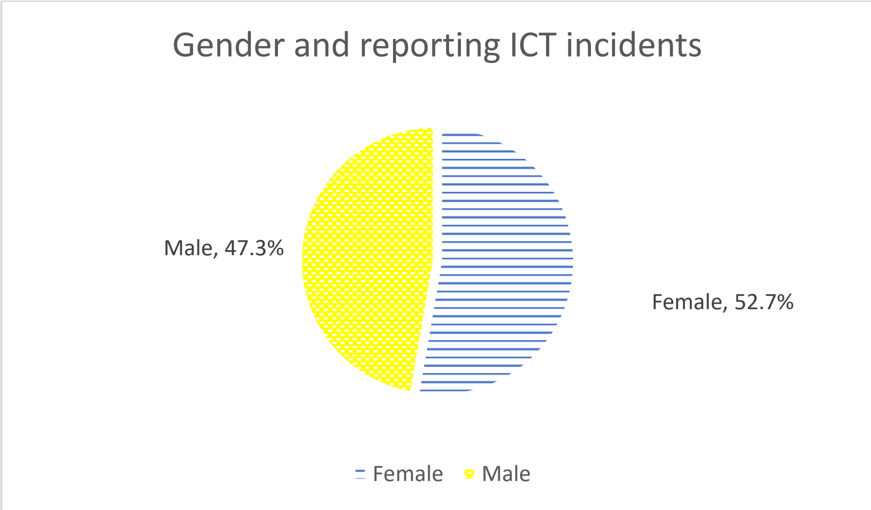


***Chart 5.3*** Percent of staff reporting ICT incidents (by gender)

The findings from the current study support the findings from numerous research (Addis and Mahalik, 2003; Good *et al*. 1989; Wasylkiw and Clairo, 2016) that argue men are unwilling to seek help from professionals. Wasylkiw and Clairo (2016) argue that this is due to masculinity and conformity to social norms in particular, in the areas of psychology and mental health concerns. The results from the analysis of gender and reporting ICT incidents found that there is a significant but weak relationship between gender and reporting an ICT incident. Female staff are more likely to report ICT related incidents than male staff. The reason for this is perhaps, male staff at SMG typically conform to traditional masculine norms e.g., responsibility, self-agency, and self-reliance (Farrimond, 2012) as part of their occupational identity. Thus, partially viewing this method of help seeking negatively.

The results from this study indicate that gender plays a role in the reporting of ICT incidents at SMG. Female staff members are more likely to report low-level to mid-level ICT incidents than their male counterparts. ICT Service desk staff should seek to promote the use of knowledge articles to non-ICT staff. The findings from this study present several valuable contributions to mLearning research and ITSM practice at SMG and the broader context of ITSM practice. For example, ICT skills workshops or lunch and learn activities could be promoted to encourage more female SMG staff to develop their ICT skills so that they become more confident in resolving ICT related issues themselves.

This would equally benefit any organisation inside or outside of the cultural heritage sector that operate an ICT service desk function. This is because those staff could benefit from the additional confidence gained from learning to build ICT skills. It is acknowledged that offering ICT skills workshops alone will not eradicate disparities among female and male SMG staff regarding ICT skills. However, it will help to reduce the digital divide amongst staff by empowering more female staff with more skills and confidence than they currently have to solve ICT incidents themselves.

***RQ2:*** What are the relationships between gender and reading ServiceNow™ knowledge articles?

***RQ3:*** What are the relationships between gender and reporting ICT incidents?

Based on 2728 reported incidents, (Chapter 4,) results from Table 4.13 which lists the results from the test of independence carried out via a Chi-square difference ($\Delta\chi^2$) test used to examine the relationship between gender and reporting ICT incidents related to knowledge articles. The p-value was 0.054 with an $\alpha$ of 0.005 the Chi-square statistic (3.70197417191808) was less than the Chi-square critical value (3.841) with 1 *df*. This signifies there is not a statistically significant relationship between gender and reporting ICT incidents related to knowledge articles.

The findings from the analysis of ICT incident reports and the knowledge articles report found that there was no significant relationship between gender and reporting an ICT incident related to the knowledge article read. These findings are congruent, in part with Lin and Huang's (2008) research on determining the key factors affecting KMS usage in IT. Their research found that despite having more male than female participants in their study, there were no significant difference between male and female KMS usage. Despite having the opposite male to female ratio than Lin and Huang’s (2008) research participants (e.g., more females than males), in the current study, both male and female staff at SMG are equally likely to report an ICT incident that is related to the knowledge article they have read. This is perhaps because many of the ICT incidents are related to tasks that only the ICT Service desk team can perform. For example, one of the most popular knowledge articles read is Remote working. This knowledge article outlines the equipment needed to work from home with a step-by-step guide on how to use the hardware and software. Yet, many staff members need to contact the ICT Service desk team to have their SMG accounts configured to work with SMG's Virtual Private Network (VPN). Similarly, many staff members who have worked from home have requested assistance with resetting their passwords. Although, many of these staff have read the knowledge article on how to reset passwords and unlock their accounts, they still need to contact ICT Service desk staff to reset passwords and unlock their accounts. The steps described in the knowledge article only work when physically connected to the SMG network and not when connected to your personal broadband. Therefore, non-ICT staff still need to contact ICT Service desk staff to get their passwords reset as in these situations, it can only be achieved by ICT Service desk staff.

## 5.2 Factors that determine employees' behavioural intention to use mLearning

This section presents a discussion of the results of the modified UTAUT model used to examine the determinants that predict behaviour intention to adopt mLearning at SMG. This discussion consists of an in-depth examination of the individual UTAUT constructs and moderators used in the current study. Additionally, in this section there are discussions about the comparisons and contrasts that were drawn between what the current research found and what the literature suggested would be expected.

The specific aims and objectives of this phase of the study were to analyse questionnaire data using a series of statistical approaches to determine the correlation among the variables in the questionnaire to ascertain contributing factors to mLearning adoption at SMG. The goals of the second phase of the research were achieved by the following research objectives:

- To examine various considerations in andragogical practice, i.e., Self-directed learning.
- To analyse questionnaire data and determine the use of mLearning in SMG.

- To analyse questionnaire data and determine factors contributing to mLearning adoption at SMG.

- To provide recommendations to the SMG's Senior Management team for improving the implementation and adoption of mLearning in the SMG in order to achieve operational objectives.

This section addresses the last two research questions which were based on the results of the data captured from the proposed extended UTAUT model that was empirically tested through a series of SEM steps and processes.

***RQ4***. What factors determine SMG employees' behavioural intention to adopt and use mLearning?

***RQ5.*** To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?

These results were derived from the second phase research objectives. The results from this study show that performance expectancy, effort expectancy, social influence and facilitating conditions are all significant determinants of behavioural intention to use mLearning. Surprisingly, the newly proposed construct, Self-directed learning was not a significant determinant of behaviour intentions to use mLearning. The findings of this study present several unique contributions to research using the UTAUT model, mLearning research and ICT Service desk practice at SMG. These contributions will be discussed further in the sections that follow.

Previous research on the UTAUT model (e.g., Alaba *et al*., 2020; Chao, 2019; Onaolapo *et al*., 2018) has used various combinations of UTAUT constructs to explain the impact on the endogenous/dependent variable, such as behaviour intentions or Use behaviour. Other researchers (e.g., Hong *et al*., 2011) have integrated UTAUT with other theoretical models for example, Information System (IS) continuance model. In this study, the use of UTAUT constructs performance expectancy, effort expectancy, social influence, and facilitating conditions was used and integrated with Self-directed learning to address the following research question.

***RQ4***. What factors determine SMG employees' behavioural intention to adopt and use mLearning?

The follow sections will discuss each of the UTAUT constructs as well as the added construct, self-directed learning in more detail.

### 5.2.1 Performance expectancy

Performance expectancy is defined as the degree to which individuals believe using mLearning will help him or her attain gains in job performance (Venkatesh *et al*. 2003). Performance expectancy survey items in this study addressed productivity, accomplishing tasks more quickly and the increased chance of promotion. The findings from both this and previous research suggest that performance expectancy is essential to a user's intention to use mLearning because perceived usefulness of mLearning will help individuals improve their performance.

The results obtained from this study indicate performance expectancy is the second strongest positive predictor of behaviour intention to use mLearning (β0.347) and was found to have a greater level of significance than in the research carried out by Nassuora (2012) and Alharbi *et al*. (2017). The current study's findings are corroborated by prior mLearning and UTAUT research in universities by Nassuora (2012) (β0.112) and Alharbi *et al*. (2017) (β0.287). A possible reason why this was found to be one of the strongest significant predictors in this study is because this construct is affected by an individual's perception of system responsiveness and the system's response time (Weber, 2012). The significance of this is that an individual's high values of performance expectancy will tend to be associated with high values of behavioural intention. These high values of performance expectancy exhibited in the data collected from SMG staff can be attributed to their current experience of other high-performance technology within the museum.

The results from this study are inconsistent with research from Cheng *et al*., (2011) who do not support these findings. Cheng *et al*., (2011) research did not find Performance expectancy to be a significant predictor of behaviour intention to use mLearning. This is perhaps because, unlike staff at SMG, the Taiwanese staff and managers felt they would not benefit from using mLearning to aid their work performance. These findings are significant as they help to expand the body of knowledge regarding the use of the UTAUT model for investigating determinants of mLearning in the workplace. Furthermore, it highlights the different purposes for mLearning usage. In the current study, staff use mLearning for just-in-time knowledge acquisition for resolving ICT related incidents. Thus, these results present unique insights as they reveal the divergence of work contexts, resulting in this variety of strengths and significances of performance expectancy as a predicator of behaviour intention across various countries and demographics.

Accommodating staff with high performance expectations, requires creators of knowledge articles to consider the development of valuable and up-to-date content. System developers need to optimise the system so that relevant knowledge articles are served to the user. ICT Management will need to maintain records of usage so that out-of-date knowledge articles can be retired, and newer more reliant ones can be created. Additionally, the knowledge articles need to be responsive to mobile devices with varying screen sizes and resolutions. Previous research has identified screen sizes and resolutions as barriers to adoption (Alharbi *et al*., 2017; Sian, Lim and Shen, 2001; Yousafzai *et al*., 2016).

### 5.2.2 Effort expectancy

Effort expectancy is the extent to which an individual perceives the degree of ease associated with using or learning to use mLearning (Venkatesh *et al*., 2003). Effort expectancy survey items in the current study addressed clarity and quality of the materials as well as the ease of becoming skilful at operating the system. The findings from both this and previous research suggest that effort expectancy is essential to user's intention to use mLearning because the perceived ease of use and low levels of complexity will help shape their engagement with mLearning.

The results obtained from the quantitative findings in this study indicate effort expectancy is the strongest positive predictor of behaviour intention to use mLearning (β0.460) and was found to have a greater level of significance than in the research carried out by Nassuora (2012) and Alharbi *et al*. (2017). These results in the current study suggest that the more effort SMG staff members feel they must devote to using mLearning technologies, the less likely they are to accept it. Thus, making it an important factor to consider when adopting mLearning technologies. The findings in the current study are supported by prior mLearning research by Nassuora (2012) (β0.279) and Alharbi *et al*. (2017) (β0.453). A possible reason why this was found to be one of the strongest significant predictors in this study is because this construct is affected by early stages of new behaviour/experience and an individual's perception of overcoming hurdles (Davis *et al*. 1989; Szajna 1996; Venkatesh and Speier, 1999; Venkatesh *et al*., 2016). These high values of effort expectancy exhibited in the data collected can be attributed to staff's perception of this novel approach to just-in-time learning intervention for museum staff that has never been carried out by any UK museum.

The results from this study are inconsistent with research from Jambulingam (2013) on mobile technology in the learning environment in Malaysia and Thomas *et al*. (2013) on mLearning adoption in higher education in Guyana who do not support these findings. This is perhaps because participants in Jambulingam's research were fully familiar with mobile devices and the various ways they can be used. Thomas *et al*.'s research participants felt that the usefulness of the technology was more important in determining intention to adopt mLearning than how easy they were to use. This is a unique context as both studies are in the milieu of universities and the opinions of students are being investigated. Most of the previous research on mLearning are within this context, albeit in other countries. These results are significant as they highlight some of the unique differences between the work-place environment of a UK museum and the university environment. For example, in the work-place environment new knowledge can be transformed into practice. Whereas in an academic environment, new knowledge is applied to academic assignments (Le Maistre and Paré, 2004). This is perhaps the reason for the inconsistency in the results. Students may not place an emphasis on the ease of learning to use mLearning for knowledge acquisition due to the context of what the new knowledge is being applied to.

To support staff who believe that mLearning system should be easy to use, it is suggested that educational designers focus on simplicity of system navigation. Thus, making the system user friendly and intuitive for more novice users. Additionally, accessibility standards and guidelines need to be adhered to. It would also be helpful if staff had a range of formats to cater for different learning styles, e.g., visual, and auditory (Barbe and Milone, 1981). Staff would also benefit from being trained in the use of mLearning for just-in-time knowledge acquisition. All data entry actions need to be simplistic, requiring very little effort from the user.

### 5.2.3 Social influence

Social influence in this study is understood to be the degree to which an individual perceives that important staff such as managers and other colleagues believe he or she should use the new system (Venkatesh *et al*., 2003). The Social influence survey items addressed professionally valued opinions of colleagues and those who can influence behaviours at work. The findings from both this and prior research suggest that social influence is essential to a user's intention to use mLearning because social factors and image plays a role in their use of mLearning.

The results obtained from this study indicate social influence is the third strongest positive predictor of behaviour intention to use mLearning (β0.199) and was found to have a similar level of significance as research conducted by Wang *et al*. (2009) (β0.12). Research by Cheng *et al*. (2011) (β0.54) and Al-Adwan *et al*. (2018) (β0.201) was found to have social influence as a stronger positive predictor of behaviour intention than the current research. A possible reason why social influence was found to be one of the least strongest significant predictors in this study is because this construct is impacted by an individual's opinion of people or groups that are influential to them or who are admired by them. However, Morris and Venkatesh (2000) states that social influences decline with experience of the technology. These lower values of social influence exhibited in the data collection reflect this notion as 59% of SMG staff already have experience of using mobile phones for knowledge acquisition.

This study's findings were not consistent with findings from Jambulingam (2013) and Jackman (2014) who do not support these findings. This is because Jambulingam's research participants did not need to be influenced by their peers as many of them are members of a generation that would have encountered technology, early in their lives. In contrast to Jambulingam's study, 33% of participants in this study are over the age of 40. Thus, not from the digital generation (Barone, 2005) or born between approximately 1980 and 1994 (Bennett *et al*., 2008). Therefore, would not 'have grown up using technology and internet' (Hockly, 2011, p. 322). These results are significant as they demonstrate the variety in the strengths and significances of social influence as a predicator of behaviour intention across various countries and demographics.

Early adopters in the form of line managers and technological champions at SMG can be used to form powerful coalition that is able to communicate the usefulness of mLearning for just-in-time knowledge acquisition. They help to remove barriers to change through demonstration and coaching. Early adopters help to steward their colleagues through the change by raising the number of mLearning users to reach a critical mass point, leading to self-sustaining growth (Wenger *et al*., 2009). The early adopters may begin to convince their colleagues of the benefits and application. Additionally, as new employees join the organisation the use of mLearning should be advertised to them as well as embedded in various processes as and when they are introduced to the new process.

### 5.2.4 Facilitating conditions

Facilitating conditions in this research is the degree to which an individual believes that organisational and technical infrastructure exists to support the use of mLearning (Venkatesh *et al*. 2003). Facilitating conditions survey items address favourable conditions, technological infrastructure, and management support. The findings from both this and past research suggest that facilitating conditions is essential to user's intention to use mLearning because the degree to which an individual perceives the environment both technologically and supportively void of impediments will influence their use of mLearning.

The results obtained from this study reveal that facilitating conditions is the weakest positive predictor of behaviour intention to use mLearning (β0.109) and was found to have a lower level of significance than in the research carried out by Thomas *et al*. (2013) (β0.397) and Jackman (2014) (β0.238). The findings for facilitating conditions as the weakest positive significant predictor of behaviour intention to use mLearning is unique and not supported by prior reviewed mLearning studies using the UTAUT model. Both Jackman (2014) and Thomas *et al*. (2013) research show strong beta values for this construct. A possible reason why this was found to be the weakest significant predictor is because this construct is affected by the experience of the individual sourcing several opportunities to get help and support to use this novel intervention (Venkatesh *et al*. 2003). This is reflected in the mobile device usage survey items where only 19% of staff have used a mobile device to access SMG knowledge articles or ICT Training YouTube channel. Despite the low numbers of staff using the mobile devices to access SMG knowledge articles, many staff have already experienced the professional but overstretched SMG's ICT Service desk for other ICT related issues. Thus, SMG staff do feel slight apprehension about the opportunities of help and assistance available to support this novel use of mLearning at SMG.

The results from this study with regards to facilitating conditions being a positive predictor of behaviour intention to use mLearning are inconsistent with research from Jambulingam (2013) and Alharbi *et al*. (2017) who do not support these findings. This is perhaps because unlike Jambulingam's (2013) research participants who can 'use gadgets without referring to the user manual' (p. 1268), many of SMG staff need support to work with technology. These findings present interesting yet conflicting results. Contrary to Venkatesh *et al*. (2003) UTAUT research that claims, 'when both performance expectancy constructs and effort expectancy constructs are present, facilitating conditions becomes nonsignificant in predicting intention' (p. 454). The findings from this research have shown that both performance expectancy and effort expectancy are present and significant predictors of behaviour intentions. These findings are significant because they contribute to the expansion of the body of knowledge regarding the UTAUT model.

The role of technological and organisational infrastructure influences mLearning adoption therefore it is key that ICT support staff, senior management and ICT technology provides a reliable means for staff to use mLearning. It is imperative that support is readily available to staff who face problems using the system as this may undermine adoption efforts. Moreover, if SMG and management made it demonstrable that they support the use of mLearning, this would help to bolster adoption.

### 5.2.5 Self-directedness

Self-directedness is the degree to which an individual takes initiative over their learning with or without the assistance of others (Brookfield, 1985). Self-directedness survey items in this research address both autonomous learning and self-discipline. The findings from previous research suggest that self-directedness is essential to a user's intention to use mLearning because learners need to control their own learning when engaging with learning materials independently of teachers or trainers (Al-Adwan *et al*., 2018). Wang *et al*. (2009) claims that those with self-directedness are highly likely to engage with mLearning activities.

The results obtained from this study reveal self-directedness as a nonsignificant predictor of behaviour intention to use mLearning (β -0.032). The lack of effect of self-directedness on behaviour intentions to use mLearning is unique to this study as numerous scholars (Wang *et al*., 2009; Al-Adwan *et al*., 2018) found that self-directedness predicts behavioural intention to use mLearning.

These findings are surprising as collectively 80% of the respondents in this research have either Bachelor or Postgraduate degrees, suggesting highly autonomous learning capabilities. There are numerous reasons for this unexpected nonsignificant finding. A possible explanation might be due to staff not considering self-directedness as playing a role in using mobile devices for just-in-time knowledge acquisition. Perhaps, another reason why self-directedness was nonsignificant in this study is because the wording and focus of the scale items may not be familiar to the participants. Thus, not appearing to be related to using mobile devices for learning. Unlike the other survey items, these questions did not include the term mLearning. A further reason may be because individuals with high levels of learning abilities are more likely to be inclined to use formal educational channels, such as eLearning, printed text, or traditional offline teacher-led classroom sessions. These results are significant as they broaden the understanding of the UTAUT model in the context of mLearning.

