Determining the usability, user experience, and continuance use of a mobile application and an online portal: A comparative case study

by

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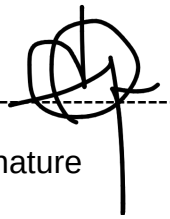
DECLARATION

I, Thobani Mhlongo, hereby declare that the thesis titled "**Determining usability, user experience, and continuance use of a mobile application and an online portal: A comparative case study"** is the result of my own independent investigation and that all the sources I have used or quoted have been indicated and acknowledged utilising complete references. I further declare that the work is submitted for the first time at this university/ faculty towards the *Magister Scientiae degree in Computer Science and Informatics* and that it has never been submitted to any other university/ faculty for the purpose of obtaining a degree. I also declare that I am aware that the copyright of this thesis is vested in the University of the Free State.



---------- 22 Sep 2023 ----------

Signature Date

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This work would not have been possible without the support from various individuals and institutions, either in small or big ways. On that note, I would like to thank you for your tremendous support.

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To all, *ngithi nime njalo*

DEDICATION

I have so much respect for the birds for their consistent melody, reminding humankind of the beauty of nature. I, therefore, dedicate this thesis to the birds.

ABSTRACT

Background: The increasing number of users with access to the internet, computers, and mobile devices propels most institutions to avail their services through online portals and mobile applications. However, these online portals and mobile applications depend on users utilising them. There are instances where users underutilise or completely opt out of these platforms. The reasons may include poor usability and negative user experience. This is a cause for concern since funds are invested in their development with the anticipated return on investment.

Aim: This study aimed to compare the usability, user experience, and continuance use of a regulatory institution's mobile application and online portal with respect to performance, user satisfaction, and continuance intentions.

Methodology: This single case study followed an explanatory sequential design, wherein the initial phase consisted of data collection using a self-administered questionnaire (quantitative phase). For the second phase, the data was collected using an interview protocol (qualitative phase). The self-administered questionnaire compared the usability, user experience, and continuance use of the mobile application and the online portal. The interview protocol was used to further explain the quantitative results. Participant recruitment used systematic random sampling for the quantitative phase and purposive sampling for the qualitative phase. The analytical approach involved descriptive and inferential statistics, and thematic analysis.

Findings: The results established that the online portal was more usable than the mobile application; users had a positive user experience with the online portal and were more likely to use the online portal in future, but not so much with the mobile application. The contributing factors to the online portal findings were its efficiency, user-friendliness, understandability, and learnability. In addition, inefficiency, errors, limited functionality, and lack of user-friendliness issues were identified as contributors to the mobile application's negative experience and moderate usability. Regarding continuance use, the quantitative and qualitative results suggested that participants were keen to use the online portal in the future. However, the quantitative results for the mobile application indicated that the participants did not have interest in using the mobile application again in future, despite the interview results indicating otherwise. Participants identified improvement in efficiency and visual appeal as conditions for their future re-use of the mobile application.

Keywords: Usability; user experience; continuance use; continuance intentions; Human-Computer Interaction; mobile application; online portal

PUBLICATIONS

A paper from this study was accepted and presented at the 10th International Conference on Human Interaction and Emerging Technologies, August 22-24, 2023, Université Côte d'Azur, Nice, France.

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The paper is listed as Appendix G.

ACRONYMS

CLT	Cognitive Load Theory
CSUQ	Computer System Usability Questionnaire
ECM	Expectation-Confirmation Model]
ECT	Expectation-Confirmation Theory
GHREC	General/Human Research Ethics Committee
HCI	Human-Computer Interaction
ISO	International Organization for Standardization
ISSM	Information System Success Model
KMO	Kaiser-Meyer-Olkin
KZN	KwaZulu-Natal
MD	Mean Difference
PACMAD	People At the Centre of Mobile Application Development
PCA	Principal Component Analysis
SPSS	Statistical Package for Social Sciences
TAM	Technology Acceptance Model
UEQ	User Experience Questionnaire
UX	User Experience

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CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

The early stages of computing did not have a typical end-user in mind, whether in software or hardware designs (MacKenzie, 2013). Specifically, in the case of hardware, the design of computers in the early stages was geared towards advanced users. The notion of designing and developing products that would be user-friendly (i.e., easy to use by a typical 'person on the street') was not even a consideration. The operation of computers at the time was mainly within the realm of computer specialists. It was only in the early 1970s, when the notion of personal computing was introduced, that user-friendliness became a desired attribute for computer devices (Ceruzzi, 2003).

Nowadays, designing and developing user-friendly products is critical for the overall adoption of the product and continuous use. The usability of applications or products should not be an after-thought (Inostroza *et al.*, 2012; Lacerda & von Wangenheim, 2018). Rather, it should form part of the iterative development of the product. The usability and overall user experience (or UX as it is generally referred to) of a product are the cornerstones that determine whether the product will be used as intended and/or whether the user will consider the product as part of their daily lives (i.e., continuance use).

The juncture between the user and the product lies in the user interface of the product (Reynoso & Romo, 2020). For this dissertation, the term *product* includes interactive systems like mobile applications, websites, or online portals. User interaction with these products is generally via a well-defined user interface. The interaction may evoke a positive or negative experience, perception, and/or attitude towards the product. According to Knijnenburg *et al.* (2012), the extent to which the user has a positive experience with the product depends on the user's need for self-reliance, the capability to perform tasks at hand, and stimulation invoked when one uses the product. These needs are more important for self-service oriented products due to the limited availability of user support.

The preceding discussion identifies the following three components: interaction, usability, and user experience of products. The upcoming discussion provides further background and context to the current study. In addition, the research problem,

research questions, research objectives, research methodology, research validity, reliability and trustworthiness, ethical consideration, and contributions of the study are discussed. This is followed by identifying the limitations of the study and future research, and the chapter is then concluded with the layout for this dissertation.

1.2 Background and context

There is a gap in the body of knowledge regarding studies that compare the different service platforms for similarities and differences, if any, in terms of usability, UX, and continuance use. In addition, a trend has been observed in various institutions, where services typically available through online portals are now provided using mobile applications (Almarashdeh *et al.,* 2019; Alswaigh & Aloud, 2021; Khan *et al.*, 2021). This trend is also visible in Company X[1], the company used as a case study for the purpose of this research.

Often, mobile applications become alternative platforms for the same services offered through online portals or other platforms, albeit with some services only reserved for specific platforms. The usability of websites and/or e-learning platforms dominates previous studies (Lim *et al.*, 2019), thereby necessitating the investigation of usability in other domains, particularly service-oriented domains.

The usability of a product is as important as the product itself. This view is well-established and supported in prior studies (Máchová *et al.*, 2018; Mack & Sharples, 2009; Merino *et al.*, 2012; Nikiforova & McBride, 2021). Equally, UX is a fundamental tenet of users adopting the product and, to some extent, how users perceive the product's usability. Owing to the importance of usability and UX in the value chain of product development, various studies have investigated the usability and/or UX of mobile applications (e.g., Han *et al.*, 2018; Kortum & Sorber, 2015; Othman *et al.*, 2018). Depending on product usability and UX, the user may decide whether to use the product again.

The study by Han *et al.* (2018) investigated the correlation between augmented reality applications and UX within the context of heritage tourism, and the findings confirmed the correlation between product features and UX. However, the study focused on UX instead of both usability and UX. Kortum and Sorber (2015) investigated the usability

[1] The identity of the company used as a case study was anonymised in this dissertation for privacy purposes.

of mobile applications on mobile phones and tablets alike, and their findings suggested that mobile applications were more usable on a mobile phone than on a tablet. This study only focused on usability and limited the investigation to mobile devices (i.e., mobile phones and tablets).

Anchahua *et al.* (2018) tested the UX maturity model to improve user satisfaction among web applications. The findings of this study established that the UX maturity model improved the UX maturity of web applications, and that the conversion rate of the website improved significantly. It should be noted that the study was geared towards web applications and UX was the critical focus. It is unclear whether the same findings may hold when the model is extended to mobile applications. On the other hand, Harrati *et al.* (2015) explored using a task-based model for user interaction with a system (i.e., web application). The findings suggested the importance of the task-based model in discovering usability issues of a website and/or web application. However, the task-based model was applied only to the web application. The limitation in testing usability on web applications only was also noted in the study by Ssemugabi and De Villiers (2016). This limitation (as well as those mentioned in the studies above) requires further investigation, particularly regarding the usability, UX, and continuance use of mobile applications and online portals.

The commonality among these studies is that they investigated the usability and/or UX of either the mobile application or web application, but not both. The current study therefore conducted a comparative investigation on the usability, UX, and continuance use of a mobile application and online portal that offer the same functionality from the point of view of its users. It is crucial to consider comparing the online portal and the mobile application in terms of these three constructs to understand how they influence these two platforms. Previous studies on UX and/or usability generally did not extend to the continuance use of the product (i.e., the extent to which usability and UX contribute towards the prolonged and continued use of the product (Yusof & Iahad, 2019). While this study investigated UX, usability, and continuance of using a mobile application and online portal, it did not investigate the cause-effect relationship between these phenomena.

1.3 Research problem

The research problem emanated from the experiences that Company X had on its service provision platforms, namely the mobile application and online portal. The extent of utilising the above-mentioned platforms differed fundamentally since the launch of the mobile application. According to Nkuna (personal communication, 23 July 2020), the use of the Company X mobile application was significantly lower than that of the online portal. The introduction of a mobile application as an extension to their online portal by most institutions is based on the assumption that smartphone access and mobile application downloads were increasing exponentially. Furthermore, mobile application downloads have recently seen a significant increase in emerging economies like South Africa (Iqbal, 2022).

The Company X mobile application reviews on Google Playstore[2] suggested that the prevalent challenges amongst its users were login and user interface issues, making it difficult for users to transact. Hoehle and Venkatesh (2015) maintain that institutions overlook the nature of mobile devices when designing a mobile application, and as such, user interactions and usability for mobile applications may become a challenge. Aljedaibi and Bashmail (2021) underpin the user satisfaction as an important factor for mobile application developers and mobile companies alike. The Company X mobile application has been downloaded more than 100 000 times, yet user activity only accounted for a fraction of the downloads. A small portion of the downloaded applications is used again, despite users spending more time on their mobile phones than on their web browsers (Hoehle & Venkatesh, 2015; Tao & Edmunds, 2018). This could be attributed to poor usability and UX, as this could cause some users to switch from mobile to web, or completely discontinue using the mobile application. For example, with Company X, one user switched back to the online portal because the application was frustrating.

There is a dearth of knowledge on the relationship between the UX and usability of a product, and its continuance use. Tan *et al.* (2020) argue that examining both usability and continuance use has received less attention than deserved. Previous studies on customer loyalty were limited to website usability, satisfaction, and customer loyalty,

[2] https://play.google.com/store/apps/details?id=za.co.companyx.app&hl=en_ZA&gl=US

whereas this study extended the scope to include usability and UX and focused on the continuance use of an online portal and mobile application. The comparative nature of this study may thus form the basis for future correlational or cause-effect studies on usability, UX, and continuance use of a product.

1.3.1 Problem statement

Based on the problems experienced by Company X revolving around the underutilisation of their mobile application (Section 1.3), this study aimed to compare the usability, user experience, and continuance use of Company X's mobile application and online portal with respect to performance, user satisfaction, and continuance intentions. The purpose was to determine similarities and differences that informed users' perception of the mobile application and online portal in terms of these three aspects.

1.3.2 Introducing Company X

Company X, the company used as a case study for this research endeavour, is an institution of the state in the public administration sector. It was established in terms of the Companies Act (Act no. 71 of 2008). Its primary functions are to register and maintain companies, close corporations, co-operatives, and intellectual property rights. The mobile application and online portal evaluated in this study, are used by Company X in the registration and maintenance of company registries, including name reservation, director amendments, company registration, filing of annual returns, and the production of company registration certificates.

A contributing factor for choosing Company X as a case study, was the fact that its target population is the general public, including unemployed and digitally illiterate users, thus making it even more important to pay attention to product usability and UX.

1.4 Research questions

The above research problem gave rise to the main research question for this study, namely:

How does the usability, user experience, and continuance use of a mobile application and online portal compare in terms of performance, user satisfaction, and continuance intentions?

In order to answer the main research question, the following subsidiary questions needed to be answered:

- Which performance and satisfaction (self-reported) metrics are applicable in comparing a mobile application's usability, user experience, and continuance use with its associated online portal?
- How does the usability of a mobile application and its associated online portal compare in terms of performance?
- How does the user experience of a mobile application and its associated online portal compare in terms of user satisfaction?
- How does the continuance use of a mobile application and its associated online portal compare in terms of continuance intentions?

1.5 Research objectives

To answer the main research question, the following main research objective was pursued:

To compare the usability, user experience, and continuance use of a mobile application and online portal in terms of performance, user satisfaction, and continuance intentions.

The following subsidiary objectives guided the answering of the subsidiary research questions:

- To determine the performance and satisfaction metrics that are applicable in comparing the usability, user experience, and continuance use of a mobile application and its associated online portal;
- To compare the usability of a mobile application and its associated online portal in terms of performance;
- To compare the user experience of a mobile application and its associated online portal in terms of user satisfaction; and

- To compare the continuance use of a mobile application and its associated online portal in terms of continuance intentions.

With the research questions and objectives defined, it was necessary to determine the research design and methodologies that had to be deployed to answer these research questions and address the research objectives.

1.6 Research methodology

This section provides a brief description of the research methodology pursued in this study. The outline is structured in terms of the research onion layers (Saunders *et al.*, 2019), comprising the philosophical approach, the approach to theory development, the methodological choice, the research strategy, the time horizon, and the techniques and procedures. Each layer, including the suitability for each choice, is discussed in more detail in Chapter 3.

1.6.1 Research philosophy

The philosophical grounding of a study is informed by the position that the researcher adopts. The available philosophies include positivism, critical realism, interpretivism, postmodernism, and pragmatism (Saunders *et al.*, 2019). This study adopted a pragmatic approach which acknowledges that there is no single view of understanding social reality, that is, social reality and the nature of knowledge are the result of human experiences, and such experiences can be objectively derived (Kaushik & Walsh, 2019).

1.6.2 Approach to theory development

The primary approaches to theory development are deductive, inductive, and abductive reasoning. Since this study adopted a pragmatic approach, deductive and inductive approaches were considered appropriate and thus adopted. According to Bryman and Bell (2019), it is not always practical for studies to be exclusively deductive or inductive.

1.6.3 Methodological choice

This study used a mixed-methods research design by means of an explanatory sequential design. The nature of explanatory sequential design is such that there are

two phases, beginning with a quantitative phase followed by a qualitative phase (Creswell & Creswell, 2018). The major phase of the study was quantitative, and the qualitative phase was used to further explain the quantitative results. A structured questionnaire was used in the quantitative phase of data collection, whereas the qualitative phase employed a semi-structured interview protocol.