The findings in this research are significant because they expand the understanding of the UTAUT model. This was achieved by integrating a new exogenous mechanism, self-directedness with the UTAUT model's original four constructs, to examine the drivers of SMG staff acceptance of mLearning as a just-in-time knowledge acquisition tool. Furthermore, this study's findings present a unique understanding of the determinants of behaviour intentions based on a novel environment such as a UK museum. This study is useful to other UK museums desirous to implement mLearning for just-in-time knowledge acquisition for their staff.

### 5.2.6 Moderating variables

Some previous UTAUT research has included a variety of moderating variables to investigate the moderating effect on a variety of UTAUT exogenous variables, when explaining their effect on the endogenous variable. The use of moderating variables gender and age were used in this study to address the following research question.

***RQ5.*** To what extent does age or gender moderate factors that affect employees' intention to adopt and use of mLearning?

#### 5.2.6.1 Gender

Gender, in this study was divided into two groups: male (42%) and female (58%) based on the self-identification of the research participants. Chapter 4, Table 4.24 lists the results of the global multigroup comparison test carried out via a Chi-square difference ($\Delta\chi^2$) test with constraint and unconstraint models to examine the significance of moderation of gender. The p-value 0.052 suggests that there are statistically significant gender differences in the moderation of the factors that determine behavior intentions to use mLearning as a just-in-time knowledge acquisition tool.

The path coefficients and their significance are outlined in Chapter 4, Table 4.25 indicating the moderating effects of gender on behaviour intention to use mLearning as a just-in-time knowledge acquisition tool.

The results obtained from this study indicate performance expectancy was stronger for female staff (β 0.651). This suggests that female SMG staff are more likely to believe that using mLearning will help them attain job performance gains then male SMG staff. These findings agree with previous research by Wang *et al*. (2009) who reported performance expectancy was stronger for females (β 0.317). This is perhaps because in the context of SMG, female staff adoption of mLearning for just-in-time knowledge acquisition is dependent on its perceived usefulness. Conversely, these findings are contrary to past research conducted by Bandyopadhyay and Fraccastoro (2007) who reported performance expectancy was stronger for male professionals and university staff members.

In this study, effort expectancy was stronger for male staff (β 0.749) than female staff. This suggests that male SMG staff are more likely to adopt mLearning if it is perceived to be easy to use or learn to use. These findings are supported by previous research by Wang *et al*. (2009) who reported effort expectancy was stronger for males (β 0.224). This may be because this group of male staff anticipates hurdles to be overcome at this early stage of this new behaviour. Therefore, making effort expectancy stronger for them. These findings are contrary to prior research conducted by Bandyopadhyay and Fraccastoro (2007) who reported performance expectancy was stronger for female professionals and university staff members. Similarly, Al-Adwan *et al*. (2018) reported performance expectancy was stronger for female university students.

Results from the current study show social influence was stronger for male staff (β 0.382) than female staff. This suggests that social factors and image are more important to male SMG staff than female staff and thus male staff are more likely to adopt mLearning based on this factor. These findings are confirmed by previous research by

Wang *et al*. (2009) who reported social influence was stronger for males (β 0.224). This is perhaps because this group of female staff in the early stages of experience with mLearning are less likely to be influenced by individual early adopters. Conversely, these findings were unexpected and contrary to earlier research conducted by Cheng *et al*. (2011) who reported social influence was stronger for females.

The results obtained from this study indicate self-directed learning was a non-significant predictor of behavior intention to use, there were no statistically significant differences between male and female staff. This means that staff who take initiative over their learning with or without the assistance of others has no bearing on the adoption of mLearning regardless of gender. The findings are contrary to past research by Wang *et al*. (2009) who reported self-directed learning was stronger for females (β 0.337). This is because 84% of the SMG workforce hold undergraduate and postgraduate degrees suggesting they have strengthened their capabilities of self-directedness. For example, perception of self-directedness among SMG staff was not seen to meaningfully affect behaviour intentions to adopt mLearning. Thus, further contributing to the understanding of mLearning research and the use of the UTAUT model.

#### 5.2.6.2 Age

Age in this study was divided into two groups: the older group consisted of ages greater than 30 years (63%) and the younger group with ages less than or equal to 30 years (37%). Chapter 4, Table 4.26 lists the results of the global multigroup comparison test that was carried out via a Chi-square difference ($\Delta\chi^2$) test with constraint and unconstraint models to examine the significance of the moderation of age. The p-value 0.000 signifies that there are statistically significant age differences in the moderation of the factors that determine behavior intentions to use mLearning as a just-in-time knowledge acquisition tool.

The path coefficients and their significance outlined in Chapter 4, Table 4.27 show the moderating effects of age on behaviour intention to use mLearning as a just-in-time knowledge acquisition tool.

The results obtained from this study indicate performance expectancy was stronger for older staff (β 0.426) than younger staff. This suggests that older SMG staff are more likely to believe that using mLearning will help them attain job performance gains then younger SMG staff. These findings are substantiated by previous research by Bandyopadhyay and Fraccastoro (2007) who reported performance expectancy was stronger for older people (β 0.301). The rationale for this could be that many of the older SMG staff have been working for SMG for numerous years and have become accustomed to the high-performance technology provided by the SMG technical team. Conversely, these findings are contrary to earlier research conducted by Wang *et al*. (2009) who reported performance expectancy was stronger for younger people.

The results from the current study suggest effort expectancy was stronger for older staff (β 0.501) than younger staff. This suggests that older SMG staff are more concerned with the ease of use and are likely to adopt mLearning if it is perceived to be easy to learn to use. These findings are corroborated by past research by Wang *et al*. (2009) who reported effort expectancy was stronger for older people (β 0.301). This is perhaps because according to Venkatesh *et al*. (2003) older staff have been shown to be associated with having difficulty in processing complex operations. Therefore, older staff members may perceive this novel way of acquiring knowledge as difficult. These findings are contrary to earlier research conducted by Bandyopadhyay and Fraccastoro (2007) who reported performance expectancy was stronger for younger people.

In this study, the social influences construct was found to be significant for only younger staff (β 0.895). This suggests that social factors and image are more important to younger SMG staff than older staff and thus younger staff are more likely to adopt mLearning based on the influences of other more influential and senior ranked staff members. These findings are contrary to previous research by Wang *et al*. (2009) and Cheng *et al*. (2011) who reported social influences being stronger for older people (β 0.213) and (β 0.63), respectively. This is perhaps because younger staff members constitute 37% of SMG workforce. This group may have recently joined the workforce and are unfamiliar with this novel use of mobile devices in a formal setting for the purposes of knowledge acquisition. Perhaps this group of staff members have been chastised for or prohibited from using mobile phones in the classrooms at school, college, or university. Thus, making this significant for younger staff in their early stages of work experience (Venkatesh *et al*., 2003) and the adoption of mLearning.

The results obtained from this study indicate that although self-directedness was a nonsignificant determinant of mLearning it was only significant for younger staff (β 0.256). This is perhaps because younger staff have developed highly capable autonomous learning abilities. These findings are contrary to earlier research by Wang *et al*. (2009) who reported self-directedness as being stronger for older people (β 0.337).

## 5.3 Summary

This chapter presents a discussion on the findings of this research work and provides the explanation and justification for the three broad objectives and 16 hypotheses being investigated. The discussions present comparisons and contrasts that were drawn between what the research found and what the literature suggested would be expected. The aim was to fulfil the three broad objectives of this research. Objective one, involves determining which staff members have the tendency to report an ICT incident. The role of ICT incident reports was to catalogue all ICT incidents that were reported by staff. This established the relationship between gender and reporting an ICT incident. It was found that female staff were more likely to report an ICT incident than male staff.

The second objective of the study involves an analysis of the ITSM knowledge articles to determine which staff members have the tendency to read them. The role of knowledge articles in the current study is to provide staff who have ICT related issues with just-in-time knowledge to solve those issues themselves, rather than calling ICT service desk staff to resolve their issues. This indicates a relationship between gender and reading knowledge articles. It was observed that both genders are equally likely to read knowledge articles. Furthermore, both genders are equally likely to report an ICT incident related to the knowledge article that they have read.

The final objective involves deriving models for the use of mLearning as a form of just-in-time knowledge acquisition tool to confirm that performance expectancy, effort expectancy, social influence and facilitating conditions influence behavioural intention to use mLearning as a knowledge acquisition tool. This was achieved through the SEM analysis which is used to specify CFA models, regression models and path models. Furthermore, Performance expectancy is stronger for older female staff than any other group. Additionally, effort expectancy is stronger for older male staff than any other group. Moreover, social Influence is stronger for younger male staff than any other group. The final objective also attested that age and gender were moderators found to influence behavioural intention to use mLearning at SMG.

This chapter further discusses theoretical implications towards UTAUT studies and the practical implications of the research which could be used by ICT Service desk staff, Senior ICT management and ICT Service desk policy makers to gain a better understanding of techniques for embedding mobile technology devices in ICT Service desk practices.

The following chapter presents the contributions to practice and theory. Specifically, expounding on the limitations of this study and recommendations for further mLearning adoption research.

# Chapter 6. Conclusions and contributions to research and practice

This chapter concludes this thesis by presenting a summary of the key contributions the current study makes to knowledge and practice with future recommendations for research. The chapter also discusses the weaknesses and limitations of this study.

The aim of this study was to investigate mLearning as a just-in-time knowledge acquisition tool for solving ICT training related incidents at the SMG. This aim was achieved by collecting data from the ITSM tool reports for the purpose of conducting a series of statistical tests to analyse this data. Furthermore, survey data based on an adapted UTAUT model was also collected and subsequently analysed using a series of statistical tests which are covered in *Chapter 4*. The overall purpose of collecting and analysing this data was to uncover the current use of mLearning as a just-in-time knowledge acquisition tool at SMG. Moreover, the current study sought to discover the factors that determine SMG's employees' behaviour intention to use mLearning as a just-in-time knowledge acquisition tool.

The use of mobile devices in an educational context to support learning has drawn considerable attention. However, there is relatively scarce research about how it can be used effectively as a just-in-time knowledge acquisition tool in workplace environments. Additionally, there is limited research on mLearning in the workplace environment using technology acceptance as the underpinning theoretical foundation. mLearning research in the workplace needs to consider the determinants of behaviour intention. This thesis makes an original contribution to the body of knowledge in technology acceptance and mLearning. The current study provides a foundation for future research into mLearning and technological acceptance in the context of a museum environment.

## 6.1 Contributions to theory

There are a number of theoretical contributions that are made by the current study. Firstly, contrary to Connelly and Kelloway (2003) whose research suggests female employees perceived knowledge sharing culture differently from their male counterparts, the current research found that there is no statistically significant relationship between gender and reading knowledge articles. However, it was found that there is a statistically significant relationship between gender and reporting ICT incidents. In the current study, non-ICT female staff at SMG are more likely to report ICT incidents than male staff. The results from this study have contributed to the understanding of the theory of ICT Service desk management and knowledge sharing when considering the role of gender in both practices.

Secondly, the original conceptualisation of the UTAUT model consists of four main constructs: performance expectancy, effort expectancy, social influence, facilitating conditions (Venkatesh *et al*., 2003). However, the current study extended the original UTAUT model by adding a new construct, self-directedness. The extended model used in the current study has significantly increased the original model's predictive power to determine behavioural intentions to use mLearning in a UK museum environment ($R^2$ =.875). This indicates that collectively the predictors account for a significant amount of variation in behavioural intention to use mLearning. This is a significant finding as it means that the explanatory power of this model is higher than similar studies from Wang *et al*.'s (2009) research who reported 58% explanatory power and Venkatesh *et al*.'s (2003) research who reported 70% explanatory power. Although the explanatory power of the current research was higher than similar studies e.g., Wang *et al*.'s (2009) research and Venkatesh *et al*.'s (2003) research, these outcomes cannot be readily compared with other extended UTAUT models and their data. This is due to a few factors such as the current study uses research participants which are influenced by a variety of contextual factors that are different to those in Wang *et al*.'s (2009) research and Venkatesh *et al*.'s (2003) research. Additionally, there is a variation of sample sizes of the forementioned author's research.

Thirdly, Venkatesh *et al*. (2003) UTAUT research found that when the performance expectancy and effort expectancy constructs are present and statistically significant, facilitating conditions then becomes nonsignificant in predicting behaviour intention. However, contrary to Venkatesh *et al*.'s (2003) findings, in the current study, it was observed that both performance expectancy and effort expectancy constructs were statistically significant predictors of behaviour intentions as was facilitating conditions.

These findings present an expansion of the body of knowledge regarding the UTAUT model.

Fourthly, in the original UTAUT research, facilitating conditions was only used to measure the Use behaviour construct and not the behaviour intention construct. However, in the current study, facilitating conditions was used to measure behaviour intention and was found to be a statistically significant determinant of behaviour intention. These findings also present an interesting and unique expansion of the understanding of the UTAUT model which contributes to UTAUT scholarship in the workplace context.

When comparing the findings from the constructs in the current study with the original constructs from Venkatesh *et al*.'s (2003) constructs (performance expectancy, effort expectancy, social influence), the majority of both studies' constructs were the same and were found to be statistically significant predictors of behaviour intentions. However, in the current study, it was found that when these constructs were moderated by gender and age, there were statistically significant differences among the groups. This means that the emphasis placed on each of the UTAUT constructs by SMG staff are stronger or weaker depending on which group the staff member belong to.

In the current study, the results for the moderator variable gender, all yielded contrary results to Venkatesh *et al*.'s (2003) findings. For example, in the current study, performance expectancy was found to be a stronger determinant of behaviour intention for females whereas in Venkatesh *et al*.'s study it was stronger for males. Likewise, in the current study, effort expectancy was found to be a stronger determinant of behaviour intention for males whereas in Venkatesh *et al*.'s study it was stronger for females. In the current study, social influence was found to be a stronger determinant of behaviour intention for males whereas in Venkatesh *et al*.'s study it was stronger for females.

Similarly, all age moderators in the current study yielded opposite results to the ones found in Venkatesh *et al*.'s (2003) findings, with the exception of effort expectancy. In both studies, effort expectancy was found to be a stronger determinant of behaviour intention for older staff. In the current study, performance expectancy was found to be a stronger determinant of behaviour intention for older staff whereas in Venkatesh *et al*.'s study it was stronger for younger staff. Likewise, in the current study, Social influence was found to be a stronger determinant of behaviour intention for younger staff whereas in Venkatesh *et al*.'s study it was stronger for older staff. These findings are unique and have not been discovered in previous research underpinned by the UTAUT model. These findings further increase the understanding of UTAUT in different contexts.

This study also found that moderators gender and age yielded different results to Venkatesh *et al*. (2003) results, in the current study it has been proven that gender and age differences exist in the moderating effects of the determinants of behaviour intention to use mLearning in a UK museum setting. These findings are unique and informative in relation to UTAUT, mLearning research, and general IT Service Desk practice and research in this sector.

In the current study, a post hoc analysis of common method variance using Common Marker Variable was used because no marker variables were created when the survey was being constructed. As a result, two survey items were combined to create the CMV, which was named Mobile. Both items measured experience, the first measured experience with using the mobile phone at home for the purposes of knowledge acquisition and the other, using the mobile phone at work for the same purposes. Although both survey items measure experience, they diverge from the original UTAUT construct that measures experience, as well as the TAM and UTAUT2 measures of experience. This is because in both the original UTAUT and UTAUT2 models, the measurement of experience was operationalized via a dummy variable that took ordinal values of 0, 1, or 2 to capture increasing levels of user experience with the system. The increasing levels of user experience was based on three different time periods (1), post-training was when the system was initially available for use; 2) one month later; 3) three months later). However, the adapted UTAUT model used in the current study only used categorical values of yes or no to measure experience with the use of mLearning and was not based on the passage of time. This was because in the current research, the use of mLearning was novel and not a widespread practice among SMG staff. For example, there were no training delivered as part of the system implementation. Furthermore, the current study was not factored in as part of the ITSM tool project scope. This meant that any data captured pertaining to training that had occurred as part of the project implementation may not have been useful in the current study. This is because any training data captured was for a specific purpose and not for the purpose of the current research.

This study found that there were notable differences and similarities between the model used in the current study and those reviewed in *Chapter 2.* For example, in the reviewed research papers, it was found the more than half of these papers did not use the experience construct as a moderator which is similar to the current study. However, it has been acknowledged, post study, that the use of the experience moderator variable would have been useful as a moderator and as a CMV (further discussion of this topic is found in section *Recommendations for future research*). Additionally, it was found that of those that used the experience moderator, the major of them found that experience moderates the relationship among the UTAUT constructs. Another similarity with other UTAUT research is that the majority of them did not use the moderator Voluntariness of use. However, those that did use it found that it did moderate the relationship among the UTAUT constructs.

The current study found that self-directedness was nonsignificant among SMG staff. These findings are in contrast with studies conducted by Wang *et al*. (2009), who expanded the original UTAUT model to include self-directedness in order to examine mLearning adoption among user groups in Taiwan. Similarly, the findings from the current study diverge from findings from Al-Adwan *et al*. (2018) who also expanded the original UTAUT model to include self-directedness in order to examine mLearning adoption among Jordanian higher education students.

## 6.2 Contributions to practice

The current study provides senior management and ICT Service desk staff insight into the factors that influence the acceptance of mobile technology among SMG's non-ICT staff and colleagues. These factors include performance expectancy, effort expectancy, social influence, facilitating conditions and self-directedness. These factors should be considered when implementing mLearning for just-in-time knowledge acquisition at SMG as well as at other organisations. This assists SMG as well as other organisations to gain success in this novel ICT implementation and ensure the achievement of its andragogical application.

**Senior management:** The current study provides senior management with the insight needed to anticipate and plan for successful implementation and adoption of mLearning as a just-in-time knowledge acquisition service. It also provides an understanding into strategies that address non-ICT staff's resistance to mLearning adoption. For example, effort expectancy was the strongest significant predictor of behaviour intention to use mLearning and is supported by prior mLearning research by Nassuora (2012). Facilitating conditions was found to be the weakest significant predictors in the current study. These findings have implication on how non-ICT staff will use mLearning. Therefore, senior management inside and outside of SMG can use the findings from this study to assist with resource allocation and decision-making pertaining to new ICT project implementations. More focus needs to be placed on promoting mLearning as an easy to learn tool for just-in-time knowledge acquisition. Based on the findings in the current study, the promotion of mLearning can be targeted towards older male staff members. This is because effort expectancy was found to be stronger for older male staff.

Although facilitating conditions was found to be the weakest significant predictor of behaviour intention in this study, ensuring that SMG as well as other organisations have the organisational and technical infrastructure to support the use of mLearning may still be useful as facilitating conditions was found to be a significant predictor of mLearning adoption, albeit the weakest one in the current study.

**ICT Service desk staff and knowledge article content creators:** The current study presents ICT Service desk staff information on mLearning and the types of just-in-time knowledge non-ICT staff may need to acquire in their day-to-day jobs. This information can help ICT Service desk staff better support non-ICT staff with the use of mLearning.

ICT Service desk staff may also recommend and contribute to the creation of knowledge articles based on trends emanating from ITSM tool's incident reports. ICT Service desk staff will have better insight into ways knowledge articles can be created to support mLearning.

The results from the current study have established the utility of the UTAUT model as a viable tool to predict mLearning adoption at SMG and potentially other organisations. These results can also present useful insights for other organisations inside and outside of the culture and heritage sector.

## 6.3 Limitations of this research

The results of the analysis of SMG ICT training YouTube video views data were not as comprehensive as the results found for other data analysed in subsequent sections of the *Findings* chapter. This is because YouTube analytics provides the user with limited tools to perform in depth analysis. For example, YouTube analytics are not able to record information about the individuals who have viewed the video such as their gender or age unless the individual has a registered YouTube account and has logged on to the account. Moreover, this is dependent on if the account holder reliably volunteers this information. In the context of SMG, it is believed that not a substantial number of staff have registered for YouTube accounts. Furthermore, YouTube does not record if an individual has viewed the video more than once. Therefore, the results from this analysis will not be as accurate as the analysis of the data from the UTAUT questionnaire. This is because YouTube occasionally runs algorithms that causes video view statistics to be reduced (Dsouza, 2016).

The accuracy of the logged information in the ServiceNow™ reports are questionable as they are subject to human data entry errors such as mis-categorisations.

There is a disparity between the actual number of staff in this study and the number of staff reported in SMG's gender pay gap report. This is because it is acknowledged there is a possibility that both contract staff and volunteer staff form part of the sample group in this study whereas they have been excluded from the number of staff reported in SMG's gender pay gap report.

The analysis of the knowledge articles and ICT incident reports were limited and only focused on gender. Age and individual departments were not investigated. Additionally, there is some missing data on who is actually experiencing the ICT issue as many senior management team members have personal assistants (PAs) and executive assistants (EAs) who handle many of the administrative tasks for their managers. Thus, if the senior manager is the one that is experiencing the ICT related issue, this information is not recorded because the PA or EA would be the one reporting the incident.

The results and their implications are from a single UK museum group and may not be generalisable to other museums or galleries in the sector. The conclusions in this study must be carefully evaluated before attempting to project these finding on an alternative Museum setting. Staff populations in other Museum environments may have distinct ICT skill levels and face different ICT challenges than those in this study's participant survey.

This study is geographically limited to the United Kingdom. To make this study more generalisable, samples should be taken from more geographically dispersed groups.

There were limitations to accessing the population for the purpose of distributing the survey. Thus, the use of an exponential non-discriminative snowball sampling strategy (Etikan *et al*., 2015). Although this sampling strategy is the best, based on the given constraints, it does present limitations. Using this approach limits the study's ability to capture an unbiased cross section of participants in terms of job role, department, level of IT skills, and use of Service desk. Subsequently, an inaccurate determination of the margin of error reduces the study's ability to generalise.

Despite the adequacy of the goodness of-fit indices for both the measurement model and the structural model, there may be some discriminant validity problems with the survey instrument.

This study only focused on seekers of knowledge and not contributors in the evaluation. Additionally, this study did not focus on the individual participant's perceptions of knowledge sharing in the organisation. This insight would help to provide a more holistic understanding of knowledge article usage. The focus of the current study was not on the retention of knowledge or the subsequent decision-making process as a result of using mLearning. This is because neither of these aspects play a critical role in the adoption of mLearning as a just-in-time knowledge acquisition tool.

The results and conclusion are limited and not intended to be exhaustive. Therefore, there are limitations to the interpretation of the findings. Several suggestions throughout this study and specifically in the *Discussion* chapter will require further research to confirm their validity.

This study used a single-time approach which was different from the research proposed by Venkatesh *et al*. (2008) where three measuring times of the same groups of samples were applied. This included adoption, initial use, and post-adoptive use. This may be one of the reasons why the results from the current study are different from Venkatesh *et al*. (2008).

An inherent, limitation of the questionnaire is its static nature. Recipients can only answer the questions that researchers thought to ask. Therefore, it is acknowledged that further information may have been omitted. To mitigate some of this inherent limitation, staff from other groups were invited to review the questionnaire and provide suggestions. Another inherent limitation of the questionnaire is the possibility of common method bias for some of the results (Podsakoff *et al*., 1986). Although, this study tested for common method variance (CMV) in the UTAUT constructs and concluded that there was no significant presence of CMV, there is still a possibility of underlying biases in some of the other data captured.

To ascertain the determinants of mLearning adoption this study based its conclusions on quantitative data collected from 118 respondents. It could be argued that this sample size is too small to perform a reliable and stable EFA or CFA (MacCallum *et al*., 1999). Thus, could be extended to a larger group of staff. The use of a longer timeframe to collect responses and additional communications to encourage further participation would have potentially increased the number of survey respondents. However, this study used more lenient guidelines from several scholars (Gorsuch, 1983; Kline, 1979) who recommend that the sample size should be at least 100.

It is acknowledged that the determinants of mLearning adoption in the current study may not be found to predict behaviour intentions in other mLearning studies. Although, self-directed learning was not considered a predictor of mLearning adoption in this study, it should not be overlooked in other mLearning studies.

The inclusion of a mixed method approach e.g., quantitative, and qualitative data to investigate would present an understanding of the perceptions of the factors determining mLearning adoption.

The inclusion of mLearning implementation data would help to assess if the use of mLearning has achieved its objectives which is to help manage ICT related support calls and increase technological knowledge among SMG staff.

## 6.4 Recommendations for future research

Further UTAUT research may investigate, self-directedness to understand perception of self-directedness and how it relates to mLearning.

A continuation of the current study could explore more diverse geographical locations to include other museums and galleries in the culture and heritage sector.

Further mLearning research could investigate the relationship between contributors and seekers of knowledge as this would help to uncover staff's perception of knowledge sharing within SMG.

It would be expedient to investigate which departments in SMG have the proclivity to report ICT ServiceDesk incidents and read knowledge articles. This knowledge would be insightful as it could potentially be used to diagnose ICT training needs and capabilities within specific departments in order to create more meaningful and targeted learning interventions for those departments.

To enhance understanding of staff's, use of mLearning and the determinants tested in this study, further research could help uncover whether there is longitudinal evidence supporting the findings of this study.

Further mLearning research could investigate the inclusion of the experience moderator as a marker variable to test CMV when using the UTAUT model. In the current research, experience was measured using only yes and no responses in two survey items. These two survey items could become one item that would measure experience as the passage of time in the same way this construct (i.e., experience) is used in TAM, UTAUT and UTAUT2 models.

To increase generalisability, future research could use the same survey instrument and randomly sample staff working in other museums throughout the United Kingdom. Researchers could administer the survey at the pre-mLearning implementation and then 6 months post implementation, which would allow staff response comparisons.

## 6.5 Concluding comments

The findings from the current study presents contributions to both knowledge and practice as well as a variety of approaches to support mLearning at SMG. Comprehending the determinants of staff's acceptance and use of mLearning as a just-in-time learning intervention is critical to the successful implementation of organisational instructional information.

Prior to investing in the development of this novel solution, it is pertinent for senior management to anticipate factors which influence museum staff's technological adoption. If staff reject the mLearning offering, then they will not utilise it to seek and exchange information. Thus, resulting in a wasted budgetary expense.

The results from this study have confirmed that the UTAUT constructs performance expectancy, effort expectancy, social influence and facilitating conditions are all significant determinants of behavioural intention to use mLearning. In contrast to previous UTAUT research (Wang *et al*., 2009; Al-Adwan *et al*., 2018), the newly proposed construct, self-directed learning was not a significant determinant of behaviour intentions. Further examination found age and gender moderate the relationship between the UTAUT constructs. These findings present several beneficial implications for mLearning research and practice at SMG and can inform a broader set of mLearning and technical adoption research and strategy.

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# Appendices

## Appendix 1 – International Association for Development of Information Society (IADIS) Conference Paper

# MOBILE LEARNING ADOPTION AT THE SCIENCE MUSEUM GROUP

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**ABSTRACT**

Mobile learning (mLearning) at the Science Museum Group (SMG) in the United Kingdom (UK) could reduce ICT support calls, increase productivity and develop technical knowledge SMG staff. However, challenges are pervasive in any technological adoption. This paper uses the unified theory of acceptance and use of technology (UTAUT) model to explain the determinants of mLearning adoption at the Science Museum Group (SMG).
Results indicate that the UTAUT constructs, performance expectancy, effort expectancy, social influence and facilitating conditions are all significant determinants of behavioral intention to use mLearning. A newly proposed construct, self-directed learning was not a significant determinant of behaviour intentions. Further examination found age and gender moderate the relationship between the UTAUT constructs. These findings present several useful implications for mLearning research and practice for ICT service desk at SMG. The research contributes to mLearning technology adoption and strategy.

**KEYWORDS**

Mobile Learning, Workplace Learning, Technological Adoption.

## 1. INTRODUCTION

The Science Museum Group (SMG) service desk team in the United Kingdom (UK) faces Service Level Agreement (SLA) breaches due to an overstretched Service Desk team. Furthermore, this team suffers a recruitment freeze due to significant reductions in funding made by the Department for Culture, Media and Sport (DCMS) in the UK. Thus, service desk staff are required to manage incidents and other demands with minimal resources.

The aim of this paper is to derive models for adoption of mobile learning (mLearning) as a form of just-in-time knowledge acquisition. This will be achieved by addressing two objectives

1. Analyse questionnaire data establishing factors contributing to mLearning adoption at SMG
2. Provide recommendations to the SMG's service desk management on improving the implementation and adoption of mLearning in the SMG in order to achieve operational objectives.

### 1.1. mLearning in the workplace

While mLearning research has grown in popularity in the milieu of educational institutes i.e. schools, colleges and universities, its use as a knowledge acquisition method remains a relatively new concept in the field of organizational learning, more specifically, communities of practice (Lave and Wenger, 1991). It is widely accepted that staff training and staff propensity to be trained is a contributing factor in facilitating new technological adoption. Rossett and Marshall's (2010) research found the use of mobile devices for learning was uncommon practice. As a result, this presents a missed opportunity as mLearning provides useful just-in-time knowledge acquisition. The focus of most researchers over the last few years has been on evaluating the effects of mLearning (Chee et al., 2016).

## 1.2. Main contributions

The extent to which mLearning can be used as a tool for knowledge acquisition and its impacts on productivity and specifically, the effective management of ICT support calls in the museum sector remain largely unknown. Due to lack of research in this area, this study on mLearning adoption in SMG is important to senior SMG ICT management as it will provide insight and help to illuminate important drivers for technological adoption. These contributions are useful within and outside the museum sector as it provides insights for technological adoption strategies.

# 2. RESEARCH MODEL AND HYPOTHESES

Venkatesh et al. (2003) research found that the constructs appear to be significant determinants of user acceptance and usage behaviour. The remainder of this section presents a definition of each of the determinants and their relationship across eight technology acceptance models. Additionally, stating the role of the key moderators (gender and age), and proposing the theoretical rational for the hypotheses that will be advanced in this study. Finally, this section will present the adaptation of the UTAUT model that will be used in this research.

**Performance expectancy**: Venkatesh et al. (2003) defines performance expectancy as the extent an individual considers the utility of an information system and the performance gains attained in their job from using it. There are five constructs pertaining to performance expectancy, namely perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT).

Modification to the performance expectancy construct to incorporate the mLearning context suggests SMG staff will find it useful to apply mLearning as a knowledge acquisition solution.

Numerous authors ((Morris and Venkatesh 2000; Venkatesh and Morris 2000) theorised that gender and age have been shown to play moderating roles in the context of technological adoption. Research conducted by Minton and Schneider (1980) on gender differences suggests that adult males tend to be more task-oriented than adult females. Whilst, research on job-related attitudes (Hall and Mansfield 1975; Porter 1963) suggests that younger workers place more emphasis on extrinsic rewards. Therefore, the influence of performance expectancy on behavioural intention will be moderated by gender and age, such that the effect of gender will be stronger for men, in particular, younger men Venkatesh et al. (2003). Therefore, this study will advance the following hypotheses:

*Hypothesis 1: Performance expectancy has a positive effect on behavioural intentions to use mLearning*

*Hypothesis 2: Performance expectancy influences behavioural intention to use mLearning more strongly for male staff than for female staff*

*Hypothesis 3: Performance expectancy influences behavioural intention to use mLearning more strongly for younger staff than for older staff*

**Effort expectancy:** Venkatesh et al. (2003) defines effort expectancy as the extent to which the use of the information system is achieved with ease. Three constructs from three models denote the concept of effort expectancy: perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT).

The notion of effort expectancy being a stronger determinant of an individuals' intention for women than men is supported by prior research (Venkatesh and Morris 2000; Venkatesh et al. 2000). Additionally, based on similar claims in the context of performance expectancy, it is anticipated that gender and age will have comparable moderating effects on effort expectancy. Accordingly, based on the same arguments presented in UTAUT, it is anticipated that individual acceptance of mLearning will depend on the extent to which the use of it will be achieved with ease. Additionally, Rossett and Marshall's (2010)'s research found the use of mobile devices for learning was uncommon in current practice and was hardly considered for staff training albeit formal, non-formal or informal work-based learning. Moreover, it is anticipated that gender and age will have comparable moderating effects on effort expectancy. Thus, the following hypotheses will be tested:

*Hypothesis 4: Effort expectancy has a positive effect on behavioural intention to use mLearning*

*Hypothesis 5: Effort expectancy influences behavioural intention to use mLearning more strongly for female staff than for male staff*

*Hypothesis 6: Effort expectancy influences behaviour intention to use mLearning more strongly for older staff than for younger staff*

**Social influence:** Venkatesh et al. (2003) defines social influence as the extent to which an individual perceives that either senior staff members or someone that can influence behaviour thinks they should use the information system. The construct social influence is represented as subjective norm in TRA, TAM2, TPB/DTPB and C-TAM-TPB, social factors in MPCU, and image in IDT.

Some authors (Venkatesh et al. 2003; Wu et al., 2008; Indrawati et al., 2010) suggest that social influence affects the intention to use new technology. It has been theorised that women tend to be more sensitive to the opinions of others and therefore find social influence to be more prominent when forming an intention to use new technology (Miller 1976; Venkatesh et al. 2000). Additionally, Rhodes' (1983) research suggests that older staff members are more likely to place emphasis on social influences. Transposing these arguments to the context of mLearning is the rationale for anticipating that social influence is a significant determinant of behaviour intentions to use mLearning, likewise, will be moderated by gender and age in the same way. Thus, the following hypotheses will be advanced.

*Hypothesis 7: Social influence has a positive effect on behavioural intention to use mLearning*

*Hypothesis 8: Social influence influences behavioural intention to use mLearning more strongly for female staff than for male staff*

*Hypothesis 9: Social influence influences behavioural intention to use mLearning more strongly for older staff than for younger staff*

**Self-directed learning:** Livingstone (2006) defines self-directed or informal learning as any activity involving the pursuit of understanding, knowledge, or skill that occurs without the presence of externally imposed curricular criteria' (p206) or instructor (Chee et al., 2016), research on mobile learning trends between 2010 and 2015 found, that informal learning was the most popular approach within mLearning research, compared to other learning approaches such as formal learning and non-formal.

From both a techno-centric and andragogical viewpoint, aspects of mLearning can be considered as a kind of self-directed eLearning via mobile devices. For example, both eLearning and mLearning are learner centred thus, self- learning (Behera, 2013). It is expected that a person's level of self-directedness of learning will have a positive influence on his or her behavioural intention to use mLearning as a knowledge acquisition intervention. Beck's (1983) research on cognitive therapy suggests evidence to support the notion that men are more likely to possess autonomous personality traits than women. As a result, it is anticipated that the effect of self-directed learning on mLearning acceptance will be moderated by gender and age, such that the effect will be stronger for men, particularly older men. Thus, the following hypotheses will be tested:

*Hypothesis 10: Self-directed learning has a positive effect on behavioural intentions*

*Hypothesis 11: Self-directed learning influences behavioural intentions to use mLearning more strongly for Male staff than for Female staff*

*Hypothesis 12: Self-directed learning influences behavioural intention to use mLearning more strongly for older staff members than for younger staff members*

**Facilitating conditions:** Venkatesh et al. (2003) defines facilitating conditions as the extent to which an individual perceives the organisational and technical infrastructure's ability to provide support for the information system. The construct facilitating conditions is typified by three different constructs from five models; perceived behavioural control (TPB/DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT).

Based on arguments presented by Venkatesh et al. (2003) it is anticipated that the effect of facilitating conditions on mLearning adoption will not be moderated by gender and age. Therefore, this study will advance the following hypothesis:

*Hypothesis 13: Facilitating conditions does not impact behavioural intentions*

**Behaviour intentions to use mLearning:** Based on arguments presented by Venkatesh et al. (2003) regarding behavioural intentions. This research expects that behavioural intention would have a significant positive effect on use behaviour. Thus, the following hypothesis will be tested:

*Hypothesis 14: Behaviour intentions has a positive effect on Use behavior Learning, Workplace Learning, Technological Adoption.*

# 3. METHODOLOGY

## 3.1 Data collection

A structured questionnaire was created using an electronic form (google form) and disseminated to both SMG staff via emails to gatekeepers. Thus, convenience sampling, a non-random sampling technique was used. The questionnaire consisted of SMG specific questions, demographic questions, internet connected mobile device usage questions and reviewed UTAUT questions. Each item on the UTAUT survey is scored on a 5-point Likert scale. The wording of the items on the survey were reviewed by a selection of SMG staff for the purpose of clarity and completeness.

**Data Screening:** The data was screened for missing data, unengaged responses, outliers and data normality. There were no missing data in the dataset. Five cases were removed due to unengaged responses. Mahalanobis distance was calculated to locate and remove outliers. No cases were removed as the maximum value calculated for this dataset was 67.089 and the critical value is 69.3.

Data normality is examined by conducting a Skewness and Kurtosis test. The results of the analysis showed fairly normal distributions for the indicators of latent factors and all other variables were observed. However, mild Kurtosis was found in seven items. The Kurtosis observed ranged from benign to 3.17. This does fall below more lenient rules suggested by Sposito et al. (1983) who recommend 3.3 as the upper limit.

## 3.2 Data analysis

Data was analysed using the Structural Equation Modelling (SEM) approach. SEM is a comprehensive statistical modelling technique used to specify confirmatory factor analysis models, regression models and complex path models. Thus, this approach was used in this study. Anderson and Gerbing (1988) recommend a two-step approach which this study adopted. First, an examination of the measurement model for reliability and validity was conducted. Secondly, the assessment of the structural model to test the suitability of the model and research hypotheses was carried out.

# 4. RESULTS AND DISCUSSIONS

## 4.1 Participants

This section describes the descriptive statistics for the 118 staff whose responses from the mLearning adoption survey was usable.

Sixty-eight (58%) of the staff were female, and fifty (42%) were male. Participants' age group were reported as follows: 3 (2%) <21; 41 (35%) 21 - 30; 36 (30%) 31 - 40; 23 (20%) 41 - 50; 15 (13%) >50;

The highest educational attainment of staff members was reported as 3 (3%) having attained a Secondary school education; 5 (4%) Further Education (FE) College; 11 (9%) Higher Education (HE) college 53 (43%) Bachelor; 46 (39%) Postgraduate.

All of the main departments of SMG were represented; 8 (7%) Collections Services; 6 (5%) Commercial Experience; 1 (1%) Curatorial / Library / Archives; 6 (5%) Development; 5 (4%) Directorate; 10 (9%) Exhibitions; 14 (12%) Finance / Procurement; 21 (18%) ICT; 9 (8%) Learning; 5 (4%) Marketing and Comms; 5 (4%) Masterplan, Estates & Design; 12 (10%) Operations (including Visitor Fundraising); 4 (3%) People & Culture; 6 (5%) Retail; 6 (5%) Other.

43 (36%) staff had management responsibilities, leaving 75 (64%) that did not.