1.6.4 Research strategy

The research strategy for this study was a case study in which Company X was used as a case, and two products (i.e., online portal and mobile application) were compared for usability, UX, and continuance use. The case study may use one case (i.e., a single case study) or more (i.e., multiple case studies) (Yin, 2018). Since only Company X was used as a case, the study followed a single case study design.

1.6.5 Time horizon

The time horizon for a study can be cross-sectional or longitudinal (Saunders et al., 2019). Owing to the time limit, this study adopted the cross-sectional approach as data collection was conducted at one point (Babbie, 2021; Creswell & Creswell, 2018).

1.6.6 Techniques and procedures

The choice of techniques and procedures for this study was informed by the composition and sparsity of the study population, the research questions, the research objectives, and the research design and methodology adopted. The recruitment of participants was conducted using an e-mail invitation based on the database of Company X customers obtained from the institution. Approval was granted for the latter by Company X in August 2020 (Appendix E).

The study had two phases: quantitative and qualitative phases. In the quantitative phase, systematic random sampling was used to recruit participants, and the online questionnaire (Appendix A) was distributed to the study sample. Participation in the qualitative phase depended on the interest of participants as per their indication in the quantitative phase. The recruitment of participants in the qualitative phase used a purposive sampling strategy, and interviews, using an interview protocol (Appendix B), were conducted remotely (i.e., over the telephone and online).

Data analysis was also two-phased. In the quantitative phase, descriptive statistics (i.e., frequency distribution, central tendency, and dispersion) and inferential statistics (i.e., paired sample *t*-test) were conducted. Qualitative data was analysed by means of thematic analysis.

1.7 Research validity, reliability, and trustworthiness

Research validity and reliability were treated distinctly for the quantitative and qualitative phases. In the qualitative phase, trustworthiness represented the validity and reliability of the research.

The measuring instrument (i.e., structured questionnaire) used to measure usability and UX for the quantitative phase, had been validated in previous studies (Sürücü & Maslakçi, 2020). Additional statements for the cognitive load and continuance use constructs were validated using the exploratory factor analysis method. Further details are provided in Section 3.8.1.1. Research reliability was measured by means of internal consistency using Cronbach's alpha coefficient test (Barchard, 2012). Various statements in the questionnaire were used to measure each construct relevant to this study. Both positive and negative statements were included to mitigate random responses from participants.

As part of establishing the trustworthiness of the qualitative phase, outliers of the quantitative phase findings were identified and included in the qualitative phase for further insight (Bryman & Bell, 2019; Leedy & Ormrod, 2021). Outliers constituted participants whose scores for the mobile application and online portal were extremely negative and/or positive in relation to usability, UX, and continuance use.

1.8 Ethical consideration

The conduct throughout the study conformed to the ethical principles related to the research processes and treatment of the participants. This was important since the primary methods for data collection involved human participants. Among the ethical principles observed were keeping participants unharmed throughout the study, voluntary participation, obtaining consent before pursuing data collection, and anonymisation of findings during data analysis and reporting. Furthermore, the researcher obtained ethical clearance from the General/Human Research Ethics Committee (GHREC) of the University of the Free State (Appendix C) before data

collection commenced. Permission was also sought from Company X to access their customer data for the recruitment of participants (Appendix E), and adherence to their policies was maintained. Adherence to the Protection of Personal Information Act (Act No. 4 of 2013) was observed, and participants gave their individual consent before participating in the study.

1.9 Contributions of the research

Various usability models have been used for a litany of studies in relation to mobile, desktop, and web applications alike. The People At the Centre of Mobile Application Development (PACMAD) model, as defined by Harrison, Flood, and Duce (2013), was of interest to this study. The model recognises the user, the task at hand, and the service channel context.

The proposed study intended to compare the online portal and mobile application with regard to usability, UX, and continuance use. The findings of this study may thus form the basis for decision-making when considering usability and UX evaluation, and user interface designs for online portals and mobile applications. The extent of similarities or differences in terms of usability, UX, and continuance use, as defined in the objectives, may also help practitioners make appropriate decisions regarding user interface designs of the mobile application and online portal, with specific reference to the usability of the products. Furthermore, this study may be of good use to company decision-makers on whether moving services to the mobile application(s) would be desirable at a given point.

1.10 Limitations and future research

The scope of this study was limited to the mobile application and online portal in terms of usability, UX, and continuance use, with a focus on Company X as the case study. This study intended to compare the usability, UX, and continuance use of these platforms without expanding into a causal relationship and/or explaining the relationship between these platforms in terms of usability, UX, and continuance use. The findings of this study may form the basis for future studies to investigate the causal relationship between mobile applications and online portals in terms of these three aspects.

The second phase of this mixed-methods study consisted of semi-structured interviews as a follow-up to a structured questionnaire (used in the first phase) to explain the questionnaire results obtained. The selection of the participants for the second phase employed the purposive sampling strategy based on the results from the first phase. The very nature of purposive sampling is that it introduces an element of bias in selecting participants, thereby impacting the external validity of the results. However, the second phase was intended to further explain the results and did not alter the findings of the first phase, which formed the main part of the study.

Due to the COVID-19 pandemic, the interviews in the second phase of the study were conducted remotely. Telephonic interviews are as effective as face-to-face interviews, except that they do not allow the interviewer to observe the non-verbal expressions of the interviewees (Farooq & de Villiers, 2017).

This study used Company X as a case study with a specific focus on comparing the usability, UX, and continuance use of the mobile application and online portal of this institution. Therefore, it should be considered that the results of the case study may not necessarily extend to other contexts. Nevertheless, the results may serve as the basis for further studies that could expand the scope beyond the Company X. Furthermore, this study considered participants who had used the mobile application and the online portal under consideration before, and thus the aspect of learnability of the mobile application and online portal for the usability evaluation was excluded.

1.11 Chapter layout

This dissertation is structured in the following way:

Chapter 1: Introduction

The introduction chapter introduces and provides the background of the study. The chapter discusses the research problem, research question, sub-questions, and research objectives. Chapter 1 also briefly discusses the research design and methodology followed in this study, as well as the validity, reliability, and trustworthiness, and associated ethical aspects. The chapter is concluded with the rationale and contributions of the research, limitations, and future research possibilities.

Chapter 2: Literature review

Chapter 2 is a comprehensive review of the literature and previous studies on usability, UX, and continuance use. Furthermore, a conceptual framework and related models are discussed to provide context to the study.

Chapter 3: Research design and methodology

The research design and methodology of this study are detailed in Chapter 3. The chapter is structured using a research onion, providing various segments that underpin the research design and methodology. The following segments are discussed: the philosophical approach, approach to theory development, methodological choice, research strategies, time horizon, and techniques and procedures.

Chapter 4: Data analysis, presentation, and discussion

The approach followed in the analysis and presentation of results is covered in Chapter 4. Furthermore, this chapter details the graphical, statistical, and textual presentation of the results from the measuring instruments used for this study. The remaining section discusses the results, considering the findings from previous studies.

Chapter 5: Conclusion and recommendations

Chapter 5 concludes this dissertation by dissecting the findings of the study in relation to the research question and sub-questions, study objectives, as well as subsidiary objectives. The theoretical and practical contributions of the findings to the industry and the academic community are discussed in this chapter. Furthermore, the limitations of the study are revisited and recommendations for future studies are identified.

1.12 Summary

The preceding discussion briefly surveyed previous studies on usability, UX, and continuance use, considering the relevance of usability, UX, and continuance use with specific reference to their importance in product development, and identified gaps in the human-computer interaction body of knowledge. The background was the foundation of this study, including the research problem, research questions, and research objectives. The research methodology section addressed how the study was carried out, taking the validity, reliability, trustworthiness, and ethical issues into

consideration. The anticipated contribution of this study, the limitations, and suggestions for future research were discussed to allow the study results to be contextualised within the perimeters of its limitations. The last part mapped the overall structure of this dissertation in terms of the chapters and their descriptors. It should be noted that the aspects that guided this study and which were briefly addressed in Chapter 1, will be discussed in more detail in subsequent chapters.

The upcoming chapter surveys the literature on human-computer interaction, usability, UX, and continuance use. A conceptual framework will also be devised to guide this study.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The preceding chapter introduced and provided a background to this study, especially its relevance, importance, and specific objectives, among other things. This chapter serves as a foundation and a theoretical base for the overall study. The first sections of the discussion reflect on the historical account of usability and user experience (UX) as sub-components of the broad field of Human-Computer Interaction (HCI). This includes the discussion of the interaction as the mediator for usability and UX. Subsequent sections provide a conceptual understanding and review of usability, UX, and continuance use. The later sections detail the developed conceptual framework guiding this study and delve into usability, UX, and continuance use evaluation in relation to mobile applications and online portals.

2.2 Historical account of usability and user experience

The historical development of the HCI discipline is centred on European and North American traditions, which approached the discipline differently. Two themes encompassed the field, namely, computer interfaces and ergonomics. The North American tradition was rooted in computer interfaces, whereas the European tradition, led by Shackel (Grudin, 2017), was rooted in computer ergonomics. As can be seen in Figure 2.1, key developments relevant to this study encompass three waves and paradigmatic shifts underpinning HCI development (Chen & Anwood, 2007). These waves are aligned with the interaction dimensions identified by Hornbæk and Oulasvirta (2017).

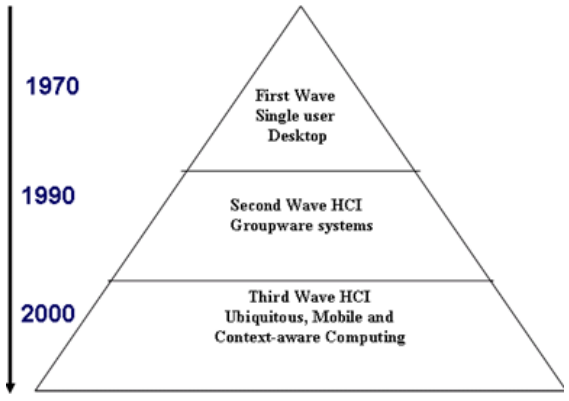

Figure 2.1. Three waves of HCI development (Chen & Atwood, 2007)

It is worth noting that each wave of human-computer interaction development did not override the preceding one. Rather, it expanded the scope of HCI further. For example, the first and second waves were underpinned by usability, whereas the third wave was underpinned by UX. Depending on the experience with the product, the user may decide whether or not to continue using it (Bataineh *et al.*, 2015; Franque *et al.*, 2020). The behavioural outcome resulting from the experience and product usability is referred to as continuance use. Continuance use is an intentional behaviour and is thus commonly characterised in terms of continuance intentions. According to Yusof and Iahad (2019), continuance use signifies the user's intention to continue using the product. Although continuance use did not originate from the HCI discipline, its relevance is derived from product usability and UX alike. Therefore, this study compounds continuance use to usability and UX.

2.2.1 First wave

The first wave of HCI emphasised 'the man-machine coupling' (Duarte & Baranauskas, 2016, p. 1). This notion of man-machine interaction is aligned with the interaction as a dialogue between the user and the machine. In this wave, the focus was on the interaction rather than on the user or the computer. According to Bødker (2015), the user was seen as a subject, not a participant in the man-machine interaction.

Harrison *et al.* (2007) define the first wave in terms of a paradigm view underpinned by industrial engineering and computer ergonomics. This paradigmatic view defined the North American (i.e., computer interfaces) and European (i.e., computer ergonomics) traditions, respectively. The North American focus was geared more toward individual users, while the European focus was geared toward office users (Grudin, 2009). One may maintain that usability is associated with the first wave – as industrial engineering and computer ergonomics are machine-focused instead of user-focused.

2.2.2 Second wave

In the second wave, a paradigmatic shift was witnessed where the user was given the focus, albeit on a small scale. According to Duarte and Baranauskas (2016), the second wave emphasised 'information processing' as part of cognitive processes. The user was acknowledged as an active participant in the mind-machine process.

However, the interaction remained a mechanical process where the interaction between the user and the machine was seen as an information processing exercise in which both parties took turns communicating their message through interaction. Wiberg and Stolterman (2021) refer to the information processing paradigm as a temporal aspect of interaction: the man-machine turn-taking during the interaction process. The second wave remained focused on groups and work settings with little regard for individual users (Bødker, 2006).

2.2.3 Third wave

The arrival of personal computing in the 1980s expanded the scope of HCI. The focus shifted from man-machine interaction as a functional exercise to communication between the user and the computer (Grudin, 2017). Furthermore, this paradigmatic shift saw the user's role in the man-machine scenario dominating. Also, this paradigmatic shift went from man-machine interaction for formal structures (e.g., work setting) to everyday computer use (Bødker, 2015). Different authors refer to this paradigmatic shift as a third wave of HCI (Bødker, 2015; Duarte & Baranauskas, 2016). The user's role in the interaction process changed to a meaning-making process that emphasised the context of use (Harrison *et al*., 2007). User experience (UX) emerged as a fundamental component of the man-machine interaction. Interaction as experience is aligned with this wave of HCI development.

Owing to the importance of interaction between the user and the computer in relation to usability and user experience, the following section further unpacks the interaction concept as it relates to the current study.

2.3 Interaction as a mediator for usability and user experience

In the HCI setting, the user and computer communication needs to be mediated by means of user interfaces. ‘Mediated’ implies that a mutually understood language needs to be devised. The choice of the user interface has an impact on UX and product usability (Choi & Tulu, 2017; Dharmayanti *et al.*, 2018). Haria *et al.* (2017) assert that the fundamental tenet of HCI is to simplify the interaction between the computer and the users. Along the same lines, Hornbæk and Oulasvirta (2017) identify various dimensions of interaction. Three pertinent interaction dimensions discussed here are the following: interaction as a dialogue, transmission, and experience.

2.3.1 Interaction as a dialogue

This dimension of interaction encapsulates a communication typical of human-human communication, in which two or more actors are involved in a mediated exchange of messages through user interfaces. The user is conversing with the computer, and each party should understand the response of the other party. The dialogue is realised by what Hornbæk and Oulasvirta (2017) call a mapping and feedback mechanism, that is, each party must comprehend what the other party communicates so that the interaction becomes a complete dialogue.

A communication model that is more applicable to the 'interaction as a dialogue' context, is the two-way communication model (see Figure 2.2). This model sees both the sender and recipient as equal partners in the communication process, where the sender and receiver roles are occasionally interchanged.

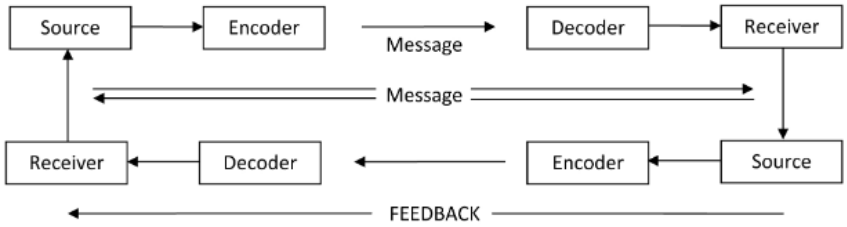

Figure 2.2. Two-way communication model (Umeozor, 2020)

Unlike in human-human interaction, users and the computer take turns in communicating their messages through interaction (Hornbæk & Oulasvirta, 2017), assuming that parties will understand each other. When noise occurs (e.g., the user clicks a button, but no response is received), the whole dialogue is interrupted.

2.3.2 Interaction as a transmission

While interaction as a dialogue prioritises the role of actors (i.e., the user and the computer), interaction as a transmission shifts towards the message and the channel involved, rather than the actors. According to Hornbæk and Oulasvirta (2017), transmitting information and/or messages from a user to the computer, or vice versa, defines the interaction between these two parties. The success of the interaction is measured by the accuracy of the transmitted message and the rate at which such transmission takes place. The user sends the message (e.g., clicking a button), hoping that it will reach the computer and that the computer will act as expected. Sundar,

Bellur *et al.* (2016) define interactivity as message interactivity, wherein one message serves as the input, and the other message serves as the output. In this input-output message scenario, the user and computer interfaces are essential in the message transmission.

2.3.3 Interaction as an experience

Interaction as an experience departs from other interaction dimensions because the focus is on the cognitive and behavioural responses as an outcome of the interaction with the computer. These cognitive and behavioural responses may sometimes be subjective, depending on the user's emotional state before, during, or after interacting with a computer. The feelings and expectations that the user has about the computer underpin and mark the user's experience with the product (Hornbæk & Oulasvirta, 2017).

When users interact with a computer, specific behavioural outcomes are projected by users. These user behaviours include, among others, perceptions, attitudes, and intentions (Rzepka & Berger, 2018). The user's behavioural patterns shape the experience from using the computer. Interaction as an experience highlights the importance of the experience, rather than the quality of the product. The study by Sutcliffe and Hart (2017) established the interwoven positive link between the attractiveness of interactive features and the UX of the applicable product. The notion of UX acknowledges the importance of product interactivity as a precursor to users' feelings, perceptions, attitudes, and behavioural projections towards the product.

Referring to Chapter 1, the main research question of this study was defined as follows: *How does the usability, user experience, and continuance use of a mobile application and online portal compare in terms of performance, user satisfaction, and continuance intentions?*

The three main components of this study, namely usability (Section 2.4), user experience (Section 2.5), and continuance use (Section 2.6) are unpacked in the sections to follow. As usability will be addressed first, the following section will delve into the conceptualisation of usability, usability models, and attributes adopted in this study. A survey of related studies on the usability of mobile applications and online portals will conclude the usability section.

2.4 Usability

Since this study intended to compare the usability of a mobile application and an online portal, the upcoming discussion presents the conceptualisation of usability, along with the different usability models developed over the years and the associated attributes applicable to this study.

2.4.1 Conceptualising usability

The term usability differs from author to author because there is no agreed standard definition. This lack of a standard definition leads to different usability models that conceptualise and measure the usability of products differently. The most widely adopted usability definition comes from the International Organization for Standardization (ISO). According to the most recent ISO standard on usability (ISO 9241-11:2018, p. 11), usability refers to the "extent to which the system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use." This definition recognises the user, the product, the goal, and the context of use. The ISO definition considers the concepts of effectiveness, efficiency, and satisfaction as the key attributes of the usability of a product.

While the ISO 9241-11 (2018) definition of usability is centred around the user, the usability definition from Rusu *et al.* (2015) leans towards software (or product) quality, although the user remains at the centre. In this way, usability is understood as to how the product is understood, learned, used, and attractive to users upon using it under the specified condition. In the latter definition, the fundamental context of product usability focuses on its attractiveness, learnability, understandability, and operability. On the other hand, Shackel and Richardson (1991) approach usability from the perspective of the human’s capability to use the product with ease and in an effective manner with little help and support.

The above definitions do not consider the product design and user interface per se as the determinant of usability. Ferre *et al.* (2001) contend that the look and feel of the user interface do not constitute the usability aspect of the product. Instead, it is how the user interacts with the product and the overall logical flow of the interaction that contributes to the usability of the product. From Nielsen's point of view (in Harrison *et*

al., 2013), the usability of a product is based on learnability, efficiency, memorability, errors, and user satisfaction.

The definition of usability in this study considers the components mentioned in the ISO 9241-11 (2018) definition and those identified by Nielsen. Thus, usability is defined as the extent to which the product is designed and presented intuitively to the user. The user is expected to fulfil the intended goals of effectiveness and efficiency with the least number of errors and a certain level of satisfaction.

2.4.2 Usability models

Product usability as a concept and a construct is directly linked to the development of human-computer interaction, and it has not fallen short of models that intend to fathom and measure it over the past three decades. According to Mohamed *et al.* (2017, p. 495), a model depicts "how the properties of the system, team and organisation influence different usage activities." There are models dedicated to the usability of desktop and web systems, mobile technologies, drones, and other embedded systems.

Various usability models (Table 2.1) emanated from previous studies. Most models differ in terms of the attributes considered in investigating the usability of products. Currently, there is no universally adopted usability model. Each study is built on existing model(s) or an adapted model. For example, the Integrated Model for Software Usability, as proposed by Gupta *et al.* (2014), is built on previous models, particularly on models created by Abran *et al.* (2004), Donyaee and Seffah (2001), Harrison *et al.* (2013), ISO 9241-11 (1998), Nielsen (1993), and Preece *et al.* (1993). However, the earlier version of the Integrated Model for Software Usability did not have universality and productivity attributes (Dubey *et al*., 2012). The surveyed models (Table 2.1) have common usability attributes: effectiveness, learnability, efficiency, memorability, satisfaction, safety, and/or security. The choice of these attributes considers the number of models with the same attribute(s).

Table 2.1. Usability models (adapted from Dubey *et al.*, 2012)

Attributes	Abran *et al.*	Donyaee & Seffah	Dubey *et al.*	ISO 9126-1	ISO 9241-11	Nielsen	Preece *et al.*	Shackel	Gupta *et al.*	Harrison *et al.*
Effectiveness	✓	✓	✓		✓		✓	✓	✓	✓
Learnability	✓	✓	✓	✓		✓		✓		✓
Flexibility								✓		
Subjectively pleasing								✓		
Efficiency	✓	✓	✓		✓	✓	✓		✓	✓
Memorability						✓			✓	✓
Errors						✓				✓
Satisfaction	✓	✓	✓		✓	✓			✓	✓
Safety/security	✓	✓					✓		✓	
Enjoyability							✓			
Understandability				✓						
Cognitive load										✓
Operability				✓						
Attractiveness				✓						
Usability compliance				✓						
Productivity		✓							✓	
Trustfulness		✓								
Accessibility		✓								
Universality		✓							✓	
Usefulness		✓								

The People At the Centre of Mobile Application Development (PACMAD) model (see Figure 2.3) combines ISO 9241-11 (1998) and Nielsen's (1993) models, except that the cognitive load is an additional attribute in the PACMAD model not featured in both previous models. Cognitive load represents context of use as one of the usability criteria that needs to be considered in product usability.

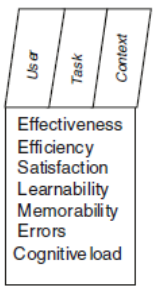

Figure 2.3. PACMAD Model for usability (Harrison *et al*., 2013)

Most importantly, the PACMAD model considers the user, task, and context of use as fundamental features of product usability. In other words, product usability is not isolated from the user, the task, and the context of use. These concepts are now briefly discussed.

User: For this dissertation, the term 'user' refers to anyone who uses the product for the intended purpose. The development of products that do not consider the user may be very costly, especially when such products do not meet the users' needs and expectations (Sauvola *et al.*, 2015). It is therefore essential to consider the previous experience of the users, their expertise, and preferences in relation to the usability of the product (Harrison *et al*., 2013).

Task: When the user utilises the product, there is a specific goal (or task) to fulfil. The complexity and multiplicity of the tasks that the user can execute in a software product may hinder the fulfilment of the intended goal (Harrison *et al*., 2013).

Context: The context of use refers to the environment where the product is used (Harrison *et al*., 2013). Multitasking while using a product may exhaust the cognitive capability of the user and thus impact the concentration level expected from them.

The inclusion of the cognitive load attribute for usability differentiates the PACMAD model from other existing models. Cognitive load (see Section 2.4.3.7) refers to the amount of cognitive processing the user requires at a given time. This may include the surrounding environment, other concurrent tasks, the other products, amongst other things, and all these elements compete for the available cognitive processing capacity (Harrison *et al.*, 2013; Shaban *et al.*, 2021).

This study adopted the PACMAD model because cognitive load and context of use are considered important for mobile applications and online portal usability. While the PACMAD model was tailored for mobile contexts, it contains important attributes from other usability models that are suitable for evaluating other platforms, like websites. Therefore, the PACMAD model was deemed suitable for comparing a mobile application and an online portal.

2.4.3 Usability attributes

Usability cannot be measured directly (Hornbæk, 2006). Rather, one can measure it through a set of associated attributes (see Table 2.1). In this section, only attributes

associated with the PACMAD model are discussed. These attributes include effectiveness, efficiency, learnability, memorability, errors, satisfaction, and cognitive load.

2.4.3.1 Effectiveness

Effectiveness is the extent to which a task is completed with a high level of accuracy and precision (Dubey *et al*., 2012; Gupta *et al*., 2014). It is assumed that system tasks are not endless, lest they enter an infinite loop. In this context, a task executed by a user has to be completed, and its completion status has to be visible to the user. Task success (or task completion) as a measure finds its way into most usability studies, since such studies rely mainly on the ISO definition of usability (Kortum & Peres, 2014). Moreover, one needs to consider that task completion as a measure may be considered a dichotomous variable where a task is either completed (successful) or not completed (unsuccessful). Also, task completion can be understood in a continuum sense, with one end and another extreme opposite end. In the latter sense, decisions are made about whether partially completed tasks are counted towards the complete or incomplete side of the continuum. Cattaneo *et al.* (2015) view effectiveness from the goal fulfilment perspective, that is, whether the product does what it is meant to do. Similarly, Shackel (in Hasan & Al-Sarayreh, 2015) sees effectiveness in human performance; that is, the user should successfully perform the task.

Dubey *et al*. (2012) identify the following aspects that determine the effectiveness of an interactive product:

- *Task accomplishment:* how the product helps the user perform the tasks and achieve the desired outcomes.
- *Operability:* the product capabilities affording the user to perform the intended tasks correctly; and
- *Universality:* the capability of the product to be operated by users with different backgrounds and varying levels of knowledge.

2.4.3.2 Efficiency

The distinction between product effectiveness and efficiency is sometimes convoluted. The definition and the usability model one follows determines the stance one takes as to whether effectiveness and efficiency are treated distinctly. For example, Shackel (in

Susanto *et al.*, 2018) views product effectiveness as the time needed to complete a task with the least number of errors committed during the product interaction. The preceding view may be construed as referring to product efficiency, as evident in this section.

Nonetheless, in this discussion, product efficiency is considered distinct from its effectiveness, albeit with a very high degree of interwovenness of these concepts. According to Hussain *et al.* (2015), product efficiency refers to the resources needed to complete the task. Resources in this context refer to the time and effort needed to perform the given task(s) under normal circumstances. However, the experience of the user with the product may have a bearing on the time one takes to complete a task (Do Nascimento Mendes & Dias-Neto, 2016; Kabir *et al.*, 2016). Hence, the PACMAD model considers the user, task, and context.

2.4.3.3 Learnability

The complexity of the system determines the extent to which the specified user grapples with the system and completes the intended tasks. Learnability is seen from different vantage points, though. In some cases, it is seen as a sub-component of comprehensibility. It may be seen as a standalone attribute that contributes to product usability in other cases. In the comprehensibility context, learnability is seen as the simplicity and intuitiveness of the product as such that the users understand and interact with the product easily (Dubey *et al*., 2012). The interaction components familiar to the user should behave as one would expect. For example, a right-click should result in the context menu, as would typically be the case. In the context of learnability as a standalone attribute, Ferre *et al*. (2001) define learnability as the extent to which the novice user learns to use the product with ease and proficiency within the shortest time possible. Harrison *et al*. (2013) and Gupta *et al*. (2014) contend that the product should be easy to learn so that the user can get going. The measure of learnability considers the product's simplicity and time to learn (Dubey *et al*., 2012). Hasan and Al-Sarayreh (2015) extend this to include memorability, user documentation, understandability of error messages, and access to help when using the product.

2.4.3.4 Memorability

Memorability is deeply interwoven with the learnability of the product. Some usability models present memorability as a sub-property of learnability, whereas other models treat learnability as a sub-property of memorability. Nevertheless, both properties (i.e., learnability and memorability) have to do with one's ability to learn and understand how to use and interact with the product.

In this study, memorability is treated as a separate attribute that contributes to the usability of the product. Do Nascimento Mendes and Dias-Neto (2016) assert that memorability is about the ability of the user to retain the knowledge and understanding of how to use the product after a period of non-use. In contrast, Hasan and Al-Sarayreh (2015) see memorability as the user's average time to remember using the product. The preceding argument recognises that time-lapse is an important factor in the memorability property of product usability. Subsequently, a product that requires little to no time to remember how to use and interact with it, has a high level of memorability. The opposite also holds; that the product that requires one to re-learn how to use it may have a low level of memorability.

2.4.3.5 Errors

The rate of errors, when one uses the product, should be minimised (Yuniarto *et al.*, 2018). Also, a correlation exists between the rate of errors and user satisfaction in relation to mobile applications (Saleh *et al.*, 2017). However, the latter cannot be extended to online portals. Nevertheless, errors (or mistakes and bugs – as one may call them) are undesirable and have a bearing on the usability of a product.

Errors may culminate in two ways: from the product's user or the product itself. Errors that emanate from the product are often referred to as bugs. Another class of errors occurs from the user's side, where the user makes mistakes while interacting with the product. These types of errors contribute to the usability of the product. According to Nurhudatiana *et al.* (2018), a product is usable if it can limit the number of errors committed by users while interacting with the product. The more the users commit avoidable errors, the higher the chances that the product is not usable. Therefore, it shall be the product designer's goal to minimise errors when the product is used (Alturki & Gay, 2017). Yuniarto *et al*. (2018) maintain that products should be error-

tolerant; that is, the user interface should prevent a user from errors or help the user recover from them.

2.4.3.6 Satisfaction

Satisfaction is one factor that is heavily dependent on user perception, attitude, and emotional state. According to Hussain *et al*. (2015), user satisfaction is a perception-oriented measure of product usability. User satisfaction is subjective and depends on the user's experience with the product. Moreover, user satisfaction with the product may be informed by other things. For example, a user may have a negative attitude towards the product. Capece and Campisi (2013) maintain that satisfaction is an attitudinal aspect of usability that informs behavioural intentions.