A large majority (114; 97%) of the participants reported they had used a mobile device at home with Internet access. Seventy-seven (65%) said they had used a mobile device at work, seventy (59%) of staff members reported that they used their mobile device to acquire knowledge or skill, and twenty-two (19%) stated that they used their mobile device to access SMG knowledge articles or ICT Training YouTube channel.

## 4.2 Evaluation of the measurement model

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are used to explain relationships among several observed variables using a smaller number of unobserved variables also known as latent variables or factors (Hair et al, 2006). The overall assessment was carried out using EFA, CFA, SPSS 20 and AMOS 25 tools to examine convergent and discriminant validity. Convergent validity is dependent on three indicators: 1) the reliability of each construct, 2) the item reliability of each measure (factor loading), 3) the average variance extracted (AVE). Constructs are considered to have convergent validity when the composite reliability (CR) exceeds the criterion of 0.70 and the average variance extracted is above 0.50 (Hair et al. 2006). Table 1 shows the factor loadings, the AVE, CR and the Cronbach Alpha values. All AVE's were above the 0.5 threshold and all CRs were above 0.7. Sixteen items were removed due to low loadings, cross loadings and optimising the reliability analysis. Thus, the results support the convergent validity of the scales. Additionally, all Alpha values are above the 0.7 threshold thus exhibiting good reliability (Nunnally and Bernstein, 1994).

Table 1. Results for the measurement model

| Heading level | Example | Font size and style |
|---|---|---|
| Performance Expectancy | **1. INTRODUCTION** | 13 point, bold |
| Effort Expectancy | **1.1 Printing Area** | 13 point, bold |
| | **1.1.1 Text** | 11 point, bold |
| Social Factors | | |
| Facilitating Conditions | | |
| Self-Directed | | |
| Behavioural Intention | | |
| Use | | |

The assessment of discriminant validity is the square root of the AVE for each construct compared with the inter-factor correlations between that construct and all the other constructs. If the AVE is higher than the squared inter-scale correlations of the construct, it shows good discriminant validity (Gefen et al. (2000); Hair et al. 2006). However, regarding this measurement model, the square root of the AVE for EE is less than its correlation with BIU and the square root of the AVE for PE is also less than its correlation with

BIU. Therefore, according to Gefen et al. (2000) this measurement model is exhibiting poor discriminant validity. This means that some constructs are correlated with others that are designed to measure theoretically different concepts. See Table 2 for results.

Table 2. Results for the measurement model

| | EE | SF | Use | FC | SD | PE | BI |
|---|---|---|---|---|---|---|---|
| EE | **0.830** | | | | | | |
| SF | 0.614*** | **0.900** | | | | | |
| Use | 0.779*** | 0.615*** | **0.926** | | | | |
| FC | 0.291** | 0.549*** | 0.300** | **0.837** | | | |
| SD | 0.580*** | 0.367** | 0.477*** | 0.292** | **0.793** | | |
| PE | 0.658*** | 0.783*** | 0.688*** | 0.510*** | 0.482*** | **0.793** | |
| BIU | 0.840*** | 0.792*** | 0.824*** | 0.465*** | 0.495*** | 0.842*** | **0.906** |

The square root of the average variance extracted is inserted diagonally and printed in bold. Off diagonal elements are the shared variance

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

**Common Method Variance:** The purpose of testing for common method variance (CMV) is to estimate to what degree biases exist. Common marker variable statistical technique was used in this study to estimate such variance. Lindell and Whitney (2001) recommend using variables with low correlations between observed variables as measures for the latent method variable. The results show that the constrained and unconstrained models are invariant. Therefore, failing to detect the presence of any specific response bias affecting the model.

## 4.3 Measurement model fit

Seven common model-fit measures were used to assess the model's overall goodness-of-fit. Chi-square mean/Degree of freedom ($\chi 2$/df), Incremental fit Index (IFI), Tucker Lewis Index (TFI), Comparative fit index (CFI), Root mean square error of approximation (RMSEA), Standard root mean square residual (SRMR). Overall, the results of the proposed research model showed an adequate fit: ($\chi 2$/df 1.646., GFI 0.804, IFI .948, TLI .934, CFI .947, RMSEA .075, SRMR = .053).

**Multivariate and outliers:** A cook's distance analysis was carried out to determine if any multivariate influential outliers existed. There were no observed cases of a Cook's distance greater than 1. Most cases were less than 0.280, indicating no presence of influential outliers.

**Multicollinearity:** An examination of the Tolerance and Variance Inflation Factors (VIF) was carried out to assess multicollinearity. The multicollinearity does not exist in a regression model when the Tolerance value is greater than 0.1 and the VIF value is less than 10 (Field, 2009). The results of the Tolerance and VIF indicated that all Tolerance values were greater than 0.1, and the VIF values for all UTAUT constructs were less than 5. Thus, the assumption of the absence of multicollinearity was met.

## 4.4 Evaluation of structural model

The second step is to assess the structural model which includes testing the theoretical hypothesis and the relationships between the latent constructs. Seven common model-fit measures were used to assess the model's overall goodness-of-fit. Overall, the results of the proposed research model showed an adequate fit: ($\chi 2$/df 1.691., GFI .817, IFI .945, TLI .932, CFI .944. RMSEA .078, SRMR .0582). These results provided evidence that the model fit the data adequately. Thus, able to proceed to investigate the determinants, age and gender differences in mLearning adoption. Table 3 lists the path coefficients and their significance.

As expected, hypotheses (H1, H4, H7) representing the relationship among the main constructs (PE, EE, SI) to BIU were supported in this study. The hypothesis that was not supported was H10: SD to BIU. Self-Directed did not significantly predict behaviour intention to use mLearning (-0.03, n.s). Surprisingly, the data proved that FC did significantly predict behaviour intention to use mLearning. Thus, H13 was not supported.

Table 3. Structural model results

| Path/Hypothesis | Beta | t-value | Results |
|---|---|---|---|
| PE → BIU (H1) | 0.347** | 3.244 | Supported |
| EE → BIU (H4) | 0.460*** | 5.590 | Supported |
| SI → BIU (H7) | 0.199* | 2.160 | Supported |
| SD → BIU (H10) | - .032 | -0.504 | Ns |
| FC → BIU (H13) | 0.109† | 1.822 | Not Supported |
| FC → USE | -0.206 | -2.690 | Negative relationship |
| BIU → USE (H14) | 0.960 | 10.659 | Supported |

Model fit indices: $\chi^2/df$ 1.691., GFI 0.817, IFI .945, TLI .932, CFI .944. RMSEA .078, SRMR = .0582

† $p < 0.100$ * $p < 0.050$ ** $p < 0.010$ *** $p < 0.001$ *ns* non-significant

The results of the analyses of gender and age differences are outlined in Tables 4 and 5 respectively, listing the path coefficients and their significance. Additionally, a multigroup comparison test was carried out via a chi-square difference ($\Delta\chi^2$) test to test significance of moderation. This resulted in the p-value of the chi-square difference ($\Delta\chi^2$) test to be significant.

Table 4. Structural model results (moderators male and female)

| Path (Hypothesis) | Male Beta | Female Beta | Results |
|---|---|---|---|
| PE → BIU (H2) | -0.173 | 0.651*** | Not supported. Stronger for Female staff than Male. |
| EE → BIU (H5) | 0.749*** | 0.442*** | Not supported. Stronger for Male staff than Female staff |
| SI → BIU (H8) | 0.382* | -0.037 | Not supported. Stronger for Male staff than Females |
| SD → BIU (H11) | 0.056 | -0.146 | Not supported. No difference |

† $p < 0.100$ * $p < 0.050$ ** $p < 0.010$ *** $p < 0.001$

Participants were divided into two groups: the older group consisted of ages greater than 30 years and the younger group with ages less than or equal to 30 years. A Multigroup comparison test was carried out via a chi-square difference ($\Delta\chi^2$) test to test significance of moderation. It was observed that the p-value of the chi-square difference ($\Delta\chi^2$) test is statistically significant. Therefore, the model differs across the different groups (Younger staff and Older Staff).

TABLE 5. Structural model results (moderators younger staff and older staff)

| Path | Older Beta | Younger Beta | Results/Interpretation |
|---|---|---|---|
| PE → BIU (H3) | 0.426*** | 0.240 | Supported. stronger for younger staff than older staff |
| EE → BIU (H6) | 0.501*** | 0.248 | Supported. Only significant for older staff |
| SI → BIU (H9) | 0.097 | 0.895*** | Not supported. Stronger for Younger staff than older staff |
| SD → BIU (H12) | -0.082 | 0.256* | Not supported. Stronger for Younger staff than older staff |

† $p < 0.100$ * $p < 0.050$ ** $p < 0.010$ *** $p < 0.001$

Finally, $R^2$ value of the behavioural intention was 0.875 and that of the usage was 0.683. Translating these values into explanatory power, behavioural intention was 87.5% whilst use was 68.3%. This means that the explanatory power of this model is higher than Venkatesh et al. (2003) research reporting 70% explanatory power.

## 5. CONCLUSION

The purpose of this study was to use the UTAUT model as a theoretical framework to understand key factors that influences mLearning adoption at SMG. Due to the dearth of published research on the use of UTAUT in Museums, it can be assumed, this is the first assessment of the UTAUT model in relation to mLearning in the milieu of the Museum sector. The analysis of both the data captured and the UTAUT model was carried out using SEM. The findings from this study showed that there are age and gender differences that moderate the relationship between the UTAUT constructs. It was also found that the newly added self-directedness construct was not a predictor of behavior intentions to use mLearning at SMG. The conclusions in this research will help the diffusion of mLearning at SMG and across the museums, galleries, arts, academic, charitable and cultural heritage sector.

Numerous authors believe the future direction of research is motivated and dictated by mobile device applications. (Pereira and Rodrigues 2013; Lim and Churchill 2016). Lim and Churchill (2016) suggests that research should also focus on aspects of multimedia content, communication, digital storytelling, social networking and cloud computing.

Senior management at SMG are keen to explore machine learning capabilities as a way of automating many of the service desk processes.

The results and conclusion are limited and not intended to be exhaustive. Limitations exists in the interpretation of the findings thus suggestions throughout this study and specifically in the discussions section will require further research to confirm their validity.

This study used a single-time approach which was different from the research proposed by Venkatesh et al. (2008) where three measuring times of the same groups of samples were applied.

An inherent, limitation of the questionnaire is its static nature. Recipients can only answer the questions that researchers thought to ask. Therefore, it is acknowledged that further information may have been omitted.

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# Mobile Learning for Just-In-Time Knowledge Acquisition in a Workplace Environment

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***Abstract*-The use of mobile devices in an educational context to support learning has drawn considerable attention, however, there is relatively little systematic knowledge about how it can be used effectively as a knowledge acquisition tool in workplace environments. This paper proposes mobile learning (m-learning) as a just-in-time learning tool to support and manage ICT problem related calls in a Science Museum (SM). Employee's intention to use m-learning is investigated using the Unified Theory of Acceptance and Use of Technology (UTAUT) model. Selected UTAUT factors including performance expectancy, effort expectancy, social influence and facilitating conditions are analysed to explain the determinants of m-learning adoption at the SM. Results demonstrate that the selected UTAUT factors had a significant impact on employee's hehavioral intention to use m-learning at the SM. Further examination found age and gender moderate the relationship between the UTAUT factors. These findings present several useful implications for m-learning research and practice for ICT service desks.**

***Keywords—Mobile learning; mobile computing; ubiquitous learning; workplace learning; ICT service desk; technology adoption***

## I. INTRODUCTION

Advances in mobile communication technologies have changed the way we live and work in the twenty-first century. The proliferation of smart phones and mobile applications enables a mobile world where information is acquired anytime and anywhere. More than ever, mobile devices have become a vital tool in the workplace for learning and supporting work performance. Organisations are rapidly waking up to new opportunities provided by Mobile learning (m-learning) for employee competence development and solving of immediate work challenges [1]. M-learning, a relatively new learning paradigm which enables learning beyond traditional learning environments via mobile devices [2], offers employees the opportunity to access just-in-timejob-related knowledge, onsite and at the point when needed. However, m-learning as a knowledge acquisition method in workplace settings has not been extensively investigated, and not enough is known about the key factors influencing employee's intention to adopt m-learning. This study contributes to the body of research in workplace learning by investigating behavioural intentions to use m-learning as a just-in-time learning tool to support and manage ICT problem related calls in a Science Museum (SM).

M-learning in formal educational context has been studied in recent years as a means for dynamic information delivery in order to support and manage learning, particularly in Higher Education Institutions [3]. The application and impact of m-learning was investigated in [4], and found to improve students' learning achievements, motivation and interests. The benefits of m-learning for students as a self-directed, anytime, anywhere learning tool was studied in [5]. The research results suggest that better retention occurs when m-learning is presented as part of a blended learning program. Moreover, m-learning has also been shown to benefit learners for acquiring input, archiving a learning log, and found to be more favourable to students' learning outcomes compared with traditional learning [6].

While educational use of m-learning continues to increase in popularity as a new mode for content delivery, only a few research studies have been conducted to analyse its effect in workplace environments [7, 8, 9]. In [7], students were guided to learn in a museum using an adaptive navigation support system on a mobile device. The student focused research suggested m-learning allows effective and efficient utilisation of learning resources and effective knowledge acquisition. Studies conducted within [8] and [9] have shown how m-learning can be used as a knowledge acquisition tool in medicine to support clinical practice of newly qualified doctors. It was found that m-learning enabled evidence-based decisions, reduced delays and inspired confidence in the newly qualified doctors. However, little is known about how these results apply to other work

environments. One other form of just-in-time learning approach involves augmented reality developments such as Google's augmented reality project [10], but little is known about how the technology can be applied in work-based environments. Moreover, the use of m-learning to tackle immediate work challenges, and its impact on productivity of a SM workforce has not yet been explored.

This paper aims to derive models for m-learning adoption as a form of just-in-time knowledge acquisition mechanism to address excessive demand on the service desk team of a SM in the United Kingdom (UK). The SM service desk management staff are required to manage incident calls and other demands with minimal resources due to funding cuts by the UK government. It is therefore vital to explore innovative ways to support their work performance via m-learning. Employees' intention to use m-learning will be investigated using the Unified Theory of Acceptance and Use of Technology (UTAUT) model to explain the determinants of m-learning adoption at the SM. Such an investigation would provide a unique lens to understand how the SM employees conceptualise m-learning and offer insights into its technological adoption and implementation.

The remainder of the paper is organized as follows. The research model and hypotheses are presented in section II, methodology for data collection are shown in section III, a description of the way in which data were analysed is presented in section IV, results and findings are discussed in section V, implication of the findings is presented in section VI, and conclusions are drawn in section VII.

## II. RESEARCH HYPOTHESES

Based on the constructs of the UTAUT model [11], this section proposes the following hypotheses for determining m-learning use behavior at the SM.

### A. Performance Expectancy

Performance expectancy is defined in [11] as the extent an individual considers the utility of an information system and the performance gains attained in their job from using it. Studies conducted by [12] have shown that gender and age play moderating roles in the context of technological adoption. Research conducted by [13] on gender differences also suggests that adult males tend to be more task-oriented than adult females. Consequently, performance expectancy will be moderated by gender and age in this paper.

**H1:** *Performance expectancy has a positive effect on behavioural intentions to use m-learning*

**H2:** *Performance expectancy influences behavioural intention to use m-learning more strongly for male staff than for female staff*

**H3:** *Performance expectancy influences behavioural intention to use m-learning more strongly for younger staff than for older staff*

### B. Effort Expectancy

Effort expectancy is defined in [11] as the extent to which the use of the information system is achieved with ease. It is a stronger determinant of an individuals' intention in women than men [12]. It is also assumed that gender and age will have comparable moderating effects on effort expectancy. Accordingly, the following hypotheses will be tested:

**H4:** *Effort expectancy has a positive effect on behavioural intention to use m-learning*

**H5:** *Effort expectancy influences behavioural intention to use m-learning more strongly for female staff than for male staff*

**H6:** *Effort expectancy influences behaviour intention to use m-learning more strongly for older staff than for younger staff*

### C. Social Influence

Social influence is defined in [11] as the extent to which an individual perceives that either senior staff members or someone that can influence behaviour thinks they should use the information system. It was suggested in [14] that social influence affects the intention to use new technology. It was shown that women tend to be more sensitive to the opinions of others and therefore find social influence to be more prominent when forming an intention to use new technology. Additionally, research in [15] suggests that older staff members are more likely to place emphasis on social influences. Thus, the following hypotheses will be advanced.

**H7:** *Social influence has a positive effect on behavioural intention to use m-learning*

**H8:** *Social influence influences behavioural intention to use m-learning more strongly for female staff than for male staff*

**H9:** *Social influence influences behavioural intention to use m-learning more strongly for older staff than for younger staff*

*D. Self-Directed Learning*

Self-directed or informal learning is defined by [16] as µany activity involving the pursuit of understanding, knowledge, or skill that occurs without the presence of externally imposed curricular criteria¶ (p206) or instructor. It is expected that a person’s level of self-directedness of learning will have a positive influence on his or her behavioural intention to use m-learning as a knowledge acquisition intervention. Research on cognitive therapy suggests evidence to support the notion that men are more likely to possess autonomous personality traits than women [17]. As a result, it is anticipated that the effect of self-directed learning on m-learning acceptance will be moderated by gender and age, such that the effect will be stronger for men, particularly older men. Thus, the following hypotheses will be tested:

**H10:** *Self-directed learning has a positive effect on behavioural intentions*

**H11:** *Self-directed learning influences behavioural intentions to use m-learning more strongly for male staff than for female staff*

**H12:** *Self-directed learning influences behavioural intention to use m-learning more strongly for older staff members than for younger staff members*

*E. Facilitating Conditions*

Facilitating conditions is defined in [11] as the extent to which an individual perceives the organisational and technical infrastructure’s ability to provide support for the information system. Based on findings by [11], it is assumed that facilitating conditions is non-significant in predicting intention. In the context of m-learning, it is also assumed that the effect of facilitating conditions on m-learning adoption will not be moderated by gender and age. Therefore, this study will advance the following hypothesis:

**H13:** *Facilitating conditions does not impact behavioural intentions*

*F. Behaviour Intentions to use m-learning*

It is assumed that behavioural intention would have a significant positive effect on use behavior as shown in [11]. Thus, the following hypothesis will be tested:

**H14:** *Behaviour intentions has a positive effect on use behavior*

## III. METHOD

*A. Data Collection*

A structured questionnaire was created using an electronic form and disseminated to both the SM staff and volunteers via emails to gatekeepers. The questionnaire consisted of the SM specific questions, demographic questions, internet connected mobile device usage questions and reviewed UTAUT questions. The UTAUT constructs along with self-directed learning are measured by the items shown in appendix. Each item is scored on a 5-point likert scale.