It is often assumed that product use and acceptance imply user satisfaction (Capece & Campisi, 2013). The preceding assumption may sometimes be misguided, especially for products with no alternatives. Most importantly, user satisfaction may be understood as a derived attribute; attributes like product effectiveness, efficiency, and error rate determine the extent to which one is satisfied with the product. According to Harrison *et al*. (2013, p. 2), satisfaction is the “freedom from discomfort and the positive attitude from using the product.” Similarly, Merino *et al*. (2012) posit that satisfaction involves comfort and acceptance of the product, which also includes enjoyment and gratification (Capece & Campisi, 2013).

2.4.3.7 Cognitive load

Cognitive load as a measure of product usability is borrowed from the Cognitive Load Theory (CLT). According to Kirschner *et al.* (2018, p. 217), cognitive load refers to “the total working memory resources required to carry out a learning task.” Human memory and cognitive schemas are limited and cannot be extended beyond capacity. While CLT applies mainly to a learning environment, its applicability can also be extended to product usability, particularly product memorability and learnability. Leppink (2017) emphasises the importance of experience and familiarity with the learning content related to cognitive load and human memory. The applicability of CLT to usability is, though not directly spelt out, depicted with the aspect of “context of use” in the ISO definition. Harrison *et al*. (2013) specifically include the cognitive load attribute in their PACMAD model for product usability. The relevance of cognitive load is drawn from

the ubiquity and multi-tasking amenable to mobile application use. Cognitive load is also important for websites (Albers & Tracy, 2006).

2.4.4 Usability: Mobile applications and online portals

The usability of mobile applications, as well as online portals, will be discussed next on the basis that a mobile application and online portal form part of the main focus of this study.

2.4.4.1 Mobile applications

The empirical studies on the use and usability of mobile applications are mainly concentrated in the retail, health, transport, and banking sectors, yet the diversity of mobile app users is expanding by the day. The sector in which the mobile app operates plays a role in why users utilise the app in the first place, and which usability attributes users may find more important for the app. For example, Shaw *et al.* (2022) found that the mobile application's ubiquity, privacy, and security risks are at the top of users' concerns with a mobile banking application, albeit with variation among users from the United States of America, Germany, and Canada.

The prevalence of mobile applications presents both opportunities and challenges emanating from the mobile devices used. The evaluation of a mobile application's usability should, therefore, consider the unique characteristics of a mobile device which are crucial for mobile app usability. Nosheen *et al.* (2019) identify the following mobile device properties which contribute to its usability: screen size, input style, resolution, and processing capacity.

However, fundamental usability attributes remain the same across all mobile app domains. Fundamental usability attributes include effectiveness, efficiency, and satisfaction, as derived from the ISO 9241-11 standard, and these attributes are common among mobile application evaluation studies (Johnson *et al.,* 2020; Weichbroth, 2020).

The PACMAD model emerges as one model that takes the mobile application context of use into account as an intrinsic aspect of mobile application usability (Patel & Dalal, 2013). Studies by Cata and Martz (2015) and Saleh *et al*. (2017) employed the PACMAD model in their investigations into the mobile applications' usability characteristics for designers and users, and important attributes for mobile

applications, respectively. The findings revealed typical usability attributes, namely usefulness, effectiveness, and satisfaction (Cata & Martz, 2015). Furthermore, mobile application users and designers differed significantly on the importance of different usability attributes. In contrast, Saleh *et al*. (2017) found that reducing cognitive load may improve the usability of a mobile application. Built from the PACMAD model, Saleh *et al.* (2017) propose two additional attributes for mobile application evaluation, namely interruptibility and simplicity. While the proposed additional attributes may be relevant, they are embedded throughout the PACMAD model. Thus, this study considers the original PACMAD model attributes sufficient.

Mobile applications developed for the public sector are not meant for profit-making. Among the expectations for these applications is their accessibility to a broad section of users. Public service is a public good, and as such, the developed mobile application cannot be the exclusive domain of the few. The users of public sector mobile applications include, amongst others, the disability community, the elderly, and children, which place significant requirements on mobile application usability (Kotala, 2015).

2.4.4.2 Online portals

The value of any web application is primarily determined by its usability (Kumar & Hasteer, 2017). Queiroz *et al.* (2018) maintain that there is a strong connection between system acceptance and its usability. According to Hussain *et al.* (2018), the usability of government portals (or any other portal) determines whether users will utilise the portal. The latter arguments emphasise the importance of usability and the extent to which it is intertwined with portal use. A surveyed literature on the empirical studies related to online portals does not discriminate between public portals (i.e., websites) and transactional sites (i.e., data-driven sites, e-portals, web applications, or online portals). Instead, studies refer to websites, electronic services, or suffixes the electronic service with the respective domain (e.g., e-learning, e-government, etc.).

Mator *et al.* (2021) postulate that usability is very domain-centric. The centrism further extends to the domain-centric terms used and the usability measures applied. For example, e-banking usability is treated in tandem with security in the banking sector. Security of the e-banking portal is considered sacrosanct. However, security and usability often compete with each other, wherein a security-oriented portal may temper

the usability of the very portal. In most cases, portal developers do not give equal attention to usability and security solutions associated with the portal (Alarifi *et al.*, 2017). However, portals from other sectors may tie usability to safety issues. A link between usability and security/safety has given rise to a usable security and privacy research domain (Lo Iacono *et al.*, 2018).

One may conclude that the portal domain may determine the usability metrics to use in measuring the usability of such a portal. In the context of the present study, it is considered that the context of use plays a significant role in online portals, much the same as in the mobile application environment. The use of online portals is often not confined to desktop computers. Rather, mobile computing devices like laptops, tablets, or even mobile phones may be used to access online portals. The context of use raises the aspect of cognitive load for website usability, similar to mobile applications. To this end, the PACMAD Model is applicable in website usability due to its incorporation of the cognitive load attribute. According to Whitenton (2013), the limited processing capacity of the human brain impacts the cognitive load one may expend on a given task. However, an exhaustive review of previous literature on website usability does not include the PACMAD model. Previous studies have investigated the cognitive load in relation to website usability.

Clarke *et al.* (2020) investigated the usability and cognitive load in the design of a personal health record – an online pre-visit summary. The findings suggest that the more mentally challenging the task, the higher the cognitive load. This supports the view that the minimisation of cognitive load maximises usability (Whitenton, 2013).

For this study, the Computer System Usability Questionnaire (CSUQ) was used to measure the usability of the mobile application and the online portal. CSUQ was complemented by the semi-structured interviews.

2.5 User experience

The second component of this study was UX. The following section will, therefore, delve into the conceptualisation of UX, UX models, and attributes adopted in this study.

2.5.1 Conceptualising user experience

The conceptualisation of UX is premised on the perceptions that the users have of the product. The definition of UX is often tied to a model that the study follows. Veldsman and Van Greunen (2017, p. 3) defined UX as "all the aspects of how people use an interactive product; the way it feels in their hands; how well they understand how a system or application works; how they feel about the product while using it; how well it serves their purpose and how well it fits into the entire context in which they are using it." In the same vein, using a different UX model may define UX differently. It is also critical to consider that the scope of the UX evaluation may impact the outcome of the evaluation and how UX is defined.

The UX White Paper (Roto *et al.*, 2011) defines UX as the outcomes and memories that the user has upon interacting with the product. The paper differentiates UX based on the time span that the user interacts with the system, which can be anticipatory, momentary, episodic, or cumulative. This dissertation focuses on the cumulative timespan (i.e., the user's feelings about the product a while after use). Similarly, ISO 9241-210:2010 defines UX as a person's perceptions and responses that result from the use/anticipated use of a product, system or service.

The intrinsic nature of UX is as such that there is an overlap between the attributes of usability and UX, particularly with the attributes of satisfaction and efficiency. Owing to the latter, this dissertation considered satisfaction and efficiency as part of both usability and UX. However, UX extends to attractiveness, perspicuity, dependability, stimulation, and novelty (Schrepp *et al.*, 2014).

2.5.2 User experience models

The multiplicity of UX models gives rise to multiple perspectives of what constitutes UX. Roto *et al*. (2011) identify user affect, interpretation, and meaning as attributes underscoring UX and attributes that inform it. Bevan (2008) approaches UX in terms of goals and consequences of using the product. The product goals consist of pragmatic goals (i.e., effectiveness and efficiency) and hedonic goals (i.e., stimulation, identification, and evocation), whereas consequences include pleasure, likability and comfort, and trust. For Morville (2004), UX encapsulates how useful, usable, findable, credible, accessible, desirable, and valuable the system/product is.

The idiographic nature of UX results in different UX dimensions (as depicted in Table 2.2) and interpretations. There are many different UX dimensions/models (Følstad, 2010; Hussain *et al.*, 2021). Each model/dimension presents and defines UX within the scope of the concerned model/dimension.

Table 2.2. UX Dimensions (adapted from Hussain *et al*., 2021)

UX Dimensions	Authors
Classical & Expressive aesthetics	Tractinsky (1997)
Functionality, Usability, & Pleasure	Jordan (2000)
Instrumentality, Aesthetics, & Symbolism	Vilnai-Yavetz *et al.* (2005)
Usability, Aesthetics & Symbolism	Tractinsky & Zmiri (2006)
Pragmatic & Hedonic	Hassenzahl (2004)
Sensual, Emotional, Spatio-temporal, & Compositional	Wright *et al.* (2008)
Instrumental, Non-instrumental & Emotional	Thüring & Mahlke (2007)
Instrumental & Non-instrumental	Mahlke (2008)
Instrumental, Cognitive & Epistemic, Emotional, Sensory, Social, Motivational & Behavioral, Utilitarian, Affective & Sociability	Buccini and Padovani (2007); Olsson (2012) Park *et al.* (2015)

Hassenzahl's UX model (Han *et al*., 2018) has been widely used to assess UX. This model is premised on the user, the product and the interaction between the product and the user. The product features (e.g., content, interaction, presentation) serve as a precursor for the product character (Han *et al*., 2018). The user perceives the product's character upon using it. The product character includes pragmatic and hedonic attributes, as identified by Bevan (2008). Depending on the user's perception of the product's character, the consequences of product use may include the extent of the user's pleasure, appeal, and satisfaction with the product. The inherent limitation of Hassenzahl's model is that it does not measure UX over time.

Most UX models are based on Hassenzahl's model, for instance, Aranyi and Van Schaik (2016) used Hassenzahl's model to assess news sites for UX. Pohlmeyer *et al*. (2009) proposed a User Experience Lifecycle Model, which considers UX as a cyclical journey throughout the user's interaction with the product. The model includes the pre-interaction, interaction, and post-interaction with the product. The main contribution of this model to UX encompasses the actual product interaction (i.e., the 'use' experience). Roto *et al*. (2011) concur with the phased notion of UX, as the authors view UX in terms of the timespan the user expends with the product. The major

drawback of the User Experience Lifecycle Model is that it does not define what UX constitutes (i.e., factors, attributes, or properties).

For this study, the UX attributes identified by Schrepp *et al*. (2017) were considered determinants of product UX, as the accompanying User Experience Questionnaire (UEQ) has been extensively validated (Isnainiyah & Triwahyono, 2021; Izabal *et al*., 2018; Kusumo & Hartono, 2019; Martono, 2021). These attributes consist of attractiveness, perspicuity, novelty, stimulation, dependability, and efficiency. The identified attributes emanate from pragmatic and hedonic qualities from Hassenzahl's Model. Excluding efficiency (which was discussed in Section 2.4.3.2), the rest of these UX attributes will be discussed next.

2.5.3 User experience attributes

2.5.3.1 Attractiveness

According to Schrepp *et al*. (2017), attractiveness is a valence dimension of UX that is informed by the user's emotional state in relation to the product. For Paramitha *et al*. (2018), Schrepp *et al*. (2017), and Gerłowska (2018), attractiveness refers to the impression that the user has about the product. Attractiveness is one aspect of UX that may not necessarily depend on the product for the user's decision to confer its attractiveness status. In addition, the variability of users is such that what may be attractive to one user about the product may be the opposite of how another user sees the same product. The degree of impression with the product determines how attractive the user finds the product. The most common indicators of product attractiveness include enjoyability, likability, pleasantness, friendliness, and goodness (Abdillah, 2020; Paramitha *et al*., 2018).

2.5.3.2 Perspicuity

Perspicuity belongs to the pragmatic quality dimension of UX. Pragmatic quality relates to the use of the product and the aspect of UX that is witnessed when the product is used.

According to Kadastik *et al.* (2018), perspicuity of the product tends to address the following questions:

- Is it easy to use, learn, and understand the product?

- Is the product understandable and clear?

The preceding questions contribute to the perspicuity of the product and the extent to which the product is easy to get familiar with (Abdillah, 2020; Gerłowska *et al*., 2018; Paramitha *et al*., 2018; Schrepp *et al*., 2017). Perspicuity and learnability are closely related attributes, except that the former applies to UX, whereas the latter applies to usability (Hinderks, 2019).

2.5.3.3 Novelty

The novelty of a product is determined by the improvements implemented in the latest version, or a creative product, process, and interaction mechanism. A novel product has to capture the user's interest (Schrepp *et al*., 2017). The challenge is that there is no formula for capturing the user's interest. Nonetheless, certain UX factors, like attractiveness, are sensitive to novelty effects (Rutten *et al*., 2020). It can be said that the novelty effect is as important as other UX factors. Unlike other UX factors, the novelty effect of the product wanes over time. A product may appear novel initially, and as time goes on and the user gets familiar with the product, its novelty effect disappears (Rutten *et al*., 2020). The pervasiveness of the novelty factor confirms its hedonic quality for UX.

2.5.3.4 Stimulation

The common denominator of all hedonic qualities for the product UX is that these qualities are not dependent on the goal of the product (Vida *et al*., 2019). According to Hassan and Galal-Edeen (2017), the product should meet the pragmatic and hedonic needs of the user. Product stimulation may be invoked before, during, and after using the product. Therefore, no specific juncture of product use is more important than the other.

Different studies differ on whether an inverse relationship exists between product usability and its stimulation (Hassan & Galal-Edeen, 2017). The product should be both useful and pleasurable to use. Product stimulation intends to address the following question: "Is it exciting and motivating to use the product?" (Santoso *et al*., 2016, p. 62). However, the extent to which the product is exciting and motivating depends on the individual user, and there is no universal standard on what is interesting or exciting. Nevertheless, product stimulation is measured considering the

extent to which the product is valuable, exciting, motivating, and interesting (Santos *et al*., 2016).

2.5.3.5 Dependability

Dependability is a pragmatic quality aspect of product UX (Somrak *et al*., 2019). When users use the product, they exhibit reactions and/or feelings in relation to what they do. Dependability relates specifically to the user reactions in relation to the interaction control that the user exerts during the interaction experience of the product.