*B. Participants*

A sample of 118 SM staff responses from the m-learning adoption survey were usable. Sixty-eight (58%) of the staff members identified as female, and fifty (42%) identified as male.  Participants’ age groups were reported as follows: 3 (2%) were less than 21years; 41 (35%) were aged between 21 and 30 years; 36 (30%) between 31 and 40 years; 23 (20%) between 41 and 50 years; 15 (13%) were greater than 50 years. The highest educational attainment of staff members was reported as 3 (3%) having attained a secondary school education; 5 (4%) further education; 11 (9%) higher education; 53 (43%) bachelor; 46 (39%) postgraduate. All the SM main departments were represented; 8 (7%) Collections Services; 6 (5%)

Commercial Experience; 1 (1%) Curatorial / Library / Archives; 6 (5%) Development; 5(4%) Directorate; 10 (9%) Exhibitions; 14 (12%) Finance / Procurement; 21 (18%) ICT; 9 (8%) Learning; 5 (4%)

Marketing and Comms; 5 (4%) Masterplan, Estates & Design; 12 (10%) Operations (including Visitor Fundraising); 4 (3%) People & Culture; 6 (5%) Retail; 6 (5%) Other; 43 (36%) staff had management responsibilities, leaving 75 (64%) that did not. A large majority (114; 97%) of the participants reported they had used a mobile device at home with Internet access. Seventy-seven (65%) said they had used a mobile device at work, seventy (59%) of staff members reported that they used their mobile device to acquire knowledge or skill, and twenty-two (19%) stated that they used their mobile device to access the SM knowledge articles or ICT Training YouTube channel.

## IV. DATA ANALYSIS

Data was analysed using the Structural Equation Modelling (SEM) approach. SEM is a comprehensive statistical modelling technique used to specify confirmatory factor analysis models, regression models and complex path models. First, an examination of the measurement model for reliability and validity was conducted. Second, the assessment of the structural model to test the suitability of the model and research hypotheses was carried out.

### *A. Evaluation of the Measurement Model*

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are used to explain relationships among several observed variables using a smaller number of unobserved variables also known as latent variables or factors [18]. The overall assessment was carried out using EFA, CFA, SPSS 20 and AMOS 25 tools to examine convergent and discriminant validity. Convergent validity is dependent on three indicators: 1) the reliability of each construct, 2) the item reliability of each measure (factor loading), 3) the average variance extracted (AVE). Constructs are considered to have convergent validity when the Composite Reliability (CR) exceeds the criterion of 0.70 and the average variance extracted is above 0.50 [18]. Table 1 shows the factor loadings, the AVE, CR and the Cronbach Alpha values. All AVE's were above the 0.5 threshold and all CRs were above 0.7. Sixteen items were removed due to low loadings, cross loadings and optimising the reliability analysis. Thus, the results support the convergent validity of the scales. Additionally, all alpha values are above the 0.7 threshold thus exhibiting good reliability [19].

TABLE I. RESULTS FOR THE MEASUREMENT MODEL

| Constructs | Items | Standard loadings | CR | AVE | Alpha |
|---|---|---|---|---|---|
| Performance Expectancy | PE4 | 0.78 | 0.835 | 0.628 | 0.829 |
| | PE6 | 0.85 | | | |
| | PE7 | 0.75 | | | |
| Effort Expectancy | EE1 | 0.89 | 0.898 | 0.688 | 0.900 |
| | EE2 | 0.80 | | | |
| | EE3 | 0.87 | | | |
| | EE4 | 0.76 | | | |
| Social Factors | SI1 | 0.89 | 0.927 | 0.809 | 0.927 |
| | SI2 | 0.95 | | | |
| | SI3 | 0.88 | | | |
| Facilitating Conditions | FC2 | 0.88 | 0.870 | 0.700 | 0.853 |
| | FC3 | 0.99 | | | |
| | FC4 | 0.59 | | | |
| Self-Directed | SD1 | 0.75 | 0.834 | 0.628 | 0.823 |
| | SD2 | 0.89 | | | |
| | SD3 | 0.73 | | | |
| Behavioural Intention | BIU1 | 0.91 | 0.948 | 0.821 | 0.943 |
| | BIU5 | 0.89 | | | |
| Use | BIU8 | 0.87 | | | 0.931 |
| | BIU10 | 0.93 | | | |
| | BIU11 | 0.97 | | | |

The assessment of discriminant validity is the square root of the AVE for each construct compared with the inter-factor correlations between that construct and all the other constructs. If the AVE is higher than the squared inter-scale correlations of the construct, it shows good discriminant validity ([18], [19]).

However, regarding this measurement model, the square root of the AVE for EE is less than its correlation with BIU and the square root of the AVE for PE is also less than its correlation with BIU. Therefore, according to [18] this measurement model is exhibiting poor discriminant validity. This means that some constructs that are correlated with others. See Table 2 below for results.

TABLE II. DISCRIMINANT VALIDITY OF THE UTAUT MEASUREMENT MODEL

| | EE | SF | Use | FC | SD | PE | BI |
|---|---|---|---|---|---|---|---|
| EE | **0.830** | | | | | | |
| SF | 0.614*** | **0.900** | | | | | |
| Use | 0.779*** | 0.615*** | **0.926** | | | | |
| FC | 0.291** | 0.549*** | 0.300** | **0.837** | | | |
| SD | 0.580*** | 0.367** | 0.477*** | 0.292** | **0.793** | | |
| PE | 0.658*** | 0.783*** | 0.688*** | 0.510*** | 0.482*** | **0.793** | |
| BIU | 0.840*** | 0.792*** | 0.824*** | 0.465*** | 0.495*** | 0.842*** | **0.906** |

The square root of the average variance extracted is inserted diagonally and printed in bold. Off diagonal elements are the shared variance

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

*B. Evaluation of the structural model*

The second step is to assess the structural model which includes testing the theoretical hypothesis and the relationships between the latent constructs. Seven common model goodness-of-fit. Overall, the results of the proposed research model showed an adequate fit: ($\chi^2/df$ 1.691., GFI .817, IFI .945, TLI .932, CFI .944. RMSEA .078, SRMR .0582). Table 3 shows the minimum acceptable thresholds for the various Goodness-of-fit indices. These results provided evidence that the model fit the data adequately. Table 3 lists the path coefficients and their significance. As expected, hypotheses (H1, H4, H7) representing the relationship among the main constructs (PE, EE, SI) to BIU were supported in this study. The hypothesis that was not supported was H10: SD to BIU. Self-Directed did not significantly predict behaviour intention to use m-learning (0.03, *n.s*). Surprisingly, the data proved that FC did significantly predict behaviour intention to use m-learning. Thus, H13 was not supported.

TABLE III. STRUCTURAL MODEL RESULTS

| Path/Hypothesis | Beta | t-value | Results |
|---|---|---|---|
| PE → BIU (H1) | 0.347** | 3.244 | Supported |
| EE → BIU (H4) | 0.460*** | 5.590 | Supported |
| SI → BIU (H7) | 0.199* | 2.160 | Supported |
| SD → BIU (H10) | - .032 | -0.504 | Ns |
| FC → BIU (H13) | 0.109† | 1.822 | Not Supported |
| FC → USE | -0.206 | -2.690 | Negative relationship |
| BIU → USE (H14) | 0.960 | 10.659 | Supported |

Model fit indices: $\chi^2/df$ 1.691., GFI 0.817, IFI .945, TLI .932, CFI .944. RMSEA .078, SRMR = .0582

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001 *ns* non-significant

*C. Moderation by Gender and Age*

A multi-group comparison test was carried out via a chi-square difference test to test significance of moderation. It was found that the p-value of the chi-square difference test is significant (P - 0.052). Therefore, the model differs across the groups (male staff and female staff). Participants were divided into two groups: the older group consisted of ages greater than 30 years and the younger group with ages less than or equal to 30 years. A multi-group comparison test was carried out via a chi-square difference test to test significance of moderation. It was observed that the p-value of the chi square difference test is significant (P - 0.052).

Results for the analysis of gender and age differences are outlined in tables 4 and 5 respectively, listing the path coefficients and their significance.

TABLE IV. STRUCTURAL MODEL RESULTS (MODERATORS MALE AND FEMALE)

| Path (Hypothesis) | Male Beta | Female Beta | Results |
|---|---|---|---|
| PE → BIU (H2) | -0.173 | 0.651*** | Not supported. Stronger fo Female staff than Male |
| EE → BIU (H5) | 0.749*** | 0.442*** | Not supported. Stronger f Male staff than Female sta |
| SI → BIU (H8) | 0.382* | -0.037 | Not supported. Stronger f Male staff than Females |
| SD → BIU (H1 | 0.056 | -0.146 | Not supported. No difference |

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

TABLE V. STRUCTURAL MODEL RESULTS (MODERATORS YOUNGER STAFF AND OLDER STAFF)

| Path | Older Beta | Younger Beta | Results/Interpretation |
|---|---|---|---|
| PE → BIU (H3) | 0.426** | 0.240 | Supported. stronger for younger staf than older staff |
| EE → BIU (H6) | 0.501** | 0.248 | Supported. Only significant for olde staff |
| SI → BIU (H9) | 0.097 | 0.895*** | Not supported. Stronger for Younge staff than older staff |
| SD → BIU (H12) | -0.082 | 0.256* | Not supported. Stronger for Younger staff than older staff |

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

Finally, $R^2$ value of the behavioural intention was 0.875 and that of the usage was 0.683. Translating these values into explanatory power, behavioural intention was 87.5% whilst use was 68.3%. This means that the explanatory power of this model is higher than [11] research reporting 70% explanatory power.

## V. DISCUSSION

Results of the extended UTAUT model used to explore the factors influencing employee's intention to adopt m-learning at the SM are presented in this section.

### A. Performance Expectancy

The results observed support hypothesis [H1] and confirm that performance expectancy is a predictor of m-learning adoption which is consistent with findings in [20]. In order to accommodate staff with high performance expectations, creators of knowledge articles should consider the development of valuable and up-to-date content. Articles need to be responsive to mobile devices with varying screen sizes.

### B. Effort Expectancy

The results support observed hypothesis [H4] and show effort expectancy to be the strongest predictor of behaviour intention to use m-learning. These results were consistent with previous research findings in [21]. To support staff who believe that m-learning system should be easy to use. It is suggested that educational designers focus on simplicity of system navigation. Thus, making the system user friendly and intuitive for more novice users.

### C. Social Influence

The results observed support hypothesis [H7] and confirm social influence be a significant determinant of mlearning adoption. This result was comparable with other studies including those by [20] and [22]. Early adopters can be used to form powerful coalition that is able to communicate the usefulness of m-learning. They help to remove barriers to change through demonstration and coaching.

### D. Self-Directedness

This construct was not a significant predictor of behaviour intentions to use m-learning, thus [H10] was not supported. The lack of impact of self-directedness on behaviour intentions to use m-learning seems to be unique to this study as studies such as [23] found that self-directedness predicts behavioural intention. These findings are surprising as collectively 80% of the respondents in this research have either bachelor or postgraduate degrees, suggesting highly autonomous learning abilities. The reason for this nonsignificant result might be because staff did not think that self-directedness plays a role in using mobile devices for just-in-time knowledge acquisition.

### E. Facilitating Conditions

The results confirmed that facilitating conditions does significantly predict behaviour intentions to use m-learning [H13] as suggested in [11] and [24]. The role of technological and organisational infrastructure influences m-learning adoption therefore it is important that ICT support staff, senior management and ICT technology provides a reliable means for staff to use m-learning. Additionally, if the SM and management made it demonstrable that they support the use of m-learning, this would help to bolster adoption.

### F. Gender and Age Differences

It was observed that performance expectancy and effort expectancy were significant for both genders, while social influences were significant for only males. Self-directedness was not significant for neither male nor female staff.

Gender differences yielded surprising results as none of the hypotheses for gender [H2, H5, H8 and H11] were supported. Performance expectancy was stronger for female staff than male. Effort expectancy was stronger for male staff than female staff. Social influence was stronger for male staff than female staff. These findings were unexpected and contrary to previous research which found that social influence is stronger in females than males. This is perhaps because women may be unfamiliar with complex m-learning technology, making them less likely to be influenced by early adopters. Evidently, self-directedness was not a significant predictor of behavior intention to use, there were no differences between male and female staff regarding self-directedness.

Performance expectancy and effort expectancy were significant for both older (ages >=31) and younger (ages <=30) age groups while Social Influences were significant for only younger age groups. Self-directedness was only significant for younger staff.

## VI. CONCLUSION

The purpose of this study was to investigate key factors affecting m-learning adoption as a just-in-time learning intervention for reducing training related ICT support calls at a SM using the UTAUT model as a theoretical framework. The analysis of the data captured and the UTAUT model was carried out using SEM. It was observed that there are age and gender differences that moderate the relationship between the UTAUT constructs. It was found that the newly added self-directedness construct was not a predictor of behavior intentions to use m-learning at the SM. The conclusions in this research will help the diffusion of m-learning at the SM.

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## APPENDIX

The UTAUT items adapted from [11] and [25]

| Construct | Item Code | Item |
|---|---|---|
| **Performance Expectancy** | PE 1 | I would find m-learning useful in my work for knowledge acquisition. |
| | PE 2 | I think that m-learning is a good way to learn new skills. |
| | PE 3 | Using m-learning enables me to accomplish activities more quickly. |
| | PE 4 | Using m-learning increases my job productivity. |
| | PE 5 | If I use m-learning, I will increase my chances of getting a promotion. |
| | PE 6 | I prefer to use m-learning to solve IT related issues. |
| | PE 7 | M-learning is particularly suited to ICT and technical subjects. |
| **Effort Expectancy** | EE 1 | If the learning materials are of good quality, my interaction with m-learning would be clear and understandable. |
| | EE 2 | It would be easy for me to become skillful at using m-learning to aid my learning at work. |
| | EE 3 | If the learning materials are of good quality, I would find m-learning easy to use. |
| | EE 4 | Learning to operate m-learning is easy for me. |
| **Social Influences** | SI 1 | People who influence my behaviour at work, (i.e. friends, colleagues or line manager) will think that I should use mlearning. |
| | SI 2 | People whose opinions I value professionally will expect I use m-learning. |

| | | |
|---|---|---|
| | SI 3 | People whose opinions I value professionally think that I should try to use m-learning for knowledge acquisition at work. |
| | SI 4 | People who influence my behaviour at work, (i.e. friends, colleagues or line manager) will think that I should try to use m-learning for knowledge acquisition at work. |
| **Facilitating Conditions** | FC 1 | I know what m-learning is. |
| | FC 2 | The management in my organisation have supported and enabled the use of m-learning. |
| | FC 3 | In general, my employer has supported and enabled the use of m-learning. |
| | FC 4 | SM will allow me enough time to pursue m-learning alongside my day job. |
| | FC 5 | I have the required ability to make use of m-learning. |
| | FC 6 | I have access to the required resources to make use of m-learning. |
| **Self-Directed** | SD 1 | I take responsibility for deciding what learning I will undertake and how I will do it. |
| | SD 2 | When I am learning at work, I set my own goals and have a high degree of initiative. |
| | SD 3 | I monitor whether I have accomplished my learning goals. |
| | SD 4 | When it comes to learning at work, I am self-disciplined and find it easy to set aside reading/video viewing time. |
| | SD 5 | I understand how I can to put learning into practice. |
| | SD 6 | I am good at managing my own learning time and get the most out of the time I have allocated for learning. |
| **Behaviour Intention** | BI 1 | I intend to use m-learning in the future for knowledge acquisition at work. |
| | BI 2 | I predict I would use m-learning in the future for knowledge acquisition at work. |
| | BI 3 | I plan to use m-learning in the future to help resolve ICT related issues at work. |
| | BI 4 | I will continue to use m-learning for knowledge acquisition. |
| | BI 5 | I will tell others about the positive aspects of using m-learning for knowledge acquisition at work |
| | BI 6 | I will recommend others to the use of m-learning to help resolve ICT related issues at work. |
| | BI 7 | Using m-learning for knowledge acquisition at work is a good idea. |
| | BI 8 | I believe that working with m-learning would be useful. |
| | BI 9 | I would like [the system] more if I used m-learning . |
| | BI 10 | Using m-learning at work for quick knowledge acquisition would be a pleasant experience. |
| | BI 11 | Using m-learning at work for quick knowledge acquisition is a good idea. |

SCALES LABLES TRONGLY AGREE, 4 =AGREE, 3 = NEITHER AGREE NOR DISAGREE, 2 = DISAGREE, 1 = STRONGLY DISAGREE

## Appendix 3 - International Journal on Computer Science and Information Systems

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# USING THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY (UTAUT) MODEL TO DETERMINE FACTORS AFFECTING MOBILE LEARNING ADOPTION IN THE WORKPLACE: A STUDY OF THE SCIENCE MUSEUM GROUP

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**ABSTRACT**

It has been observed that mobile learning (mLearning) in institutions like Museums in the United Kingdom (UK) has been underutilized. mLearning usage could potentially increase productivity by delivering just-in-time technical knowledge to the science museum group (SMG) staff. This study uses the unified theory of acceptance and use of technology (UTAUT) model to determine factors affecting mLearning adoption at the SMG. Two research questions were formulated based on an adaptation of the UTAUT model. 1) *What are the determinants of behavior intentions to use mLearning at the SMG?* 2) *Does gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning at the SMG?*
118 respondents were surveyed from the SMG. Data obtained were analysed using Structured Equation Modelling on IBM SPSS 20 and Amos version 25. Results indicate that the UTAUT constructs, performance expectancy, effort expectancy, social influence and facilitating conditions are all significant determinants of behavioral intention to use mLearning. A newly proposed construct, self-directed learning was not a significant determinant of behaviour intentions. Further examination found age and gender moderate the relationship between the UTAUT constructs. These findings present several useful implications for mLearning research and practice for ICT service desk at the SMG. The research contributes to mLearning technology adoption and strategy.

**KEYWORDS**

Mobile Learning, Workplace Learning, Technological Adoption, UTAUT

# 1. INTRODUCTION

The Science Museum Group (SMG) service desk team in the United Kingdom (UK) faces

Service Level Agreement (SLA) breaches due to an overstretched Service Desk team. Furthermore, this team suffers a recruitment freeze due to significant reductions in funding. Thus, service desk staff are required to manage incidents and other demands with minimal resources. To address the squeeze on resources, mobile learning (mLearning) is proposed as an innovative technique to maximize the efficiency of the Service Desk function. The significance of this novel technique is that until now, little attention has been paid to how newly emerging mLearning environment could facilitate better service provisioning and support ICT related problem calls and support excessive demand on the service desk team.

The aim of this paper to use the UTAUT model to determine the factors affecting the adoption mLearning in the workplace as a just-in-time knowledge acquisition tool. This will be achieved by addressing two questions

1. What are the determinants of behavior intentions to use mLearning as a just-in-time knowledge acquisition tool at the SMG?
2. Does gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning at the SMG?

## 1.1 mLearning in the Workplace

While mLearning research has grown in popularity in the milieu of educational institutes i.e. schools, colleges and universities, its use as a knowledge acquisition method remains a relatively new concept in the field of organizational learning, more specifically, communities of practice (Lave and Wenger, 1991). It is widely accepted that staff training and staff propensity to be trained is a contributing factor in facilitating new technological adoption. Rossett and Marshall's (2010) research found the use of mobile devices for learning was uncommon practice. As a result, this presents a missed opportunity as mLearning has the potential to provide useful just-in-time knowledge to support work performance. The focus of most researchers over the last few years has been on evaluating the effects of mLearning (Chee et al., 2016).

## 1.2 Main Contributions

The extent to which mLearning can be used as a tool for knowledge acquisition and its impacts on productivity and specifically, the effective management of ICT support calls in the museum sector remain largely unknown. Due to lack of research in this area, this study on the use of the UTAUT model regarding mLearning adoption at the SMG is important to senior SMG ICT management as it will provide insights that help to illuminate important drivers for technological adoption. The current study contributes new knowledge to theory and practice of IT service desk management and mLearning adoption and responds to knowledge gaps in the field of mLearning.  Moreover, these contributions are valuable within and outside the museum sector as it provides insights for a wide range of technological adoption strategies and contexts.