The feelings that the user experiences about the product contributes in a way to the extent to which the users positively perceive the dependability of the product (Pandu & Fajar, 2019; Santoso *et al*., 2017). Users' feelings are specifically in relation to how predictable and secure the product is. Dependability also includes the extent to which the product meets the user's expectations. In this context, the expectations do not only include the product serving the user's needs; it also includes the product interaction yielding the expected outcomes.

The context in which the product is used often matters in terms of which aspects of UX users consider more important than others. In the study conducted by Lee *et al*. (2021) on the drivers' trust in semi-automated vehicles, dependability, predictability, and faith in the product (i.e., semi-automated vehicles) appeared to be the dominant UX factors that drivers considered most important for the product. Similarly, Tan *et al*. (2020) established that dependability is one of the key factors within mobile applications for disaster response and its continuance use.

2.5.4 User experience: Mobile applications and online portals

The importance of UX in mobile applications will first be discussed, followed by its importance in online portals.

2.5.4.1 User experience: Mobile applications

Mobile application UX has been investigated extensively before. The User Experience Questionnaire (UEQ) dominates many of the reviewed studies. For instance, the use of UEQ in the study by Martono (2021) to establish the UX of the Child Development Monitoring application indicates that the application performed above average across all UEQ constructs. Novelty and perspicuity were rated higher than other constructs.

However, Boothe (2020) states that the UEQ is not applicable in a service-centric environment. The author used a generalised UEQ alongside the original UEQ to compare two mobile applications. The findings indicated that the results were similar for both versions of UEQ in terms of hedonic and pragmatic qualities.

The results derived from UEQ are mainly descriptive, as the questionnaire does not include open questions for user comments. The logical step is to include more than one method to establish the whole picture of the product's UX. In the study by Astuti *et al*. (2021) on the UX of a mobile application, the researchers supplemented the UEQ with a comment section for respondents to add their comments beyond just selecting the most applicable option from those provided. The comments provided a rich insight into the UX areas, as seen from the users' perspectives. While the users rated the application's pragmatic and hedonic qualities very highly, the comments provided insight into users' areas of concern, despite the application having the ability to serve user goals.

The current study used UEQ to measure the UX of Company X's mobile application and an online portal. To overcome the UEQ's limited insight, semi-structured interviews were conducted with users of the two platforms being evaluated to gain further insight into the UX areas of concern.

2.5.4.2 User experience: Online portals

Much like with mobile applications, UEQ has gained traction for evaluating website UX. Other than just the overall UX of the product, the UEQ can assess the UX Key Performance Indicator (KPI) (Hinderks *et al*., 2019). UEQ is a reliable tool for measuring website UX (Albayati *et al*., 2021; Martono, 2021).

Using UEQ, Izabal *et al*. (2018) evaluated the Focus Group Discussion website for students at the Universitas Brawijaya. The results suggest that the website performed very poorly in relation to UX. The website was subsequently redesigned, and the second evaluation showed a significant improvement from the initial results of the UEQ. These new findings suggest that UEQ may prove useful for identifying problematic UX areas, as such that one may improve the online portal based on its results. Isnainiyah and Triwahyono (2021) established that users rated the novelty and dependability aspects of the online petition website very highly as opposed to its attractiveness, perspicuity, efficiency, and stimulation. For the former, students were

the main users of the website, whereas the latter had general citizens as users. The goal of the product may impact the prominent UX areas considered important by its users.

Kusomo and Hartono (2019) integrated the eye tracker with the UEQ in their study on the UX of an academic website. The eye tracker provided results of screen areas of the website mostly focused on, along with the least gazed area(s). In addition, the UEQ revealed that the novelty of the website was rated low compared to the UEQ constructs. The combined results indicated which areas of the website needed improvements to allow for its novelty to be rated positively. The risk, though, is that the results of combined methods may not necessarily be conclusive. Owing to the shortcomings of UEQ, this study supplemented UEQ with a semi-structured interview to further explain the UX results obtainable from UEQ.

2.6 Continuance use

The third aspect of this study related to the continuance use of mobile applications and online portals. Therefore, the conceptualisation of continuance use and its associated models are discussed further in this section.

2.6.1 Conceptualising continuance use

The success of a product depends on its continuance use beyond the first encounter (Wangpipatwong *et al*., 2008). Even more important is the prolonged use of an information system (IS) product (Wu *et al*., 2022).

The continuance use mainly depends on the extent to which the product meets the users' needs. It is also seen as an extension of customer loyalty, which has long dominated the marketing field. With the advent of electronic commerce and its competitiveness, maintaining existing customers is more important than acquiring new ones. This is because it is perceived to be much easier to keep existing customers (Barker & Angelopulo, 2013).

Customer loyalty is a result of inertia, where the bond between the customer and the product is tied and indistinguishable such that the user has no appetite to use and/or try alternative products. According to Wang *et al*. (2019), inertia is an attitudinal tendency where the user does not see the need to try available alternatives. However, the opposite is true in the e-government environment because alternatives often do

not exist. In a non-competitive environment, such as e-government, continuance use is a more applicable term and very important for IS success (Alanazi, 2013).

While the continuance use concept did not originate from the IS discipline, the concept has been incorporated into the IS field through models like the Expectation-Confirmation Model (see Figure 2.4). In this study, continuance use (operationalised in terms of continuance intentions) constituted one aspect of the investigation, together with the usability and UX of mobile applications and online portals.

2.6.2 Continuance use models

The two most dominant models used to understand the adoption of IS and, by extension, their success, are the Technology Acceptance Model (TAM) and the Information System Success Model (ISSM). These models have been extended to the area of IS continuance. However, they present limitations in their application to IS continuance.

On the one hand, TAM is focused on the adoption of technology and less on its continuance use. On the other hand, ISSM is hardly used in studies related to IS continuance use (Almutairi *et al*., 2021). Acceptance models are not suitable for continuance use studies, and such models may lead to the misapplication of theories (Franque *et al*., 2020). Instead, the Expectation-Confirmation Theory (ECT) has been extensively used to understand continuance use in the IS context.

The next discussion further expands on the ECT and its associated model.

2.6.2.1 Expectation-Confirmation Theory and Model

The ECT emerged from the consumer behaviour discipline to understand consumer satisfaction and re-purchase intentions (Alanazi, 2013). However, the theory is also applied in the IS field, as information systems are like all other products – the users may or may not use them.

Based on the ECT and TAM, Anol Bhattacherjee established an Expectation Confirmation Model (ECM) (see Figure 2.4) to measure the IS users' level of satisfaction as an outcome of the extent to which the initial expectations are met at the confirmation phase (Park, 2020). According to Ambalov (2021), the ECM posits that

the perceptions about the future benefits of the IS inform the continuance intentions/use of the IS.

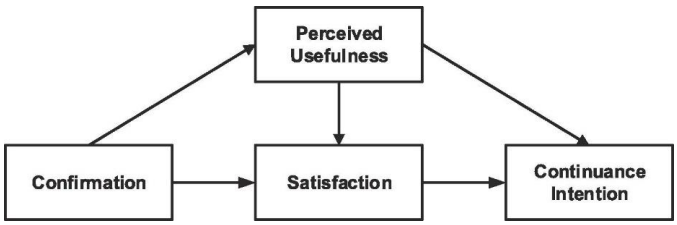

Figure 2.4. **Expectation Confirmation Model (Ambalov, 2021)**

The ECM comprises four constructs: perceived usefulness, confirmation, satisfaction, and continuance use. In this model, perceived usefulness relates to the first phase of the ECT. Furthermore, the perceived usefulness construct forms part of TAM. The critical part of the ECM is its confirmation aspect. In terms of confirmation, the users may have used the IS as such that they are in a better position to determine whether the expectations are met, or the extent to which they are met. User satisfaction is a central construct determined by the confirming or disconfirming of the user's initial expectations. According to Park (2020), satisfaction encompasses the user's overall feelings upon using the IS.

The inherent property of ECM is the continuance intention, which serves as the outcome of user interaction with the product. In this study, ECM is used to situate the behavioural outcome derived from UX and product usability.

Franque *et al*. (2020) note that previous studies on IS continuance intentions used the ECM as a primary model and may have integrated other models to cater for continuance constructs relevant to the specific domain. For instance, Mubarokah and Hidayanto (2020) included the social influence construct as one aspect of the expectations variable in their studies about factors affecting satisfaction and continuance use of a mobile application. Razak *et al*. (2017) extended the role of effort expectancy and social influence on the continuance use of the Malaysian e-government services. In a study by Ambalov (2021) on trust and habit in information technology continuance use, the trust construct featured prominently in the context of social networks.

The level of satisfaction determines the continuance intentions. Various studies (e.g., Chong, 2021; Mubarokah & Hidayanto, 2020; Sampat & Sabat, 2020) pinpoint user

satisfaction as sacrosanct to continuance intentions. The importance of user satisfaction is derived from the fact that it results from evaluating the initial expectations compared to the user's lived experience upon using the IS. The ECM sees user satisfaction as an antecedent for continuance use, that is, continuance use depends on the user's level of satisfaction. For example, Chong (2021) and Hsu and Lin (2020) established that satisfaction, perceptions, and subjective norms contribute to continuance intentions to use the mobile short video application. Perceived benefits and satisfaction directly influence the continuance use of offline applications.

It was of interest for this study to note the link between user satisfaction (which is part of both usability and UX) and continuance intentions. Further noted were the contradicting outcomes of another study on the link between user satisfaction and continuance intentions. For instance, Mubarokah and Hidayanto (2020) found no link between satisfaction and continuance intentions when referring to the use of an internal activity report application of the Ministry of Industry in Indonesia. Instead, social influence derived from authorities and close associates significantly influenced the application's continuance use. The disjoint between satisfaction and continuance intention is not a misnomer, as the ECM itself depicts a situation where perceived usefulness (i.e., pre-experience) is sufficient to sustain continuance intentions.

In addition, prior studies have established a link between usability and UX with continuance intentions (Baker-Eveleth & Stone, 2015; Shelstad *et al*., 2020). The usability factors vary in terms of their effect on continuance intentions. In their study where they evaluated a system for digital competence acquisition, Sobodić and Balaban (2022) found that efficiency was a significantly greater contributor to continuance intention than effectiveness; whereas computer self-efficiency and enjoyment were prevalent for students' willingness to continue using the cloud e-learning platform (Wang *et al*., 2019).

2.7 Conceptual framework for this study

The preceding discussion (Sections 2.4, 2.5 and 2.6) reviewed related literature on usability, UX, and continuance use. Subsequently, a conceptual framework (Figure 2.4) was constructed based on the above discussion and related literature.

The framework considered the symbiotic relationship between usability, UX, and continuance use, and could, therefore, be used in this study to compare these three

aspects in terms of a mobile application and online portal. The relationship between these three aspects was on the basis that the usability of the product informs the experience that users derive from using it, which in turn determines their continuance use. However, one should acknowledge the interwoven nature of usability and UX.

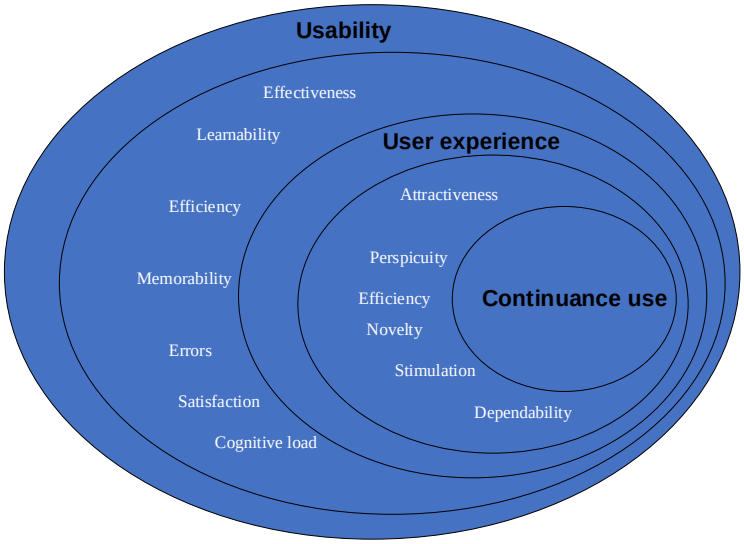

Figure 2.5. A conceptual framework for the study

At this stage, it is important to mention that this study used a conceptual framework as opposed to a theoretical framework. The reason for this decision was based on the fact that a conceptual framework is built on part of a theory (or multiple theories) and draws concepts and their interrelationships from a theory (or theories) (Ngulube, 2020). According to Ivey (2015), researchers use a conceptual framework to convey the meaning, understanding, and linkage between concepts and constructs of a study. In addition, a study without a conceptual or theoretical framework may be considered meaningless and unguided because the findings of such a study cannot be contextualised.

Different approaches are used in qualitative and quantitative studies in terms of the role of conceptual and theoretical frameworks. Quantitative studies tend to have a conceptual or theoretical framework derived from an existing theory, model, or experience. In qualitative studies, on the other hand, a conceptual or theoretical framework emerges from the generated data (Varpio *et al*., 2020). While the latter may hold, one may assert that, even for qualitative studies, a tentative conceptual or theoretical framework should exist to guide the study endeavour. According to Ngulube (2020), models are not theories. Instead, models provide an assistive role in

understanding the phenomenon. A model may also not necessarily be based on the entire theory. It aims to help identify variables/concepts to use in a study and depict a relationship between the variables dictated by the study objectives (Ivey, 2015).

Considering the preceding discussion on usability, UX, continuance use, and the related conceptual framework for this study, the next section surveys the literature on the usability, UX, and continuance use evaluation and evaluation methods, as well as usability and UX metrics, in order to address the first subsidiary research question for this study:

Which performance and satisfaction (self-reported) metrics are applicable in comparing a mobile application's usability, user experience, and continuance use with its associated online portal?

2.8 Usability, user experience, and continuance use evaluation

The literature convolutes usability and user experience evaluation in such a way that the evaluation methods for both are almost indistinguishable. The distinction is determined by the purpose of each evaluation. Usability evaluation encompasses assessment regarding the attainment of the user goals when interacting with the product, while UX evaluation measures the user's experience, emotions, perceptions and attitude towards the product (Nascimento *et al*., 2016). The evaluation scope in HCI includes functionality, usability, and experience (McNamara & Kirakowski, 2006). Each evaluation component addresses different evaluation domains. For instance, functionality focuses on the product itself, usability addresses the interaction between the user and the product, and experience addresses UX.

For this dissertation, functionality evaluation was excluded. The evaluation methods discussed in Section 2.8.1 are mainly applicable in the evaluation of usability, UX, and continuance use, notwithstanding that they may also be applicable to functionality evaluation.