## 2. RESEARCH MODEL AND HYPOTHESES

Venkatesh et al. (2003) research found that the four constructs, performance expectancy, effect expectancy, social influence and facilitating conditions appear to be significant determinants of user acceptance and usage behaviour. The remainder of this section presents a definition of each of the determinants and their relationship across eight technology acceptance models. Additionally, stating the role of the key moderators (gender and age), and proposing the theoretical rational for the hypotheses that will be advanced in this study. Finally, this section will present the adaptation of the UTAUT model that will be used in this research.

**Performance expectancy**: Venkatesh et al. (2003) defines performance expectancy (PE) as the extent an individual considers the utility of an information system and the performance gains attained in their job from using it. There are five constructs pertaining to performance expectancy, namely perceived usefulness (TAM/TAM2 and C-TAM-TPB), extrinsic motivation (MM), job-fit (MPCU), relative advantage (IDT), and outcome expectations (SCT).

Modification to the performance expectancy construct to incorporate the mLearning context suggests SMG staff will find it useful to apply mLearning as a knowledge acquisition solution.

Numerous authors (Morris and Venkatesh 2000; Venkatesh and Morris 2000) theorised that gender and age have been shown to play moderating roles in the context of technological adoption. Research conducted by Minton and Schneider (1980) on gender differences suggests that adult males tend to be more task-oriented than adult females. Whilst research on job-related attitudes (Hall and Mansfield 1975; Porter 1963) suggests that younger workers place more emphasis on extrinsic rewards.  Therefore, the influence of performance expectancy on behavioural intention will be moderated by gender and age, such that the effect of gender will be stronger for men, in particular, younger men Venkatesh et al. (2003). Therefore, this study will advance the following hypotheses:

*Hypothesis 1: Performance expectancy has a positive effect on behavioural intentions to use mLearning*
*Hypothesis 2: Performance expectancy influences behavioural intention to use mLearning more strongly for male staff than for female staff*
*Hypothesis 3: Performance expectancy influences behavioural intention to use mLearning more strongly for younger staff than for older staff*

**Effort expectancy:** Venkatesh et al. (2003) defines effort expectancy (EE) as the extent to which the use of the information system is achieved with ease. Three constructs from three models denote the concept of effort expectancy:  perceived ease of use (TAM/TAM2), complexity (MPCU), and ease of use (IDT).

The notion of effort expectancy being a stronger determinant of an individuals' intention for women than men is supported by prior research (Venkatesh and Morris 2000; Venkatesh et al. 2000). Additionally, based on similar claims in the context of performance expectancy, it is anticipated that gender and age will have comparable moderating effects on effort expectancy. Accordingly, based on the same arguments presented in UTAUT, it is anticipated that individual acceptance of mLearning will depend on the extent to which the use of it will be achieved with ease. Additionally, Rossett and Marshall's (2010)'s research found the use of mobile devices for learning was uncommon in current practice and was hardly considered for staff training albeit formal, non-formal or informal work-based learning. Moreover, it is anticipated that gender and age will have comparable moderating effects on effort expectancy. Thus, the following hypotheses will be tested:

*Hypothesis 4: Effort expectancy has a positive effect on behavioural intention to use mLearning*
*Hypothesis 5: Effort expectancy influences behavioural intention to use mLearning more strongly for female staff than for male staff*
*Hypothesis 6: Effort expectancy influences behaviour intention to use mLearning more strongly for older staff than for younger staff*

**Social influence:** Venkatesh et al. (2003) defines social influence (SI) as the extent to which an individual perceives that either senior staff members or someone that can influence behaviour thinks they should use the information system. The construct social influence is represented as subjective norm in TRA, TAM2, TPB/DTPB and C-TAM-TPB, social factors in MPCU, and image in IDT.

Some authors (Venkatesh et al. (2003); Wu et al., 2008; Indrawati et al., 2010) suggest that social influence affects the intention to use new technology. It has been theorised that women tend to be more sensitive to the opinions of others and therefore find social influence to be more prominent when forming an intention to use new technology (Miller 1976; Venkatesh et al. 2000). Additionally, Rhodes' (1983) research suggests that older staff members are more likely to place emphasis on social influences. Transposing these arguments to the context of mLearning is the rationale for anticipating that social influence is a significant determinant of behaviour intentions to use mLearning, likewise, will be moderated by gender and age in the same way. Thus, the following hypotheses will be advanced.

*Hypothesis 7: Social influence has a positive effect on behavioural intention to use mLearning*
*Hypothesis 8: Social influence influences behavioural intention to use mLearning more strongly for female staff than for male staff*
*Hypothesis 9: Social influence influences behavioural intention to use mLearning more strongly for older staff than for younger staff*

**Self-directed learning:** Livingstone (2006) defines self-directed (SD) or informal learning as any activity involving the pursuit of understanding, knowledge, or skill that occurs without the presence of externally imposed curricular criteria' (p206) or instructor (Chee et al., 2016), research on mobile learning trends between 2010 and 2015 found, that informal learning was the most popular approach within mLearning research, compared to other learning approaches such as formal learning and non-formal.

From both a techno-centric and andragogical viewpoint, aspects of mLearning can be considered as a kind of self-directed eLearning via mobile devices. For example, both eLearning and mLearning are learner centred thus, self- learning (Behera, 2013). It is expected that a person's level of self-directedness of learning will have a positive influence on his or her behavioural intention to use mLearning as a knowledge acquisition intervention. Beck's (1983) research on cognitive therapy suggests evidence to support the notion that men are more likely to possess autonomous personality traits than women. As a result, it is anticipated that the effect of self-directed learning on mLearning acceptance will be moderated by gender and age, such that the effect will be stronger for men, particularly older men. Thus, the following hypotheses will be tested:

*Hypothesis 10: Self-directed learning has a positive effect on behavioural intentions Hypothesis 11: Self-directed learning influences behavioural intentions to use mLearning more strongly for Male staff than for Female staff*
*Hypothesis 12: Self-directed learning influences behavioural intention to use mLearning more strongly for older staff members than for younger staff members*

**Facilitating conditions:** Venkatesh et al. (2003) defines facilitating conditions (FC) as the extent to which an individual perceives the organisational and technical infrastructure's ability to provide support for the information system. The construct facilitating conditions is typified by three different constructs from five models; perceived behavioural control (TPB/DTPB, C-TAM-TPB), facilitating conditions (MPCU), and compatibility (IDT).

Based on arguments presented by Venkatesh et al. (2003) it is anticipated that the effect of facilitating conditions on mLearning adoption will not be moderated by gender and age.

Therefore, this study will advance the following hypothesis:

*Hypothesis 13: Facilitating conditions does not impact behavioural intentions*

**Behaviour intentions to use mLearning:** Based on arguments presented by Venkatesh et al. (2003) regarding behavioural intentions. This research expects that behavioural intention would have a significant positive effect on use behaviour. Thus, the following hypothesis will be tested:

*Hypothesis 14: Behaviour intentions has a positive effect on Use behavior Learning, Workplace Learning, Technological Adoption.*

## 3. METHODOLOGY

### 1.1 Research Question

For the purpose of this study, two research questions were stated to determine the factors affecting mLearning adoption at the SMG

$RQ_1$: What are the determinants of behavior intentions to use mLearning at the SMG?

$RQ_2$: Does gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning at the SMG?

## 1.2 Data Collection

A structured questionnaire was created using an electronic form (google form) and disseminated to both SMG staff via emails to gatekeepers. Thus, convenience sampling, a non-random sampling technique was used. The questionnaire consisted of SMG specific questions, demographic questions, internet connected mobile device usage questions and reviewed UTAUT questions. Each item on the UTAUT survey is scored on a 5-point Likert scale. The wording of the items on the survey were reviewed by a selection of SMG staff for the purpose of clarity and completeness.

**Data Screening:** The data was screened for missing data, unengaged responses, outliers and data normality. There were no missing data in the dataset. Five cases were removed due to unengaged responses. Mahalanobis distance was calculated to locate and remove outliers. No cases were removed as the maximum value calculated for this dataset was 67.089 and the critical value is 69.3.

**Data normality:** Data normality is examined by conducting a Skewness and Kurtosis test. The results of the analysis showed fairly normal distributions for the indicators of latent factors and all other variables were observed. However, mild Kurtosis was found in seven items. The Kurtosis observed ranged from benign to 3.17. This does fall below more lenient rules suggested by Sposito et al. (1983) who recommend 3.3 as the upper limit.

## 1.3 Data Analysis

Questionnaire data was analysed using the Structural Equation Modelling (SEM) approach. SEM is a comprehensive statistical modelling technique used to specify confirmatory factor analysis models, regression models and complex path models. Hair et al. (2014) recommends that the application of SEM should only be performed if the research is developed based on strong theoretical basis. This research used the UTAUT model (Venkatesh et al., 2003) and literature to identify the variables and specify the relationships among those variables. Furthermore, Gefen et al. (2000) recommends the use of SEM in both behavioural sciences and technological research. Thus, this approach was used in this study. Anderson and Gerbing (1988) recommend a two-step approach which this study adopted. First, an examination of the measurement model for reliability and validity was conducted. Secondly, the assessment of the structural model to test the suitability of the model and research hypotheses was carried out.

# 4. RESULTS AND DISCUSSIONS

## 1.1 Participants

This section describes the descriptive statistics for the 118 staff whose responses from the mLearning adoption survey was usable. Sixty-eight (58%) of the staff were female, and fifty (42%) were male. Participants' age group were reported as follows: 3 (2%) <21; 41 (35%) 21 - 30; 36 (30%) 31 - 40; 23 (20%) 41 - 50; 15 (13%) >50. The highest educational attainment of staff members was reported as 3 (3%) having attained a Secondary school education; 5 (4%) Further Education (FE) College; 11 (9%) Higher Education (HE) college 53 (43%) Bachelor; 46 (39%) Postgraduate. All of the main departments of the SMG were represented; 8 (7%)

Collections Services; 6 (5%) Commercial Experience; 1 (1%) Curatorial / Library / Archives;

6 (5%) Development; 5 (4%) Directorate; 10 (9%) Exhibitions; 14 (12%) Finance / Procurement; 21 (18%) ICT; 9 (8%) Learning; 5 (4%) Marketing and Comms; 5 (4%)

Masterplan, Estates & Design; 12 (10%) Operations (including Visitor Fundraising); 4 (3%) People & Culture; 6 (5%) Retail; 6 (5%) Other. 43 (36%) staff had management responsibilities, leaving 75 (64%) that did not. A large majority (114; 97%) of the participants reported they had used a mobile device at home with Internet access. Seventy-seven (65%) said they had used a mobile device at work, seventy (59%) of staff members reported that they used their mobile device to acquire knowledge or skill, and twenty-two (19%) stated that they used their mobile device to access SMG's knowledge articles or ICT Training YouTube channel.

## 1.2 Evaluation of the Measurement Model

Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA) are used to explain relationships among several observed variables using a smaller number of unobserved variables also known as latent variables or factors (Hair et al, 2006). The overall assessment was carried out using EFA, CFA, SPSS 20 and AMOS 25 tools to examine convergent and discriminant validity. Convergent validity is dependent on three indicators: 1) the reliability of each construct, 2) the item reliability of each measure (factor loading), 3) the average variance extracted (AVE). Constructs are considered to have convergent validity when the composite reliability (CR) exceeds the criterion of 0.70 and the average variance extracted is above 0.50 (Hair et al. 2006). Table 1 shows the factor loadings, the AVE, CR and the Cronbach Alpha values. All AVE's were above the 0.5 threshold and all CRs were above 0.7. Sixteen items were removed due to low loadings, cross loadings and optimising the reliability analysis. Thus, the results support the convergent validity of the scales. Additionally, all Alpha values are above the 0.7 threshold thus exhibiting good reliability (Nunnally and Bernstein, 1994).

Table 1. Results for the measurement model

| Constructs | Items | Standard loadings | CR | AVE | Alpha |
|---|---|---|---|---|---|
| Performance Expectancy | PE4 | 0.78 | 0.835 | 0.628 | 0.829 |
| | PE6 | 0.85 | | | |
| | PE7 | 0.75 | | | |
| Effort Expectancy | EE1 | 0.89 | 0.898 | 0.688 | 0.900 |
| | EE2 | 0.80 | | | |
| | EE3 | 0.87 | | | |
| | EE4 | 0.76 | | | |

| | | | | | |
|---|---|---|---|---|---|
| Social Factors | SI1 | 0.89 | 0.927 | 0.809 | 0.927 |
| | SI2 | 0.95 | | | |
| | SI3 | 0.88 | | | |
| Facilitating Conditions | FC2 | 0.88 | 0.870 | 0.700 | 0.853 |
| | FC3 | 0.99 | | | |
| | FC4 | 0.59 | | | |
| Self-Directed | SD1 | 0.75 | 0.834 | 0.628 | 0.823 |
| | SD2 | 0.89 | | | |
| | SD3 | 0.73 | | | |
| Behavioural Intention | BIU1 | 0.91 | 0.948 | 0.821 | 0.943 |
| | BIU5 | 0.89 | | | |
| Use | BIU8 | 0.87 | | | 0.931 |
| | BIU10 | 0.93 | | | |
| | BIU11 | 0.97 | | | |

The assessment of discriminant validity is the square root of the AVE for each construct compared with the inter-factor correlations between that construct and all the other constructs. If the AVE is higher than the squared inter-scale correlations of the construct, it shows good discriminant validity (Gefen et al. (2000); Hair et al. 2006). However, regarding this measurement model, the square root of the AVE for EE is less than its correlation with BIU and the square root of the AVE for PE is also less than its correlation with BIU. Therefore, according to Gefen et al. (2000) this measurement model is exhibiting poor discriminant validity. This means that some constructs are correlated with others that are designed to measure theoretically different concepts. See Table 2 for results.

Table 2. Results for the measurement model

| | EE | SF | Use | FC | SD | PE | BI |
|---|---|---|---|---|---|---|---|
| EE | **0.830** | | | | | | |
| SF | 0.614*** | **0.900** | | | | | |
| Use | 0.779*** | 0.615*** | **0.926** | | | | |
| FC | 0.291** | 0.549*** | 0.300** | **0.837** | | | |
| SD | 0.580*** | 0.367** | 0.477*** | 0.292** | **0.793** | | |
| PE | 0.658*** | 0.783*** | 0.688*** | 0.510*** | 0.482*** | **0.793** | |
| BIU | 0.840*** | 0.792*** | 0.824*** | 0.465*** | 0.495*** | 0.842*** | **0.906** |

The square root of the average variance extracted is inserted diagonally and printed in bold. Off diagonal elements are the shared variance

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

**Common Method Variance:** Survey methods have the potential to introduce excessive variance that can alter research findings. There are numerous ways these biases can be introduced. One of the ways excessive variance can be introduced to survey results is when participants respond to survey items in a consistent fashion (Padsakoff and Organ 1986). Thus, the purpose of testing for common method variance (CMV) is to estimate to what degree biases exist. There are several tests that can used to test CMV, the three most popular post hoc techniques are 1) Harman single factor (Harman, 1960), 2) Common Latent Factor and 3) Common Marker Variable. Common marker variable statistical technique was used in this study to estimate such variance. During the creation of the survey, no marker variables were created. Subsequently, no data was collected for this purpose. Common marker variable statistical technique was used in this study to estimate such variance. Lindell and Whitney (2001) recommend using variables with low correlations between observed variables as measures for the latent method variable. The results show that the constrained and unconstrained models are invariant. Therefore, failing to detect the presence of any specific response bias affecting the model.

## 1.3 Measurement Model Fit

Seven common model-fit measures were used to assess the model's overall goodness-of-fit.

Chi-square mean/Degree of freedom ($\chi 2/df$), Incremental fit Index (IFI), Tucker Lewis Index

(TFI), Comparative fit index (CFI), Root mean square error of approximation (RMSEA), Standard root mean square residual (SRMR). Overall, the results of the proposed research model showed an adequate fit: ($\chi 2/df$ 1.646., GFI 0.804, IFI .948, TLI .934, CFI .947, RMSEA .075, SRMR = .053).

**Multivariate and outliers:** A cook's distance analysis was carried out to determine if any multivariate influential outliers existed. These types of outliers can distort the accuracy and outcome of statistical analysis. Outliers occur for several reasons. One of which can be erroneous data entry, causing data to contain extreme cases. The results from the test revealed that there were no observed cases of a Cook's distance greater than 1. Most cases were less than 0.280, indicating no presence of influential outliers.

**Multicollinearity:** An examination of the Tolerance and Variance Inflation Factors (VIF) was carried out to assess multicollinearity. The multicollinearity does not exist in a regression model when the Tolerance value is greater than 0.1 and the VIF value is less than 10 (Field, 2009). The results of the Tolerance and VIF indicated that all Tolerance values were greater than 0.1, and the VIF values for all UTAUT constructs were less than 5. Thus, the assumption of the absence of multicollinearity was met.

## 1.4 Evaluation of Structural Model

The second step is to assess the structural model which includes testing the theoretical hypothesis and the relationships between the latent constructs. Seven common model-fit measures were used to assess the model's overall goodness-of-fit. This was assessed using the

AMOS 25 software. Overall, the results of the proposed research model showed an adequate fit: ($\chi 2/df$ 1.691., GFI .817, IFI .945, TLI .932, CFI .944. RMSEA .078, SRMR .0582). These results provided evidence that the model fit the data adequately. Thus, able to proceed to investigate the determinants, age and gender differences in mLearning adoption. Table 3 lists the path coefficients and their significance.

**Research question 1:** What are the determinants of behavior intentions to use mLearning at the SMG?

As expected, hypotheses (H1, H4, H7) representing the relationship among the main constructs (PE, EE, SI) to BIU were supported in this study. PE was found to be the second strongest positive predictor of behaviour intention to use mLearning (β0.347) and was found to have a greater level of significance than in the research carried out by Nassuora (2012) and Alharbi et al. (2017). EE was found to be the strongest positive predictor of behaviour intention to use mLearning (β0.460) and was found to have a greater level of significance than in the research carried out by Nassuora (2012) and Alharbi et al. (2017). SI was the third strongest positive predictor of behaviour intention to use mLearning (β0.199) and was found to have a similar level of significance as research conducted by Wang et al. (2009) (β0.12). The hypothesis that was not supported was H10: SD to BIU. Self-Directed did not significantly predict behaviour intention to use mLearning (β-0.03, n.s). The lack of effect of self-directedness on behaviour intentions to use mLearning is unique to this study as numerous scholars (Wang et al., 2009 ; Al-Adwan et al. 2018) found that selfdirectedness predicts behavioural intention to use mLearning. Surprisingly, the data proved that FC did significantly predict behaviour intention to use mLearning. FC was found to be the weakest positive predictor of behaviour intention to use mLearning (β0.109) and was found to have a lower level of significance than in the research carried out by Thomas et al. (2013) (β0.397) and Jackman (2014) (β0.238). Thus, H13 was not supported.

Table 3. Structural model results

| Path/Hypothesis | Beta | t-value | Results |
|---|---|---|---|
| PE → BIU (H1) | 0.347** | 3.244 | Supported |
| EE → BIU (H4) | 0.460*** | 5.590 | Supported |
| SI → BIU (H7) | 0.199* | 2.160 | Supported |
| SD → BIU (H10) | - .032 | -0.504 | Ns |
| FC → BIU (H13) | 0.109† | 1.822 | Not Supported |
| FC → USE | -0.206 | -2.690 | Negative relationship |
| BIU → USE (H14) | 0.960 | 10.659 | Supported |

Model fit indices: $\chi^2/df$ 1.691., GFI 0.817, IFI .945, TLI .932, CFI .944. RMSEA .078, SRMR = .0582

† $p < 0.100$ * $p < 0.050$ ** $p < 0.010$ *** $p < 0.001$ *ns* non-significant

**Research question 2:** Does gender or age have a moderating effect on the factors that determine behavior intentions to use mLearning at the SMG?

The results of the analyses of gender and age differences are outlined in Tables 4 and 5 respectively, listing the path coefficients and their significance. Additionally, a multigroup comparison test was carried out via a chi-square difference test to test significance of moderation. This resulted in the p-value of the chi-square difference test to be significant.

PE was found to be stronger for female staff (β 0.651) than male staff. These findings agree with previous research by Wang et al. (2009) who reported PE was stronger for females (β 0.317). This is perhaps because in the context the SMG, female staff adoption of mLearning for just-in-time knowledge acquisition is dependent on its perceived usefulness. EE was stronger for male staff (β 0.749) than female staff. These findings are supported by previous research by Wang et al. (2009) who reported effort expectancy was stronger for males (β 0.224). This maybe because this group of male staff anticipate hurdles to be overcome at this early stage of this new behaviour. SI was stronger for male staff (β 0.382) than female staff. These findings are confirmed by previous research by Wang et al. (2009) who reported social influence was stronger for males (β 0.224). This is perhaps because this group of female staff in the early stages of experience with mLearning are less likely to be influenced by individual early adopters. SD was a non-significant predictor of behavior intention to use, there were no statistically significant differences between male and female staff. The findings are contrary to past research by Wang et al (2009) who reported self-directed learning was stronger for females (β 0.337). This is because 84% of the SMG workforce hold undergraduate and postgraduate degrees suggesting they have strengthened their capabilities of self-directedness.

Table 4. Structural model results (moderators male and female)

| Path (Hypothesis) | Male Beta | Female Beta | Results |
|---|---|---|---|
| PE → BIU (H2) | -0.173 | 0.651*** | Not supported. Stronger for Female staff than Male |
| EE → BIU (H5) | 0.749*** | 0.442*** | Not supported. Stronger for Male staff than Female staff |
| SI → BIU (H8) | 0.382* | -0.037 | Not supported. Stronger for Male staff than Females |
| SD → BIU (H11) | 0.056 | -0.146 | Not supported. No difference |

† p < 0.100 * p < 0.050 ** p < 0.010 *** p < 0.001

Participants were divided into two groups: the older group consisted of ages greater than 30 years and the younger group with ages less than or equal to 30 years. A Multigroup comparison test was carried out via a chi-square difference test to test significance of moderation. It was observed that the p-value of the chi square difference test is statistically significant. Therefore, the model differs across the different groups (Younger staff and Older Staff). This study indicate PE was stronger for older staff (β 0.426) than younger staff. These findings are substantiated by previous research by Bandyopadhyay and Fraccastoro (2007) who reported performance expectancy was stronger for older people (β 0.301). The rationale for this could be that many of the older SMG staff have been working for the SMG for numerous years and have become accustom to the high-performance technology provided by the SMG technical team. EE was stronger for older staff (β 0.501) than younger staff age staff. These findings are corroborated by past research by Wang et al. (2009) who reported effort expectancy was stronger for older people (β 0.301). This is perhaps because according to Venkatesh et al., (2003) older staff has been shown to be associated with having difficulty in processing complex operations. Therefore, older staff members may perceive this novel way of acquiring knowledge as difficult. The SI construct was found to be significant for only younger staff (β 0.895). These findings are contrary to previous research by Wang et al., (2009) and Cheng et al. (2011) who reported social influences being stronger for older people (β 0.213) and (β 0.63), respectively. This is perhaps because younger staff members constitute 37% of

SMG workforce. This group may have recently joined the workforce and are unfamiliar with this novel use of mobile devices in a formal setting for the purposes of knowledge acquisition. SD was a nonsignificant determinant of mLearning it was only significant for younger staff (β 0.256). This is perhaps because younger staff have developed highly capable autonomous learning abilities. These findings are contrary to earlier research by Wang et al., (2009) who reported self-directedness as being stronger for older people (β 0.337).

Table 5. Structural model results (moderators younger staff and older staff)

| Path | Older Beta | Younger Beta | Results/Interpretation |
|---|---|---|---|
| PE → BIU (H3) | 0.426*** | 0.240 | Supported. stronger for younger staff than older staff |
| EE → BIU (H6) | 0.501*** | 0.248 | Supported. Only significant for older staff |
| SI → BIU (H9) | 0.097 | 0.895*** | Not supported. Stronger for Younger staff than older staff |
| SD → BIU (H12) | -0.082 | 0.256* | Not supported. Stronger for Younger staff than older staff |

† $p < 0.100$ * $p < 0.050$ ** $p < 0.010$ *** $p < 0.001$

Finally, $R^2$ value of the behavioural intention was 0.875 and that of the usage was 0.683. Translating these values into explanatory power, behavioural intention was 87.5% whilst use was 68.3%. This means that the explanatory power of this model is higher than Venkatesh et al. (2003) research reporting 70% explanatory power.

## 5. CONCLUSION

The purpose of this study was to use the UTAUT model as a theoretical framework to understand key factors that influences the adoption of mLearning as a just-in-time knowledge acquisition tool at the SMG. Due to the dearth of published research on the use of the UTAUT model in Museums context, it can be assumed, this is the first assessment of the UTAUT model in relation to mLearning in the milieu of the Museum sector. The analysis of both the data captured and the UTAUT model was carried out using SEM. The findings from this study showed that there are age and gender differences that moderate the relationship between the UTAUT constructs. It was also found that the newly added self-directedness construct was not a predictor of behavior intentions to use mLearning at the SMG. The conclusions in this research will help the diffusion of mLearning at the SMG and across the museums, galleries, arts, academic, charitable and cultural heritage sector as well as institutions outside of the cultural heritage sector.

Numerous authors believe the future direction of research is motivated and dictated by mobile device applications. (Pereira and Rodrigues 2013; Lim and Churchill 2016). Lim and Churchill (2016) suggests that research should also focus on aspects of multimedia content, communication, digital storytelling, social networking, and cloud computing. Additionally, future research could be conducted as a continuation of this study, exploring more diverse geographical locations to include other museums and galleries in the culture and heritage sector. Further mLearning research could investigate the relationship between contributors and seekers of knowledge would help to uncover staffs' perception of knowledge sharing within the SMG.

Senior management at the SMG are keen to explore machine learning capabilities as a way of automating many of the service desk processes.

The results and conclusion are limited and not intended to be exhaustive. Limitations exists in the interpretation of the findings thus suggestions throughout this study and specifically in the discussions section will require further research to confirm their validity.

This study used a single-time approach which was different from the research proposed by Venkatesh et al. (2003) where three measuring times of the same groups of samples were applied.

An inherent, limitation of the questionnaire is its static nature. Recipients can only answer the questions that researchers thought to ask. Therefore, it is acknowledged that further information may have been omitted. Additionally, this study is geographically limited to the United Kingdom. To make this study more generalizable, samples should be taken from more geographically dispersed group.

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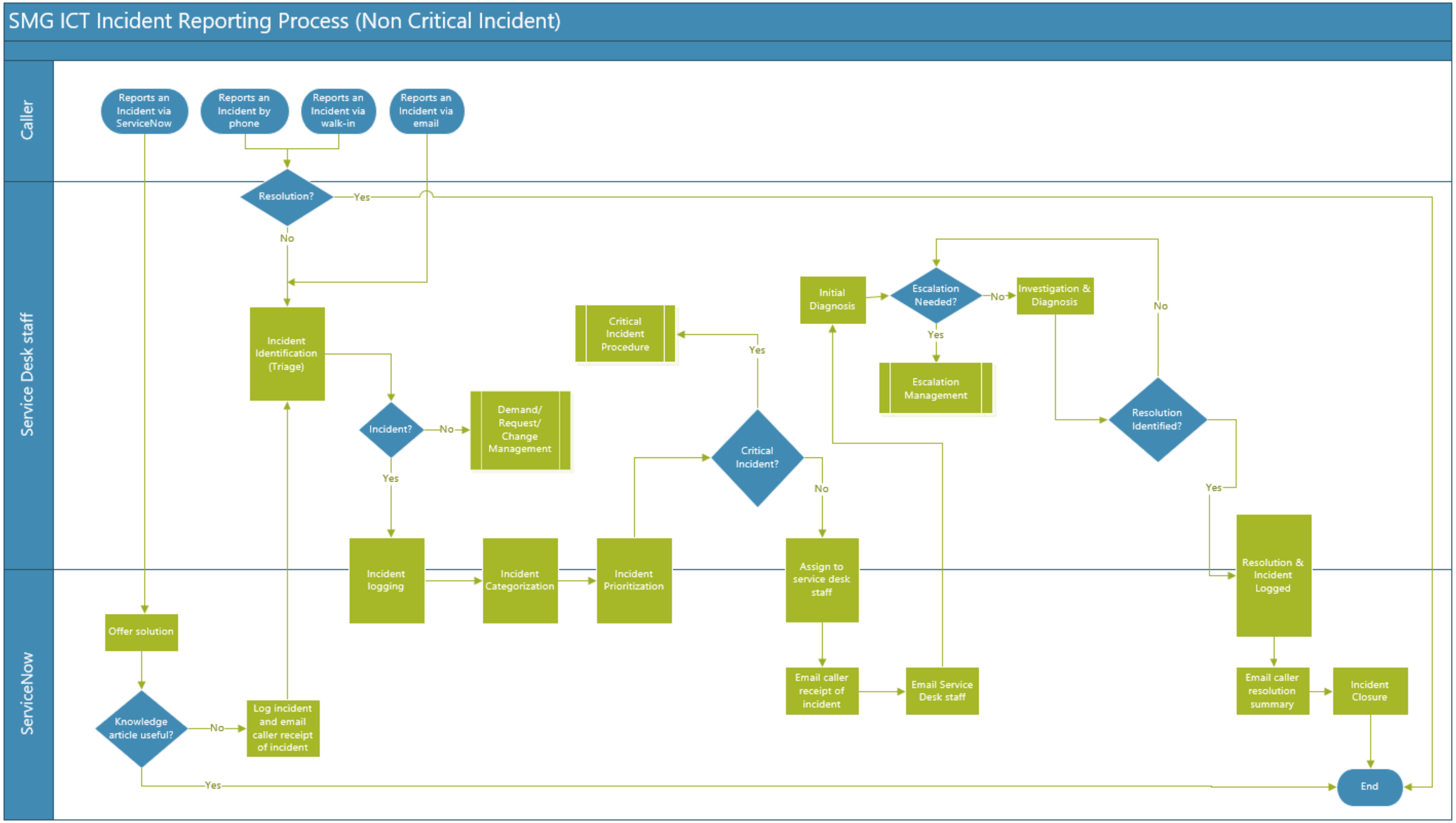
## Appendix 4 – Advances in Intelligent Systems and Computing

## Appendix 5 – ICT Incident Reporting Process



## Appendix 6 - Questionnaire

Definition: Mobile Learning, (mLearning) is learning on the go whilst using a mobile device. It is the provisioning of a learner-centered and flexible learning environment that enables knowledge construction, job skill development, and performance support across a variety of locations and work performance contexts. This environment is ubiquitous and supported by the use of mobile devices that enables direct access to learning materials and resources.

All data collected will be kept confidential. Individuals will not be identified nor will they be named in this study. This study is for the purposes of academic research only

1. Which of the following departments do you work in:

- Collections Services
- Commercial Operations
- Commercial and Live events
- Commercial Experience
- Development
- Digital
- Directorate
- Marketing and Comms
- Learning
- Masterplan, Estates & Design
- Operations (including Visitor Fundraising)
- Curatorial / Library / Archives
- One Collection
- Exhibitions
- Retail
- People & Culture
- Finance / Procurement
- ICT
- Other

2. Do you have line management responsibilities?
    - Yes
    - No
3. Gender
    - Male
    - Female
    - Other

4. Your age range

- < 20
- 21- 30
- 31 – 40
- 41 – 50
- >51

5. Highest Education Achieved

- Primary School
- Secondary School
- FE College

- HE College e.g., fd, Acess, HND, HNC
- Bachelor
- Postgraduate

6. Do you have use of an internet connected mobile device (e.g., mobile phone, tablet etc.) at work?

- Yes
- No

7. Do you have use of an internet connected mobile device (e.g., mobile phone, tablet etc.) at home?

- Yes
- No

8. Have you used a mobile device to access SMG Knowledge articles or the SMG ICT Training YouTube channel?

- Yes
- No
- Other

| | Strongly Agree | Agree | Neither agree or Disagree | Disagree | Strongly disagree |
|---|---|---|---|---|---|
| I know what mLearning is | | | | | |
| The management in my organisation have supported and enabled the use of m-learning. | | | | | |
| In general, my employer has supported and enabled the use of m-learning. | | | | | |
| SMG will allow me enough time to pursue mLearning alongside my day job | | | | | |
| I have the required ability to make use of mLearning | | | | | |
| I have access to the required resources to make use of mLearning | | | | | |
| I would find mLearning useful in my work for knowledge acquisition | | | | | |
| I think that mLearning is a good way to learn new skills | | | | | |
| Using mLearning enables me to accomplish activities more quickly | | | | | |
| Using mLearning increases my job productivity | | | | | |
| If I use mLearning, I will increase my chances of getting a promotion | | | | | |
| I prefer to use mLearning to solve IT related issues | | | | | |
| mLearning is particularly suited to ICT and technical subjects | | | | | |
| If the learning materials are of good quality, my interaction with m-learning would be clear and understandable. | | | | | |
| It would be easy for me to become skilful at using m-learning to aid my learning at work. | | | | | |
| If the learning materials are of good quality, I would find m-learning easy to use | | | | | |
| Learning to operate mLearning is easy for me | | | | | |
| I take responsibility for deciding what learning I will undertake and how I will do it | | | | | |
| When I am learning at work, I set my own goals and have a high degree of initiative | | | | | |
| I monitor whether I have accomplished my learning goals | | | | | |
| When it comes to learning at work, I am self-disciplined and find it easy to set aside reading time | | | | | |
| I understand how I can to put learning into practice | | | | | |
| I am good at managing my own learning time and get the most out of the time I have allocated for learning | | | | | |
| People who influence my behaviour at work, (e.g., friends, colleagues or line | | | | | |

manager) will think that I should use m-learning
People whose opinions I value professionally will expect I use m-learning
People who influence my behaviour at work, (e.g., friends, colleagues or line manager) will think that I should try to use mLearning for knowledge acquisition at work
I intend to use mLearning in the future for knowledge acquisition at work
I predict I would use m-learning in the future for knowledge acquisition at work
I plan to use mLearning in the future to help resolve ICT related issues at work
I will continue to use mLearning for knowledge acquisition
I will tell others about the positive aspects of using mLearning for knowledge acquisition at work
I will recommend others to the use of mLearning to help resolve ICT related issues at work
Using mLearning for knowledge acquisition at work is a good idea
I believe that working with mLearning would be useful
I would like ServiceNow more if I used mLearning
Using mLearning at work for quick knowledge acquisition would be a pleasant experience
Using mLearning at work for quick knowledge acquisition is a good idea

## Appendix 7 - Table summarising participants comments on survey items

| Survey item | What does the [question/term] mean to you? | Would you reword the question? If so, how? | When you created your response, what was it that you had in mind? General thoughts |
|---|---|---|---|
| **Which of the following departments do you work in:** | | | This question's all clear. I would not re-word it.<br><br>Should there also be a question for line managers about how likely it is they would encourage their direct reports to use m-learning? |
| **Do you have line management responsibilities** | | | This question's all clear. I would not re-word it. |
| **Gender** | | | This question's all clear. I would not re-word it. |
| **Age** | | | This question's all clear. I would not re-word it.<br><br>Do you want to know about those over retirement age? |
| **Highest Education Achieved** | | | This question's all clear. I would not re-word it.<br><br>Not sure if this is a standard set of levels, but for the last three do you expect it to make much difference for the purposes of this survey which |

| | | | |
|---|---|---|---|
| | | | postgraduate qualification people have? They could just be grouped as Postgraduate.<br><br>You could have finished secondary with no GCSEs, or GCSEs or GCSEs and A levels – I think you would want to know this? |
| **Do you have use of an internet connected mobile device at work?** | | | This question's all clear. I would not re-word it.<br><br>Maybe not mobile – eg desk top? I would maybe reword – do you connect to the internet at home at work? |
| **Do you have use of an internet connected mobile device at home?** | | | This question's all clear. I would not re-word it. |
| **I would find m-learning useful in my work.** | That I would find it helpful whilst fulfilling my duties<br><br>*If m-learning was made available to me, would I find it useful?* | m-Learning would be useful to refer to when undertaking certain tasks<br><br>*No* | That you meant people could access when they got stuck<br><br>*I answered this as a question about using m-learning for my role as PM* |

| | | | |
|---|---|---|---|
| | I think that m-Learning could help me in my work. | M-learning will help my professional development. | |
| **Using m-learning enables me to accomplish activities more quickly.** | That it would aid productivity<br><br>*Did using a m-learning module help me to learn to make me more efficient at my job.*<br><br>M-learning could (or does already?) help me be more productive at work | Referring to m-Learning would help me to accomplish activities more quickly<br><br>*No* | That it would be an advantage to having to wait for help<br><br>*I haven't responded to this as I haven't taken any m-learning. But I would think about what learning I took and whether I related any of this back to my role.*<br><br>*Is this the same as the one above?* |
| **Using m-learning increases my job productivity?** | *I think this question is too similar to the question above* | *no* | *Too similar to question above.*<br><br>I will be more efficient at my job after using m-learning. |

| | | | |
|---|---|---|---|
| **If I use m-learning, I will increase my chances of getting a promotion.** | Because I would be more efficient and better do my role<br><br>*Will I be more likely to get a promotion following m-learning?*<br><br>M-Learning could help with my career advancement and/or promotion. | *If I use m-learning, I feel I will increase my chances of getting a promotion* | *I'd think about objectives set by my manager. This could be an interesting question as they may not have any room for progression. Maybe change to helping career rather than promotion?*<br><br>*This is self-explanatory, but it's not clear why m-learning is any more likely to improve promotion chances than any other form of professional development*<br><br>I wonder if this should be if I use m-learning, I will increase my chances of career development |
| **I prefer to use m-learning to solve IT related issues** | *Do I prefer to access m-learning to solve IT related issues rather than log a call?*<br><br>M-Learning could be particularly useful for IT-related issues. | *no* | *I would think about how easy it is to look at a m-learning module and search this out over logging a call for someone to do it for me.*<br><br>I like to use online materials like videos to learn how to self-service IT issues |

| | | | |
|---|---|---|---|
| | | | The group above is split in tense between those in future tense (1,4) and present tense (2,3,5). Is this intentional, or should they all be predictive (future tense) questions? |
| **My interaction with m-learning would be clear and understandable** | *I'm not sure I understand this question. Should it say was instead of would?* | *Yes* | This would depend on the content<br><br>*N/A*<br><br>*I do not understand this question.*<br><br>I find this question slightly problematic as it depends entirely on the quality and clarity of the m-learning materials.<br><br>Not sure about what this one means |