2.8.1 Evaluation methods

Various authors classify usability and UX evaluation methods differently (Dhouib *et al*., 2016). From the literature, one establishes that the evaluation methods are classified based on the data derived from the evaluation (Zaki & Islam, 2021), the involvement

of users (Mvungi & Tossy, 2015; Sharp *et al*., 2019), and the setting where the evaluation is conducted (Sharp *et al*., 2019; Albert & Tullis, 2022).

The data-driven classification distinguishes evaluation methods between objective and subjective methods; user-driven classification distinguishes methods among user-based, evaluator-based, and automated evaluation methods; whereas setting-oriented classification uses the following classifications: controlled settings directly involving users (i.e., moderated), natural settings involving users (i.e., unmoderated or in-the-wild studies) and any settings not directly involving users (Sharp *et al*., 2019). In practice, the categorisation of evaluation methods is not mutually exclusive (i.e., there are overlaps between data-driven, user-driven, and setting-driven categorisation).

Table 2.3. User-driven classification of usability and UX evaluation methods

Evaluation categories	Description
User-based evaluation	The evaluation methods that involve the end-user as a primary participant are confined to this category (Dhouib *et al*., 2016; Mvungi & Tossy, 2015). This may include users performing defined tasks under observation in a controlled environment (i.e., lab-based studies), natural setting (i.e., in-the-wild studies) or soliciting opinions from the users (i.e., inquiry studies) about their perception of the product's usability/UX (Ammar, 2020). *Evaluation method examples: user testing, experiment, questionnaire, interview.*
Evaluator-based evaluation/inspection	Unlike user-based evaluation, no end-users are involved in the evaluator-based evaluation methods. Instead, expert evaluators assess the usability of the product using the established usability and interface guidelines, design standards, and their own knowledge (Dhouib *et al*., 2016; Mvungi & Tossy, 2015). Typically, the evaluation process consists of between two and five evaluators. *Evaluation method examples: heuristic evaluation, cognitive walkthrough.*
Automated/indirect evaluation	Automated/indirect evaluation methods do not involve any users. An evaluation may be conducted through the simulation of user interaction (e.g., modelling) with the product (Dhouib *et al*., 2016). In some cases, evaluation data may be collected through user interaction (e.g., user analytics) with the product (Mvungi & Tossy, 2015). *Evaluation method examples: modelling, user analytics.*

In this section, an overview of the evaluation method classification in terms of user involvement is adopted, as presented in Table 2.3. Table 2.3 also includes a brief discussion of different evaluation methods. In terms of continuance use, only user-based evaluation methods are feasible since users can determine their continuance intentions to use the product in future. Each evaluation method from Table 2.3 is briefly described below.

User testing: A representative sample of users perform specified tasks in a controlled environment (e.g., usability lab) to test the product user interface (Dhouib *et al*., 2016; Paz & Pow-Sang, 2016). The main disadvantage of user testing is the applicability of the findings to real-life situations.

Experiment: There are many similarities between experiments and user testing. Unlike user testing, though, experiments measure the hypothetic relationship between an independent (e.g., new keyboard) and dependent (e.g., typing speed) variable in relation to a specified task(s) (Rauf *et al*., 2019). The drawback of experiments is also the applicability of findings to the wider context beyond the lab setting.

Questionnaire: A questionnaire is used to solicit subjective opinions, attitudes, and user perceptions (i.e., self-reported metrics) of the product in terms of its usability, users' experience, and continuance intentions. The scope of questionnaires is wider compared to user testing and experiments, as a large user base is reachable through questionnaires. However, the strength of a questionnaire lies in the relevance of the questions in relation to the intended objectives (Sharp *et al*., 2019).

Interview: The interview process involves a one-on-one conversation between the user (or participants) and the usability specialist (Paz & Pow-Sang, 2016). The researcher gains a deeper user insight into the continuance intentions, usability, and UX of the product. The main drawbacks of interviews are the time and cost of conducting interviews compared to questionnaires.

Heuristic evaluation: This inspection method involves evaluators, the product, and heuristic guidelines or design standards (Sharp *et al*., 2019). The evaluators assess the usability of the product against the heuristic guidelines or design standards (Dhouib *et al*., 2016; Sharp *et al*., 2019). The final evaluation report of the evaluators depends on the heuristic guidelines/design standards used and/or the evaluators'

experiences. Heuristic evaluation cannot assess user experience, as users are not involved in the evaluation process.

Cognitive walkthrough: Similar to heuristic evaluation, users are not involved in a cognitive walkthrough. Instead, evaluators emulate the user's cognitive learning journey as they navigate the product. Throughout the inspection process, the learning experience and possible usability problems are identified (Paz & Pow-Sang, 2016). Since this method also excludes users, user experience cannot be determined. A variant of the cognitive walkthrough that involves representative users, product designers and usability professionals is known as pluralistic walkthrough (Hollingsed & Novick, 2007; Sharp *et al*., 2019).

Modelling: In a model-based evaluation, a model is created based on how humans would use the product (Kieras, 2007). Thereafter, usability metrics are obtained through predicted calculations or simulation of product use (Dhouib *et al*., 2016).

User analytics: As users interact with the product, data is collected on their interaction. The analysis is then conducted to establish interaction metrics (Mvungi & Tossy, 2015; Paz & Pow-Sang, 2016). User analytics is non-reactive since neither users nor the usability specialist is actively involved in the evaluation.

In this study, questionnaires and interviews were used to evaluate product usability, UX, and continuance use. The choice of these evaluation methods took into account the summative nature of the usability study and that users have used the product on both platforms before, thus being capable of determining its usability and UX from their perspective. It was also considered that it would be more probable to gain a deeper insight into UX with interviews and questionnaires (Husband, 2020).

A critical part of the evaluation process is what one intends to measure, that is, the evaluation metrics. The next sections dissect different usability, UX, and continuance use metrics to address the identified subsidiary research question, as indicated earlier.

2.8.2 Usability and user experience metrics

According to Albert and Tullis (2022), a metric measures or evaluates something. Moreover, a metric can either be standardised or non-standardised. For standardised metrics, it is easy to maintain consistency in terms of the meaning of the measure as opposed to non-standardised metrics.

Different authors often dichotomise metrics as performance and satisfaction metrics (Georgsson & Staggers, 2016; Palmer, 2002; van Doorn *et al*., 2013). In this dissertation, usability and UX are classified in terms of performance and self-reported metrics (Albert & Tullis, 2022). The operationalisation of performance and self-reported metrics constructs determine what scales and sub-constructs one uses, as well as the nature and type of metrics. Performance metrics are addressed in Section 2.8.2.1, followed by self-reported metrics in Section 2.8.2.2.

2.8.2.1 Performance metrics

In the literature, UX and usability are sometimes used interchangeably, whereas each is seen as independent from the other in some cases. Consequently, the performance concept is sometimes used to measure both usability and UX. In this dissertation, performance is viewed as a component of usability, given that the position in this dissertation is that UX and usability are distinct from one another, yet intertwined. According to Albert and Tullis (2022), performance is what users do and how they interact with the product. To measure performance, there must be specific goals that the user wants to achieve.

Different usability scenarios exist, indicating the performance measures that one needs to consider when measuring usability. Amongst the usability scenarios identified by Albert and Tullis (2022), are the following: completing a transaction, comparing products, evaluating the frequent use of the same product, and evaluating navigation and/or information architecture. The choice of usability scenarios informs the metrics that one needs to consider. For example, the most applicable scenarios for the present study were transaction completion and product comparison in line with the performance metrics and the usability model adopted in this study to guard against metrics that distantly measure the area of interest (Nielsen, 1993). Albert and Tullis (2022) and Nielson (1993) identified task success, time on task, errors, efficiency, and learnability as performance metrics. However, there is no consistency in the terminology classification for performance metrics. For consistency, task success is classified as product effectiveness, while time on task and efficiency are integrated to refer to product efficiency.

The product being evaluated also informs the choice of performance metrics that are considered. For example, Roy *et al*. (2014) assessed the usability of academic

websites in their study. They included the number of clicks and self-reported metrics as part of the performance evaluation of the academic websites. The authors excluded errors, efficiency, and learnability, as opposed to those mentioned by Albert and Tullis (2022) and Nielsen (1993). The point here is that the metrics chosen per study are informed by the purpose of the evaluation.

Emphatically, the usability construct is not always measured objectively (Hornbæk, 2006). There is some element of subjectivity, particularly when users are expected to report on their perception of product usability. The same is extended to performance as a construct for usability, and its operationalisation is required to comprehend it fully. The operationalisation of a construct implies that one needs to customise the construct to the study purpose, theory, and/or model used. Since this study used the PACMAD model, an additional attribute, cognitive load was considered as part of the performance metrics.

Performance metrics are often seen from the perspective of objective metrics. While the latter may be a dominant view, subjective usability metrics (including performance metrics) are equally important (Słomska-Przech *et al*., 2021). Subjective metrics view the performance measure from the perspective of the user. This implies that performance is evaluated on the basis of how the users experience the product. In the end, it is the intended user who is well-positioned to evaluate the product experience. The purpose is to situate the performance of the product from the vantage point of the user. Objective measures for performance may not always give a complete picture of the product performance rather than reinforcing the product designer's view of performance over that of the user.

2.8.2.2 Self-reported metrics

User satisfaction and performance are the fundamental building blocks of usability (Albert & Tullis, 2022). While performance leans more toward the objective measure of usability, user satisfaction is mainly a subjective element of usability measured by means of self-reported metrics. According to Hassan and White (2013), satisfaction exhibits a personal emotional state of the user and manifests itself in the form of individual behaviours arising from the interaction with the product. Rummel (2017) asserts that pragmatic aspects of product performance (e.g., effectiveness and efficiency) play a role in the extent of user satisfaction with the product.

A correlation exists between product performance and user satisfaction with the product. However, Albert and Tullis (2022) assert that it is not always the case that product performance correlates with satisfaction. Nonetheless, discrepancies between performance and satisfaction often result from users randomly rating their satisfaction with the product. In other instances, it could signal that the product usability is satisfactory from the perspective of the product designers and not necessarily from the user's perspective.

User satisfaction is regarded as self-reported data and, by extension, self-reported metrics. According to Albert and Tullis (2022), self-reported metrics yield subjective (or preference) data. On the one hand, the subjectivity of the data implies that the metrics rely on individuals' opinions, feelings, and thinking (Hassan & White, 2013). The term "preference data" for user satisfaction metrics implies that user satisfaction is about choices between available options (Albert & Tullis, 2022).

The factors that are featured in user satisfaction metrics vary from one evaluation method to another. The underlying features of user satisfaction are perceptions and emotions attached to product use, and various satisfaction metrics are intended to capture perceptions and emotional reactions on the product(s) being evaluated (Liu *et al*., 2019). Most importantly, the extent to which the user is satisfied is heavily informed by the user's need/goal. Kiseleva *et al*. (2016), and Zhang *et al*. (2020) go a step further and conceptualise user satisfaction in terms of the fulfilment of user goals.

The logical flow from the user goal is that the user may have expectations of the product to fulfil their goal(s). Consequently, the expectation measure is one aspect of self-reported metrics. Albert and Dixon (in Albert & Tullis, 2022) proposed a method, called the Expectation Measure, that compares the user's expectations before interacting with the product, with the actual experience with the product. Jang and Yi (2017) confirm the relevance of expectation confirmation and pragmatic factors in the extent of user satisfaction with the product. However, there is often no clear distinction between UX and usability in the literature because satisfaction is considered a factor of both.

From the above discussion, it is evident that various evaluation methods exist to evaluate usability, UX, and continuance use. Additionally, there are inconsistencies in

terms of different usability and UX metrics. The next section unpacks the continuance use metrics.

2.8.3 Continuance use metrics

This discussion extends from Section 2.6, specifically referring to continuance use metrics. Continuance use evaluation is premised on initial acceptance and post-acceptance of a product upon use (Tucker & Kotnour, 2021). Therefore, continuance use behaviour presupposes one would have used a product at least once. The latter relates to adopting the specific product for the intended purpose.

The first phase of the user's decision-making process starts with expectations (Abdul-Halim *et al*., 2022; Bhattacherjee & Lin, 2015). The user forms expectations based on perceived usefulness, trust, previous experience, attitude towards similar products, experience with the same institution, and anticipated benefits (Foroughi *et al*., 2023). The user's perceived usefulness and perceived ease of use of the product would imply that the user can decide whether to continue using the product (Foroughi *et al.,* 2023*)*. This entails that the user may have had some experience with the product.

The second phase occurs when the user experiences the product. During this phase, the user matches what they expected with the realised performance and experience. The confirmation exercise will result in confirmation or disconfirmation of the initial expectations, directly reflecting on the user's satisfaction (Bhattacherjee & Lin, 2015; Hariguna *et al*., 2023). In the confirmation phase, the user may have to re-evaluate their initial expectations upon experiencing the product, and after the realisation that these initial expectations may have been unrealistically low or high (Abdul-Halim *et al.,* 2022*).* Therefore, this phase would require the user to compare the expectations against the experienced reality. Only then may the user be capable of confirming or disconfirming his/her expectations. According to Abdul-Halim *et al*. (2022), there is a strong correlation between confirmation and satisfaction, as anticipated benefits from using the product would have been attained.

One may deduce that continuance use is built on three fundamental tenets: expectations, confirmation, and satisfaction. These tenets represent the continuance use metrics. In many studies (e.g., Akdim *et al*., 2022; Franque *et al*., 2020; Khan & Saleh, 2023), continuance use is presented as a behavioural outcome from expectations, confirmation, and satisfaction. This study confirmed this notion since

principal component analysis returned one composite component for continuance use (see Appendix F).

2.9 Summary

The context of a study is crucial to the understanding of its foundation, relevance, and interpretation of its findings. Thus, this chapter served three broad purposes, namely, to view and situate the study through its historical vantage point; to survey the theoretical grounds and developments accumulated over the years within the scope of the study and the broad field of HCI; and to use the identified theoretical bases and existing literature to interpret and contextualise the study findings later in the report.

A conceptual framework for this study was established in pursuit of these purposes. Furthermore, this chapter expanded on the performance and satisfaction metrics for usability and UX, as well as on the expectations, confirmation, and satisfaction metrics for continuance use. Evaluating these metrics was also discussed.

The next chapter on research design and methodology intends to detail and justify the design and methodology aspects employed in the study.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

The preceding chapter gave a theoretical foundation and situated this study within the broad field of Human-Computer Interaction (HCI). This chapter details the adopted research design and methodology. According to Babbie (2017), the research design is a blueprint of the study in terms of how it will be carried out. Furthermore, Blaikie and Priest (2019) refer to research design as a binding logic in the overall research process. While the research design answers the 'how' of the study, the research methodology underscores the fundamental principles, procedures, and practices that guide the research process (Kothari & Garg, 2019; Marczyk *et al.*, 2005).

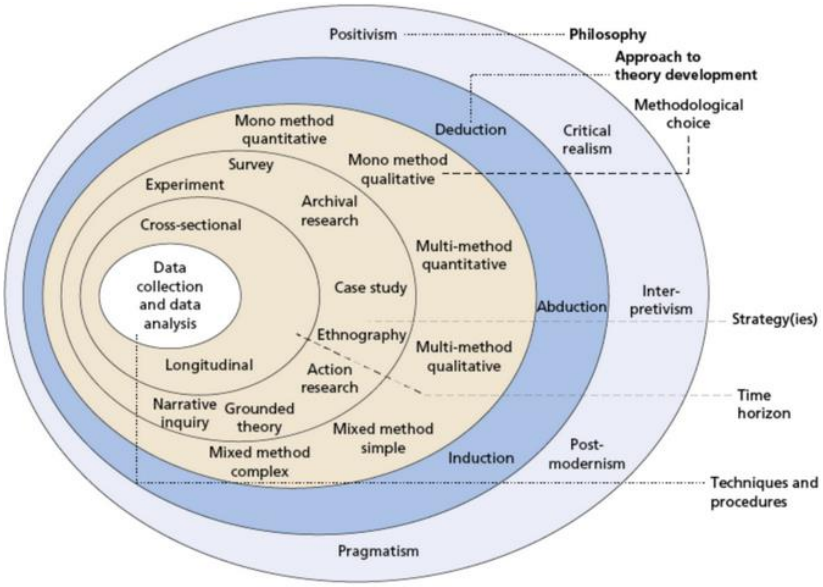

Figure 3.1. The research onion – latest version (Saunders *et al.*, 2019)

This chapter is presented in terms of the research onion (Figure 3.1), created by Saunders *et al*. in 2008 and revised in subsequent years. In this research onion, the philosophical approach (i.e., research paradigm), approach to theory development, methodological choice (i.e., research approach), a research strategy (i.e., research design), time horizon, and techniques and procedures (i.e., data collection and analysis methods) are structured and discussed.

3.2 Philosophical approach

There is consensus among scholars that choosing an appropriate paradigmatic framework is one of the fundamental parts of a scientific research endeavour (Babbie,

2017; Guba & Lincoln, 1994; Terre Blanche *et al.*, 2006). A philosophical approach is synonymous with the research paradigm. Thomas Kuhn first coined the paradigm concept in the early 1960s as a theoretical structure used by researchers to study and solve social issues (Guba & Lincoln, 1994). Terre Blanche *et al*. (2006) and Donaldson *et al.* (2015) argue that the research paradigm is a comprehensive system of interrelated practices and thinking that define the nature of inquiry along the three major dimensions, namely ontology (i.e., the nature of reality), epistemology (i.e., the nature of knowledge) and methodology (i.e., research principles, procedures, and practices). In addition, literature has shown that there is a variety of paradigms in the field of research, including positivism, post-positivism, critical realism, interpretivism, postmodernism, and pragmatism (Babbie, 2017; Guba & Lincoln, 1994; Lichtman, 2010; Terre Blanche *et al*., 2006).

Positivism, critical realism, interpretivism, postmodernism, and pragmatism will be discussed as the main research paradigms presented by the research onion (Saunders *et al*., 2019).

3.2.1 Positivism

Positivism is rooted in the natural sciences (Gaudet & Robert, 2018). The main objective of positivism is to emulate the scientific rigour of traditional sciences (Howell, 2013). The ontological posture of positivism is that we can only know and understand what we can observe and measure. Also, the observations must be verifiable and logically derived, as such that the application of the same logical reasoning leads to the same conclusion (McGregor, 2018).

A positivist paradigm argues that social reality can be objectively discovered (Denicolo *et al.*, 2016; Park *et al.*, 2020), as it can be perceived through the senses (Terre Blanche *et al*., 2006). Social reality is considered independent of the observer's perceptions, biases, and values (Stuart *et al.*, 2015). The latter culminates in the notion that social reality is external to our being (McLaughlin, 2012; Stuart *et al*., 2015). A positivist-oriented study often intends to predict and explain social phenomena (Gaudet & Robert, 2018) due to the belief that whatever exists can be scientifically verified.

3.2.2 Critical realism

According to critical realists, the nature of social reality is out there. However, there are no certain means of confirming its existence (Easton, 2010). Furthermore, objective reality is unattainable since there are no definitive criteria to form conclusive judgments about reality (Creamer, 2018; Emmel *et al.*, 2018). Shaw and Holland (2014) go a step further to suggest that social reality is two-layered (i.e., a surface layer that everyone sees and a deep structural layer that requires a critical outlook to uncover). One needs to critically and constantly evaluate the knowledge generated from studies when new evidence appears. According to Hubbard (2016), the knowledge about social reality is dynamic and context-driven, yet theory-laden.

3.2.3 Interpretivism

Positivism has not been without criticism and objections. These criticisms gave birth to interpretivism, which is commonly referred to as 'anti-positivism' (Chowdhury, 2014; Fetters & Rubinstein, 2019; Tekin & Kotaman, 2013).

Interpretivism is the stark opposite of the positivist paradigm. Interpretivism believes that natural and social realities are different, and thus the worldview applicable to natural sciences cannot apply to social sciences (Saunders *et al*., 2019; van Rensburg *et al.*, 2010).

Furthermore, interpretivism rejects the singular view of social reality. Rather, social reality is multifaceted and socially constructed (Gaudet & Robert, 2018; Saunders *et al*., 2019). The socially constructed reality implies that meanings ascribed to social phenomena are dynamic, individual, and context driven. Thus, social reality is subjectively constructed and shaped by people's thoughts, experiences, and actions (Babbie, 2021).

3.2.4 Postmodernism

While critical realism acknowledges the existence of social reality, the postmodernist paradigm views social reality and the nature of knowledge as neither here nor there. According to Babbie (2021), the postmodernist paradigm is a class of critical theory that questions both the positivist and interpretivist paradigms as a blueprint for understanding social reality. Hickman (2019) maintains that postmodernism shares philosophical grounds with pragmatism as far as both paradigms reject the dualism of

social reality. However, postmodernism is anti-establishment. This paradigm is built on a sceptical approach to the claims of objective social reality (Howell, 2013). According to Grbich (2013), an interplay between subjectivity and objectivity renders the objectivity of social reality obliterable.

3.2.5 Pragmatism

Positivist and interpretivist paradigms sit on opposite ends of the pole with regard to ontological, epistemological, and methodological positions, whereas critical realism and postmodernism employ a critical view of social reality and the nature of knowledge. On the other hand, the pragmatic paradigm takes a moderate view of both the positivist and interpretivist paradigms. Most importantly, pragmatists posit that the nature of social reality is equally objective and subjective (Donaldson *et al*., 2015). The difference lies in the extent to which the research question dictates what is more practical between objectivity and subjectivity (Maarouf, 2019). According to Kaushik and Walsh (2019), there is no single view on the means of understanding social reality, that is, the social reality and the nature of knowledge are a result of human experiences too, and such experiences and behaviours can be objectively derived. Furthermore, pragmatists acknowledge that actions and consequences are vital to understanding social reality. Pragmatism juggles observations and theory testing (Morgan, 2020). This entails that one makes observations of a phenomenon and later tests the validity of the observations. Theories are adapted as new developments emerge from the observations.

This study acknowledged both the positivist and interpretivist paradigms in terms of their importance in understanding the nature of social reality and knowledge. On the one hand, this study considered that the nature of social reality can be objectively discovered and measured to such an extent that one can establish whether the properties and/or behaviours exist by means of structured measurements. On the other hand, human experiences and actions are tied to socially constructed meanings, and as such, the interpretive paradigm was also acknowledged.

To this end, the pragmatic paradigm was adopted for this study, as it aimed to compare the usability, user experience (UX), and continuance use of a mobile application and online portal by users, as much as to the extent that each aspect of positivist and interpretive paradigms applied in the study.

3.3 Approach to theory development

A theory is considered a general abstraction of a social reality or phenomenon (Patten & Newhart, 2018). However, for a theory to be considered scientific, it should be based on empirical evidence. Every facet of social life is somewhat based on a 'theory', even though some theories are sometimes based on opinions, perceptions, and untested assumptions. Nonetheless, according to Saunders *et al*. (2019), the development of a theory is based on three fundamental reasoning approaches, namely deductive, inductive, and abductive reasoning.

Deductive reasoning is based on deductive logic, where the general statement(s), which could be in the form of an assumption, hypothesis, or a pattern of behaviour, is considered as the starting point (Leedy & Ormrod, 2021; McGregor, 2018; Remler & van Ryzin, 2015). Then, a more concrete case is considered to determine if the case can be logically derived from the general statement(s). This approach is often applied in mathematical proofs (Van Rensburg *et al*., 2010). A study that follows this method of theoretical reasoning intends to test the theory when applied to a specific case to derive a conclusion. However, the soundness of the conclusion is dependent on the validity of the general statement(s). In the case of scientific studies, the general statements are usually derived from previous studies, existing theories, and extensive literature reviews.

The opposite of deductive reasoning is inductive reasoning. According to Leedy and Ormrod (2021), theory development starts with observing the specific case(s) and then descends to a general conclusion about the observed phenomenon on a class of objects or people. In the inductive reasoning process, one "observes a sample and then draws conclusions about the larger population" (Leedy & Ormrod, 2015, p. 37). Glaser and Strauss (in Babbie, 2017) refer to this theory development approach as the grounded theory on the understanding that the theory is developed from observing specific cases. While studies based on deductive reasoning test a theory, studies based on inductive reasoning lead to the development of a theory (Van Rensburg *et al*., 2010).

In some cases, the derivation of a conclusion may not necessarily be based on observations, scientific data, or general statements. Instead, it may be based on

inferences derived from the best explanation. The latter is what Douven (2017) refers to as abductive reasoning.

This study considered the existing body of knowledge and previous studies on product usability, UX, and continuance use. It subsequently investigated these three aspects during the evaluation of the mobile application and online portal of Company X. The study further intended to understand the experiences of the participants in using the mobile application and the online portal to gain insight into the underlying meanings behind the experiences. Consequently, both inductive and deductive reasoning were employed regarding the approach to theory development.

3.4 Methodological choice

The methodological choice of a study is intrinsically tied to the philosophical approach. Thus, the ontological and epistemological assumptions of the selected philosophical approach inform the prevailing methodological choice, with a specific focus on the research objectives, data collection tools, sampling methods, data analysis, and the researcher's role in the study.

Although the research onion provides variations of quantitative, qualitative and mixed-methods in terms of the number of methods each approach uses (Saunders *et al*., 2019), this section simply refers to quantitative, qualitative, and mixed-methods approaches, respectively.

3.4.1 Quantitative approach

The philosophical root of the quantitative approach is positivism, particularly its ontological and epistemological positions. The scope of the quantitative approach includes a formalistic, objective, and systematic process whose outcome is the numerical data and conducting statistical analysis (Bloomfield & Fisher, 2019; Locharoenrat, 2017; Matthews & Ross, 2010).

The purpose of quantitative studies is often to test an existing theory in the form of explanations and predictions, so that one understands the relationship between the variables (Antwi & Hamza, 2015; Morgan, 2014). The variables need to be clearly defined at the onset, and the operationalisation of the variables cannot be changed later (Ragin & Amoroso, 2019). The variables often come from the theory under consideration. The implementation part of the quantitative study includes the selection

of concepts, which are then operationalised using the selected measuring instrument (Van Rensburg *et al*., 2010).

Qualitative phenomena like 'satisfaction' are converted into measurable variables in social sciences (Babbie, 2021). Sub-constructs for the specific concept may be identified and operationalised in the measuring instrument during the conversion process. For example, satisfaction may have sub-constructs like pleasure and enjoyment. However, each construct needs to be clearly defined to minimise ambiguity.

3.4.2 Qualitative approach

Much like the positivist and interpretive paradigms, the qualitative approach is the opposite of the quantitative approach. According to Antwi and Hamza (2015), the qualitative approach posits that people's experiences shape the meanings and understanding of the phenomenon, and the researcher is not detached from the research process. Instead, the researcher is deeply immersed in the observation (Castellan, 2010), so that their perceptions may shape the study direction. In a qualitative study, the researcher themselves becomes the measuring instrument (Atieno, 2009). The value of the study depends on how the researcher conducted the observation, or how probing the researcher was in the interview, to mention but a few. Consequently, the researcher's perception, beliefs and biases are not entirely excluded in the research process. However, the researcher's influence should be minimised as much as possible.

A study inclined to a qualitative approach intends to understand and interpret human experiences, behaviour, and perceptions (Locharoenrat, 2017) instead of deriving explanations and predictions from the subjects' behaviours (Castellan, 2010). According to Atieno (2009), one must understand the context and background that informs the subjects' thinking, perception, and behaviour. The point of departure is that each observed subject is unique; the meanings and how they experience phenomena fundamentally differ. Therefore, the qualitative approach does not subscribe to the universality of the subject's behaviour. Instead, the emphasis is on the individual's perspective. The data obtainable from a qualitative study are mainly non-numeral (Queirós *et al.*, 2017). The data may include text, images, verbal and non-verbal cues (Remler & Van Ryzin, 2015). However, the latter does not imply that qualitative studies

do not use numerical data. For instance, one may convert non-numerical data to numerical data, depending on the purpose of the study.

3.4.3 Mixed-methods approach

Not all cases require one to use either a qualitative or quantitative approach. Additionally, research approaches are not mutually exclusive. According to Remler and Van Ryzin (2015), qualitative data may include quantification, such as counting the number of categories, labels, and words. Equally, quantitative studies may also include interpreting findings wherein the researcher makes sense of and interprets the quantitative data. Integrating qualitative and quantitative approaches may be necessary to provide insight into the quantitative data beyond frequency distribution and cross-tabulation.

This study followed a mixed-methods approach. According to Creswell and Clark (2018), applying the mixed-methods approach goes beyond data triangulation. Furthermore, mixed-methods research is necessary when one approach is insufficient to give a complete picture of the phenomenon.

The quantitative phase of this study was descriptive, whereas the qualitative phase further explained the descriptive results. This latter phase was used to overcome the shortcoming of the quantitative approach. For instance, quantification does not provide an explanation and/or understanding of the results beyond the visual presentation of numerical data (Leedy & Ormrod, 2021). A better understanding of behavioural patterns and establishing a deeper meaning of the phenomenon is achieved using a qualitative approach (Babbie, 2021).

Leedy and Ormrod (2021) maintain that quantitative studies often have known variables, and the data generated are numerical. For this study, the following concepts have been identified: usability, UX, and continuance use. Furthermore, these concepts were converted into measurable variables suitable for quantitative investigation. For these reasons, the mixed-methods approach was deemed suitable for this study.