| | | | |
|---|---|---|---|
| **It would be easy for me to become skilful at using m-learning.** | *Do you mean creating, mLearning*<br><br>*I don't think I really would know how to answer this.* | I could become skilled in navigating m-Learning to my aid my learning<br><br>*Yes* | That you meant using to help me rather than me creating<br><br>*N/A*<br><br>*Should the questionnaire say what m-Learning is?*<br><br>I pick up IT related skills quickly and would find it easy to learn to use m-learning. |
| **I would find m-learning easy to use.** | *I think this is to similar to the question above and below.* | *Yes* | Completely depends on quality of content<br><br>*N/A*<br><br>I pick up IT related skills quickly and would find it easy to learn to use m-learning. |

| | | | |
|---|---|---|---|
| **Learning to operate m-learning is easy for me.** | *I think the three questions are too similar and will confuse people.* | *Yes* | *N/A*<br><br>I pick up IT related skills quickly and would find it easy to learn to use m-learning. |
| **People who influence my behaviour will think that I should use m-learning.** | *Do people that influence my decision to use m-learning do so?* | *Should it be more specific to work colleagues?* | *I would think about people that I work with. I'm not sure how people would feel about influencing behaviours. I don't feel like anyone influences my behaviour, but I know that's probably not true.*<br><br>My manager, peers and role models will expect that I use m-learning.<br><br>This could be quite a complex idea for some members of staff. Individuals aren't always conscious of less direct influences on their behaviour. |
| **People who are important to me will think that I should use m-learning.** | *Again, I think this is too similar to the question above.* | *Yes* | *I personally don't think people important to me will think about me using m-learning.* |

| | | | |
|---|---|---|---|
| | | | People whose opinions I value (professionally and personally) will expect that I use m-learning. |
| **The seniors in my organisation have been helpful in the use of m-learning.** | *Are senior staff supportive of m-learning and me using it?* | My peers and management have been helpful in the use of m-learning.<br><br>*The management team in my organisation have been supportive in the use of m-learning.*<br><br>Would change seniors to leaders and maybe rephrase to The leaders in my organisation have been keen sponsors in the use of m-learning? | Seniors could mean older people!<br><br>*I'd think about how often I'd heard the management team talk about it and encourage me to use it.*<br><br>Senior managers have supported and enabled the use of m-learning. |
| **In general, my organisation has supported the use of m-learning.** | *Is the organisation supportive of m-learning and me using it?* | *No* | *I'd think about how often I'd heard the people in the organisation talk about it and encourage me to use it. Also, what is offered on m-learning.* |

| | | | |
|---|---|---|---|
| | | | My employer has supported and enabled the use of m-learning. |
| **When it comes to learning, I am a self-directed person.** | *Would I seek out learning myself or wait until it was offered to me?* | *No* | *I'd think about how I've sought out learning in the past.*<br><br>I take responsibility for deciding what learning I will undertake and how I will do it<br><br>*Does this mean self-motivated?* |
| **When I study, I set goals and have a high degree of initiative.** | *Do I set goals use my own initiative to drive it forward when I study?* | When I learn, I set goals and have a high degree of initiative.<br><br>*No*<br><br>When I study, I set my own goals and have a high degree of initiative. | Most people do not study at work – they 'do' work<br><br>*I'd think about past time I've studied and whether I set and met goals.*<br><br>I know what I want to achieve and can decide what I need to do to achieve it. |

| | | | |
|---|---|---|---|
| **When it comes to learning, I am self-disciplined and find it easy to set aside reading time.** | *I think the question above and below are all very similar questions.* | *Yes, due to comment above.* | *N/A*<br><br>I am good at managing my own time and ensuring I prioritise learning within the time I have available |
| **I am able to manage my study time effectively.** | *Similar to the questions above. They are also talking about managing study time effectively.* | *Yes, due to comment above.*<br><br>I am able to manage my own study time effectively. | *N/A*<br><br>I am good at managing my own time and get the most out of the time I have allocated. |
| **I intend to use m-learning in the future.** | *Will I use m-learning in the future?* | *No* | *Was m-learning easy to use, did it do the job, will I use it again.*<br><br>pretty self-explanatory |
| **I predict I would use m-learning in the future.** | *Again, too similar to the question above. I'd feel like I was answering the same question over and over.* | *Yes, due to comment above.* | *N/A*<br><br>Same as above? |

| | | | |
|---|---|---|---|
| | | | pretty self-explanatory |
| **I plan to use m-learning in the future.** | *? Again, too similar to the question above. I'd feel like I was answering the same question over and over.* | *Yes, due to comment above.*<br><br>I would like to? plan to use m-learning in the future. | *N/A*<br><br>pretty self-explanatory |
| **I will continue to use mLearning.** | *Again, too similar to the question above. I'd feel like I was answering the same question over and over.* | *Yes, due to comment above.* | *N/A*<br><br>Same as above?<br><br>pretty self-explanatory |

**Overall Survey**

Pilot group member response: *My issue with the questionnaire is that its writing style seems to predicate that people 'study' when this is not the case. Learning and studying are very separate, and m-Learning is probably better suited to short educational bursts where somebody needs to learn how to perform a simple (or complex) task quickly - I do not see it as a tool for longer-term studying as some of the questions seem to be framing it, i.e. I am able to manage my study time effectively. The beauty of m-Learning is that it can picked quickly accessed at any time to help you move on rather than have to wait for human or technical support*

Researcher's response: This is a relevant point, therefore the questionnaire will be updated to reflect the pilot group member's argument raised about differentiating between studying and learning. The questions in the survey that refer to studying will be reworded to omit instances where it has stated studying. This is to reflect the true nature and purpose of this research.

After examining the responses from the group, it was found that responses from question 3 (When you created your response, what was it that you had in mind?) provided insightful guidance for revisions to the survey. This is because this question ascertained whether the survey question being asked reflected the intention of the researcher. Additionally, Question 2 aided with the rewording of the questions.

## Appendix 8 - Participant's and researcher's responses from the pilot study and UTAUT survey development

Below are some of the responses received from the evaluation of the survey items.

**M-learning definition**

Pilot group member response: *On your definition of m-learning – does it have to be on a mobile device to be m-learning? If I watch a Youtube video on a desktop, is it still m-learning? Is part of the point that it's accessed online at a time and place of the user's choosing?*

Pilot group member response: *I think the very term m-learning could be off-putting. It could help to give some examples of m-learning with which users may already be familiar e.g., your videos; Skillslab.*

Pilot group member response: *The definition of mLearning are fine. Helps to add clarity and makes the survey more logically understood.*

**Survey items – participants comments**

*Main question: When will this survey be used? Will people already have done something on M-Learning, so they know what it is? Or is this preliminary to any launch?*

Researcher's response: The survey will be launched as soon as the pilot study has concluded. There will not be any other intervention prior to the launch of this survey so staff do not need to have done anything on mLearning. Participants will be presented with a definition of mLearning along with an example.

Pilot group member response: *If you are trying to find out how much mobile-based learning they have already done, then you may want to ask things like 'I know what mobile-based learning is' 'I think that m-learning is a good way to learn new skills' 'M-learning is particularly suited to ICT and technical subjects' etc.*

Researcher's Response: This is a pertinent point that requires consideration and may be added to the questionnaire.

Pilot group member response: Y*ou can ask what they think the strengths, benefits and challenges of m-learning might be, e.g., 'SMG is likely to support m-Learning amongst its staff' 'SMG will likely allow enough time to pursue m-Learning alongside my day job' 'M-Learning needs to be directed at particular problems to be useful' etc.*

Researcher's Response: The question about asking "What they think the strengths, benefits and challenges of mLearning might be" would be useful if the purpose of this research was to ascertain staff perceptions of mLearning. In such case the research paradigm would be more qualitative. However, due to the research paradigm adopted in this research, a question framed this way would be problematic to measure as it is not asking, “To what degree would you agree with this statement”. However, the examples given are much less problematic to measure and may provide useful insight that may strengthen the measurement of the construct, Facilitating conditions.

Pilot group member response: *Would another preliminary question at the outset of the survey help, to establish whether respondents have had any/much prior experience of m-learning? And possibly to establish a (self-defined) assessment of digital literacy? Somebody like me who considers themselves an advanced IT user may naturally be more confident with m-learning*

Researcher’s response: It would be useful to present a preliminary question to establish whether respondents have any or much prior experience of mLearning. However, a self-defined assessment of digital literacy would be beyond the scope of this study as Digital literacy as defined by Martin (2006) reflects awareness, attitudes and the abilities of individuals to use digital tools to identify, access, manage, integrate, evaluate, analyse and synthesise digital resources, construct new knowledge, create media expressions, and communicate with others, in the context of specific life situations, to enable constructive social action; and to reflect upon this process.

Pilot group member response: *The questions in the survey have been split in tense between those in future tense (1,4) and present tense (2,3,5). Is this intentional, or should they all be predictive (future tense) questions?*

Researcher’s response: The reason why the survey has been split into future tense and present tense is because the survey was developed to measure staff’s readiness as well as intention to use mLearning. Readiness in this context infers a present situation for example if staff currently have the inclination; willingness and the capacity to use mLearning without the need for training or any other intervention. Whereas, the term intention in this context refers to the mental state or plan in the mind that represents a commitment to carrying out an action in the future.

Pilot group member response: *My personal opinion is that it is too long and I’d probably try and answer as quickly as I can then giving you untrue information. Some questions seem like they could be one rather than 3 or 4 helping the overall length of the questionnaire. –*

Pilot group member response: *There is generally some near-repetition in some of the groups of questions, not sure if you’re looking for the best phrase or intentionally asking variants of the same question.*

Researcher’s response: The reason why there are 3 – 4 questions asking similar things is because there are a variety of ways to measure the various ways of examining a construct. For example, the construct Effort Expectancy can be viewed from various viewpoints. It is similar to completing a psychometric test, these types of tests ask the same question in various ways as their aim is to measure various aspects of a construct. However, due to this perception and the outcomes that may come as a result, the researcher will aim to rephrase the questions as not to confuse the participants.

Pilot group member response: *I think something to explain that would be useful to stop people getting frustrated.*

Researcher's response: This is a pertinent point and will form part of the participants introduction letter.

## Appendix 9 - Consent Form

I have read and understand the research project and the way in which my contribution will be used. All questions I have had, have been answered. It has been explained to me how the information that I give the researcher or anything else that I tell them will be kept confidential, and that my identity will be protected when the researcher uses the information that I give them.

I understand that I can withdraw my consent to take part in the research at any time. I understand that the removal of my responses from the research is dependent on the researcher's ability to uniquely identify my response due to the anonymous nature of the responses.
I understand that by following the link below, I give my permission for the information that I am about to give for the above project to be used for research purposes only.

[Takes approximately 5 minutes to complete]
Click here to complete questionnaire.

Please do not hesitate to call me if you have any questions as you read over this material. I am happy to review any of this with you and answer any questions you may have. If you would like to speak with the lead researcher, please call 07482 343457 or email Tony.Welch@sciencemuseum.ac.uk.

Thank you for your time.

Sincerely,
Tony Welch

## Appendix 10 - Research introduction email Form

**Title of research project:** The impact of mLearning on the effective management of incoming ICT support inquiries: A Study of the Science Museum Group
**Name of lead researcher:** Tony Welch

Dear Participant,
I am writing you to let you know about a research study that you have the option to take part in. The research study is being conducted by Tony Welch who works in the SMG ICT Department and studies at the University of Worcester. I am contacting you because you are a Science Museum Group (SMG) colleague or a registered volunteer colleague who work frequently with SMG.

This study is being done to learn more about the use of mobile Learning and its impact on productivity namely, how mLearning can be used to effectively manage incoming ICT support inquiries. Your responses will be used to measure if, and how mLearning is currently being used by staff at the science museum. This research will lead to providing recommendations to the SMG's Senior Management team on leveraging mLearning at the SMG in order to achieve operational objectives.

### Definition of mLearning

mLearning is the provisioning of a learner-centered and flexible learning environment that enables knowledge construction, job skill development training, and performance support across a variety of locations and work performance contexts. This environment is ubiquitous and supported by the use of mobile devices that enables direct access to learning materials and resources.

### Participation

Taking part in this research is voluntary. You may choose not to take part. If you decide not to take part in this study, your decision will have no effect on any service you receive from the ICT department. Thus, you will receive the same attitudes and services that you would normally expect from the team.

### COSTS

There are no costs to you to participate in this study only the time taken to complete the questionnaire.

## Appendix 11 – UTAUT Questions, sub scale labels and constructs

| UTAUT Questions | Sub scale labels | Constructs |
|---|---|---|
| I know what mLearning is | FC1 | Facilitating conditions (FC) |
| The management in my organisation have supported and enabled the use of m-learning. | FC2 | |
| In general, my employer has supported and enabled the use of m-learning. | FC3 | |
| SMG will allow me enough time to pursue mLearning alongside my day job | FC4 | |
| I have the required ability to make use of mLearning | FC5 | |
| I have access to the required resources to make use of mLearning | FC6 | |
| I would find mLearning useful in my work for knowledge acquisition | PE1 | Performance expectancy (PE) |
| I think that mLearning is a good way to learn new skills | PE2 | |
| Using mLearning enables me to accomplish activities more quickly | PE3 | |
| Using mLearning increases my job productivity | PE4 | |
| If I use mLearning, I will increase my chances of getting a promotion | PE5 | |
| I prefer to use mLearning to solve IT related issues | PE6 | |
| mLearning is particularly suited to ICT and technical subjects | PE7 | |
| If the learning materials are of good quality, my interaction with m-learning would be clear and understandable. | EE1 | Effort expectancy (EE) |
| It would be easy for me to become skilful at using m-learning to aid my learning at work. | EE2 | |
| If the learning materials are of good quality, I would find m-learning easy to use | EE3 | |
| Learning to operate mLearning is easy for me | EE4 | |
| I take responsibility for deciding what learning I will undertake and how I will do it | SD1 | Self-directedness (SD) |
| When I am learning at work, I set my own goals and have a high degree of initiative | SD2 | |
| I monitor whether I have accomplished my learning goals | SD3 | |
| When it comes to learning at work, I am self-disciplined and find it easy to set aside reading time | SD4 | |
| I understand how I can put learning into practice | SD5 | |
| I am good at managing my own learning time and get the most out of the time I have allocated for learning | SD6 | |
| People who influence my behaviour at work, (e.g. friends, colleagues or line manager) will think that I should use m-learning | SI1 | Social Influence (SI) |
| People whose opinions I value professionally will expect I use m-learning | SI2 | |
| People who influence my behaviour at work, (e.g. friends, colleagues or line manager) will think that I should try to use mLearning for knowledge acquisition at work | SI3 | |
| I intend to use mLearning in the future for knowledge acquisition at work | BIU1 | Behaviour Intentions (BI) |
| I predict I would use m-learning in the future for knowledge acquisition at work | BIU2 | |
| I plan to use mLearning in the future to help resolve ICT related issues at work | BIU3 | |
| I will continue to use mLearning for knowledge acquisition | BIU4 | |
| I will tell others about the positive aspects of using mLearning for knowledge acquisition at work | BIU5 | |

| | | |
|---|---|---|
| I will recommend others to the use of mLearning to help resolve ICT related issues at work | BIU6 | |
| Using mLearning for knowledge acquisition at work is a good idea | BIU7 | |
| I believe that working with mLearning would be useful | BIU8 | |
| I would like ServiceNow more if I used mLearning | BIU9 | |
| Using mLearning at work for quick knowledge acquisition would be a pleasant experience | BIU10 | |
| Using mLearning at work for quick knowledge acquisition is a good idea | BIU11 | |

## Appendix 12 - Ethical review approval

University of Worcester

**HUMANITIES, ARTS AND SOCIAL SCIENCES RESEARCH ETHICS COMMITTEE (HASSREC)**
**CONFIRMATION OF APPROVAL**

**DATE: 17th August 2018**

**HASSREC CODE: HCA17180070-R**

The impact of mLearning on the effective management of incoming ICT support inquiries: A Study of the Science Museum Group.

Dear Tony,

Thank you for your application for proportionate review ethical approval to the Humanities, Arts and Social Sciences Research Ethics Committee on the 29th June 2018.

Your application has been reviewed in accordance with the University of Worcester Ethics Policy and in compliance with the Standard Operating Procedures for proportionate ethical review.

The outcome of the review is that the Committee is now happy to grant this project ethical approval to proceed.

Your research must be undertaken as set out in the approved application for the approval to be valid. You must review your answers to the checklist on an ongoing basis and resubmit for approval where you intend to deviate from the approved research. Any major deviation from the approved application will require a new application for approval.

Although ethical approval has been given for this research, please consult the information on Research Ethics Blackboard page relating to the General Data Protection Regulations (GDPR), which came into effect on 25 May 2018 prior to commencing any further work on the project. It is your responsibility to ensure that your research (and all relevant documentation) adheres to these regulations.

As part of the University Ethics Policy, the University undertakes an audit of a random sample of approved research. You may be required to complete a questionnaire about your research.

Yours sincerely,

*Bere*

**BERE MAHONEY**
*Chair - Proportionate Review Committee*
Humanities, Arts and Social Sciences Research Ethics Committee (HASSREC)
Ethics@worc.ac.uk

## Appendix 13 - Researcher's journey

This section covers a discussion of the factors that influenced the researcher's motivation and initial experiences during the development of this study.

I began my professional career as an analyst programmer for a variety of sectors e.g., Local government, Legal, Telecoms and Computer hardware and software retailers. After working in this field for approximately five years I transitioned into education. I have been working in adult education and development for the past twenty years. My interest in Technology Enabled Learning (TEL) increased when I started teaching on the blended learning unit on the Postgraduate Certificate in Education (PGCE) course in a West London further education college. This was six years after getting into the field of teaching adults on various computer courses. My interest, education, training and how it impacts businesses began to develop whilst completing my Master of Business Administration (MBA) in the year 2015. I was first made aware of how knowledge and its use in organisations can provide an irreplicable competitive advantage. This was covered in the Strategy unit where we covered competitive advantages. It was also witnessed in practice within my role as a Teacher trainer in a FE college. An example of this was the result of a knowledge drain where many staff members left the organisation and several courses had to be removed from the college's course listing because of the departure of those staff members.

More recently, I have been employed as an IT trainer for a housing association and for the science museum group. Again, these roles have involved training adults to use ICT for the purpose of improving productivity in its many forms. My role has recently morphed into a ICT Training Manager, Business Analyst and ICT Business Partner. This has further enhanced my motivation to investigate ways of improving business processes and recommending technology to help augment improvement.

My motivation to conduct this current study was determined by my interest in TEL, adult learning and development and my own interests in personal and professional development. My past and present professional and personal experiences have helped to facilitate the understanding of mLearning.

**Insider/outsider researcher**

It would be useful at this point to discuss the notion of insider/outsider research as it highlights the researcher's stance in the field as well as on the researcher continuum. Based on my positionality as an ICT Training Manager, Business Analyst, and Information Technology (IT) Business Partner, my overall approach to research at the Science Museum Group will be from an insider's perspective (Evered and Louis, 1981) drawing on a deductive strategy as it permits the formulating and testing of hypothesis (Van Maanen, 1979) to be discovered and understood. This approach to research is contested by interpretivist paradigms as the nature of inductive is, in essence grounded an incompatible ontological and epistemological principles to outsider, deductive research strategies.

Drawing on Kantian deontology and the notion of Ethics and Morals in particular 'hypothetical and categorical Imperatives' (Kant, 1785), these will be the frameworks from which I will use to reconcile some of the challenges outlined above with regards to being an insider researcher and ethical practice. Lastly, due to the complexities involved with being an insider researcher, practicing reflexivity will be essential to good research practice (Alvesson and Skoldberg, 2009).

In order to become more familiar with the start of my journey, the next chapter discusses the extant literature on the topic of this study.