The very nature of the mixed-methods approach lies in the level and the extent of integrating quantitative and qualitative approaches or study designs (Ivankova *et al.*, 2006). The latter determines which form of triangulation one may use for the study. Triangulation can be at the study design, research method, data collection, data

analysis, or a combination of levels. According to McCrudden and McTigue (2019), the integration level of the study designs results in three basic mixed-method designs, namely explanatory sequential (i.e., starting with the quantitative phase followed by the qualitative phase of the study), exploratory sequential (i.e., starting with the qualitative phase followed by the quantitative phase of the study) and convergent designs (i.e., both qualitative and quantitative phases of the study are conducted concurrently).

However, integrating research approaches in the study design presents a prioritisation challenge that one needs to address (Ivankova *et al*., 2006). This means that one should decide which approach to begin with. In addition, it is essential to decide which approach dominates the study, if any. The integration priority decisions ultimately determine the intended mixed-method design (Creswell & Clark, 2018).

Given the context above, this study was predominately based on the quantitative approach in terms of research method, data collection, analysis, and interpretation. The quantitative phase was then followed by the qualitative phase. Thus, an explanatory sequential design was followed. The quantitative phase compared the usability, UX, and continuance use of the mobile application and online portal, followed by the qualitative phase, where further explanation and understanding were sought, based on the results obtained in the quantitative phase.

3.5 Research strategies

Several research strategies exist for different HCI phenomena. According to De Vaus (2013), a research strategy is equivalent to a research design or part of it, which is a logical structure for the study.

Saunders *et al*. (2019) identify the following research strategies: experiment, survey, archival research, case study, ethnography, action research, grounded theory, and narrative inquiry. Each of these will be briefly explained in the sections to follow.

3.5.1 Overview of research strategies

An *experiment* consists of a pair of variables (i.e., dependent and independent), test conditions (i.e., pretest and post-test) and groups (i.e., experimental and control) (Babbie, 2021). The main objective of experimental research is to establish a cause-

effect relationship between the independent and dependent variables (Williamson & Johanson, 2018).

A *survey* is used to obtain information about the group of people in terms of their characteristics, opinions, perceptions, attitudes, and previous experiences (Leedy & Ormrod, 2021). Babbie (2021) maintains that survey research can be used for a descriptive, explorative, or explanatory study.

Archival research, unlike other research strategies, is based on the analysis of archival data (Ventresca & Mohr, 2017). According to Das *et al.* (2018), archival data consists of data created and kept before the research process commences. Saunders *et al*. (2019) posit that archival data was not initially created for research purposes, and researchers should consider the quality of the archival data in relation to the study purpose.

A *case study* can be defined as a method used to obtain a comprehensive understanding and learn more about a particular case, considering its context (Yin, 2018). Baškarada (2014) also maintains that a case study aims to generate a hypothesis for later investigation, rather than for illustration.

Ethnography involves studying a group with common cultural patterns in its natural setting. The research focuses on investigating the cultural group's everyday behaviours (e.g., interaction, language use) (Leedy & Ormrod, 2021). The key part of an ethnographic study is the identification of key informants and active participation (i.e., participant observation) of the researcher in the group activities, so that the researcher becomes part of the group.

Action research is a solution-oriented and practically focused applied research process (Leedy & Ormrod, 2021). According to Saunders *et al*. (2019) and Williamson and Johanson (2018), action research is participatory, that is, there should be active participation of participants in the process, and participants should take ownership of the process. Furthermore, the research process is spiral and iterative.

Grounded theory is a research method and a design that begins with qualitative data and then inductively develops a new theory (Babbie, 2017; Leedy & Ormrod, 2021; Williamson & Johanson, 2018). Saunders *et al*. (2019) maintain that a grounded theory study may also employ an abductive approach towards theoretical development.

Narrative inquiry is a reflective research strategy where a researcher listens to the stories and experiences of the participants to understand the context and their positions (Hickson, 2016). According to Wang and Geale (2015), narrative inquiry goes beyond typical storytelling, as the stories are used to reveal nuances, deep underlying patterns, and meanings of participants' experiences. A key component of this research strategy is the chronological construction of events through storytelling (Saunders *et al*., 2019).

3.5.2 Selected research strategy

The case study was selected as a research strategy for this study due to its strengths and relevance in addressing the study objectives. According to Williamson and Johanson (2018), a case study is applicable in the information systems (IS) environment since information systems and the context of use are intrinsically inseparable. Furthermore, multiple data collection techniques can be used in a case study to gain insight into the phenomenon. In this study, a questionnaire and an interview protocol were used to collect quantitative and qualitative data.

According to Saunders *et al*. (2019), the type of case study that the researcher embarks upon depends on the number of cases (i.e., single or multiple) and the scope of the case (i.e., holistic or embedded). A single case study occurs where only one case is considered, whereas a multiple case study design involves two cases or more (e.g., different organisations or individuals) (Saunders *et al*., 2019; Yin, 2018). A holistic case study implies that the study investigates the unit of analysis as a whole (e.g., the entire organisation), whereas, on the other hand, an embedded case study investigates an aspect of the unit of analysis (Yin, 2018).

A single case study design was utilised in this study to determine the usability, UX, and continuance use of a mobile application and online portal. Yin (2018, p. 51) asserts that a single case study is necessary when any of the following characteristics hold: "it is a critical, extreme or unusual, common, revelatory or longitudinal case." The choice of a single case was premised on the common practice of using a variety of service channels to provide the same services to users. In terms of the scope, an embedded case study was employed.

Additionally, the case should be bounded. Bounding the case, in this context, means limiting the scope of the case study, as one cannot investigate everything about the

case. In the context of this study, Company X was used as a case. Additionally, the specific focus of this case study was on the mobile application and online portal. The initial phase of bounding the case was contained in the research questions and objectives that set out exactly which questions the study intended to answer to fulfil the identified research objectives (refer to Section 1.5 in Chapter 1). For this study, the specific focus was on the usability, UX, and continuance use of the mobile application and online portal of Company X as an institution.

One of the advantages of a case study is that it can follow a qualitative, or a quantitative approach, or both. Therefore, a case study design provides mono- or mixed approaches (Yin, 2009). Yin (2009, p. 18) maintains that case studies usually have "many more variables of interest than data points, with data needing to converge in a triangulating fashion, and benefit from the prior development of theoretical propositions to guide data collection and analysis." A case study was, therefore, a suitable research strategy, since this study followed a mixed-methods approach, therefore using more than one research method.

3.6 Time horizon

The time horizon for a study can either be cross-sectional or longitudinal. According to Babbie (2021), a cross-sectional study is often conducted at one point in time (similar to taking a snapshot), whereas longitudinal studies are conducted over a period of time, tracking changes and developments in the subject of interest.

Owing to the limited time spent on a cross-sectional study, these studies are mainly exploratory and/or descriptive in nature, whereas longitudinal studies make provision for evaluating changes in the observed population, thus making it possible to conduct an explanatory-driven study.

The current study followed a cross-sectional approach because of limited time and resources, as well as its descriptive nature in terms of the study objectives.

3.7 Techniques and procedures

The last (inner) layer of the research onion (Saunders *et al*., 2019) refers to techniques and procedures relating to data collection and data analysis. These techniques and procedures will now be discussed, referring to participants, sampling strategies, data collection tools, and data analysis methods.

3.7.1 Participants

The units of analysis (participants) for this study consisted of existing users of the Company X mobile application and online portal which, in turn, formed part of the target population. According to Babbie (2021), the target population is the aggregate number of units of analysis for which the study intends to generalise the findings.

The inclusion criteria for this study were the following: participants should be at least 18 years old and must have used both the Company X mobile application and online portal within the past 12 months. These criteria were considered on the basis that the services provided through the mobile application and online portal required one to be at least 18 years old, and the study compared both the mobile application and online portal. It was assumed that the participants would have at least a basic knowledge of operating a smartphone and a computer, since they were expected to have used both these devices at least once in the past 12 months.

3.7.2 Sampling strategies

Studies may opt to include every element of the target population in a research study. These studies are often referred to as census studies. According to Abbott and McKinney (2013), a census is an official account of everyone in the population. The size of the population may not allow for a census study. Various sampling strategies exist that one may use. The broad sampling categories are probability and non-probability sampling.

Probability sampling implies that the selection of sample elements is conducted randomly, as such that every element in the population has an equal chance to be included in the sample (Leedy & Ormrod, 2021). The method of selection may differ. However, the randomness of element selection for the sample remains the same. The goal of probability sampling is to ensure that the sample is representative of the population of the study.

On the other hand, in non-probability sampling, not every element in the population has a chance to be selected (Leedy & Ormrod, 2021; Van Rensburg *et al*., 2010). Instead, the probability of selection depends on factors other than randomness. Thus, the composite sample may not necessarily represent the study population.

A summary of probability and non-probability sampling strategies is presented in Table 3.1.

Table 3.1. Sampling strategies

Non-probability sampling	
Convenience sampling	Readily available participants are selected irrespective of how representative the sample seems to be.
Quota sampling	Similar to convenience sampling, except that categories of interest in the study are included based on the proportion determined by the researcher (Etikan & Bala, 2017).
Purposive sampling	The researcher selects participants whom they believe would have information to assist in addressing research objectives (Etikan & Bala, 2017).
Snowball sampling	The researcher selects a handful of potential participants and then relies on the identified participants to recruit more participants (Etikan & Bala, 2017).
Probability sampling	
Simple random sampling	The selection of participants uses a lottery system or a table of numbers (Toepoel, 2016).
Systematic random sampling	The section process is similar to simple random sampling as far as selecting the first element is concerned. However, the selection of subsequent elements uses a fixed number *n* added from the first element until the sample size is reached (Etikan & Bala, 2017; Toepoel, 2016). The value of *n* is determined using the population size and the sample size (Wagner & Gillespie, 2019).
Stratified sampling	The selection process applies a random process to select sample elements for each stratum. The purpose is to ensure that each stratum of interest in the study is represented (e.g., males and females) (Toepoel, 2016).
Cluster sampling	The sampling process proceeds according to clusters (Toepoel, 2016). For example, the primary cluster could be the provinces, and then the secondary cluster could be the districts from which the sample will be drawn.

3.7.2.1 Sampling strategy: Quantitative phase

The sampling strategy used for the quantitative phase was systematic random sampling. According to Saunders *et al*. (2019), systematic random sampling is suitable for both a small and large population. Geographically dispersed populations also accommodate this sampling strategy, provided that the face-to-face data collection method is not used. Systematic random sampling may apply even without the sampling frame, particularly for internet-based studies.

The sampling frame for this study was obtained from the list of users who utilised the Company X mobile application and online portal within the last 12 months (measured at the time of data collection). Subsequently, every n^{th} user was selected for consideration. However, one needs to avoid periodicity as it has the potential to make the sampling process non-random. According to Wagner and Gillespie (2019), sample periodicity occurs where the sampling frame follows a specific pattern (e.g., every fourth element is a female), as such that the sampling is biased towards the pattern. The sampling frame used did not follow any pattern other than the list of users who used the mobile application and online portal in the past 12 months at that time.

The sample size for the quantitative phase was initially set at 250 participants, taking into account the randomness of the sampling strategy selected for this study and the average number of applications received by Company X through the online portal and mobile application in a given year. According to Delice (2010), a sampling size of between 30 and 500 participants is considered sufficient for most studies, taking into account the 95% confidence level.

The sampling frame of Company X customers who used the mobile application and online portal in the last 12 months (measured at the time of data collection) consisted of 198 000 customers. However, only 28 460 customers used both the mobile application and the online portal, whereas the remainder used only one platform (i.e., mobile application or online portal). These customers were thus excluded from the study. A 5% sample (1 423) was drawn from 28 460 customers, and a Microsoft Excel random number generator formula (=int(rand()*20000)+1) was used to determine the first element *n* for the sample. A fixed ratio of 20 was determined using the following formula:

$$\text{ratio (r)} = \frac{population\ (p)}{sample\ size\ (s)} = \frac{28460}{1423}$$

Subsequently, every element in position *n* + *r* (including position *n)* was iteratively selected until the sample size was obtained.

3.7.2.2 Sampling strategy: Qualitative phase

The second phase of this study used a purposive sampling strategy. According to Babbie (2021), the purposive sampling strategy is suitable based on the knowledge of

the population characteristics and the purpose of the study. Morgan (2014) identifies the following strategies used in purposive sampling: defining criteria, systematic comparison, special information, and developing theory and application.

Considering the purpose of this study, a systematic comparison was the most appropriate strategy in terms of purposive selection of participants. In phase two, the selection of participants consisted of those who provided their feedback in order to determine the usability, UX, and continuance use of the Company X mobile application and online portal, respectively. Additionally, only participants who indicated their interest in participating in the study's qualitative phase, were selected.

A total of 29 potentially interested participants were identified from the quantitative phase of the study. Only 13 of these 29 participants confirmed their availability and subsequently participated. The reasons for no longer being available to participate varied from incorrect contact numbers, unreachability, and confirming participation to only later not being available when contacted.

3.7.3 Data collection tools

A researcher has multiple data collection tools available to choose from in case study research, depending on the research objectives. The selected tools may combine qualitative and quantitative data collection tools. This mixed-methods study used two data collection tools: self-administered questionnaires and semi-structured interviews.

3.7.3.1 Self-administered questionnaire

A self-administered questionnaire is a type of questionnaire where the study respondents answer the posed questions independent of the researcher (York, 2020). One of the advantages of a self-administered questionnaire is obtaining data from a large population, irrespective of the geographical dispersion. The consistency of the questions (i.e., structured closed-ended questions) makes it possible for the researcher to draw reliable conclusions (Babbie, 2021).

According to Bryman (2016) and Walter (2019), self-administered questionnaires are cost-effective, respondents may remain anonymous, and the researcher's influence is absent and less confrontational. Cost-effectiveness is advantageous because questionnaires can be distributed quickly and widely. In addition, the privacy of respondents is maintained since respondents may complete the questionnaires in their

own time and private space. However, the latter may also become a disadvantage for poorly constructed questions. It should be borne in mind that a survey questionnaire cannot address every research question (Walter, 2019). For example, the cause-effect relationship cannot be addressed through questionnaires.

The self-administered questionnaire (Appendix A) was considered appropriate because of the descriptive nature of this study and the competency of the participants to provide the data required to address the study objectives (Babbie, 2021). Furthermore, the self-administered questionnaire made it possible for the participants to complete the questionnaire about the usability, UX, and continuance use of the Company X mobile application and online portal without the intervention of the researcher, thereby limiting the element of bias in the responses provided.

The questionnaire had five sections composed of participant filtering questions (Sections 1 and 5), demographic questions (Section 2), mobile application-related questions (Section 3), and online portal-related questions (Section 4). The composition of sections 3 and 4 addressed the key constructs for the study (i.e., usability, UX, and continuance use) in relation to the study objectives. The questions for the UX-related sections were adapted from the UEQ (long English version) available at https://www.ueq-online.org. Questions related to the usability of the mobile application and online portal were adapted from Sauro and Lewis (2016). The questions for the cognitive load sub-construct were derived from Harrison *et al*. (2013), Shaban *et al.* (2021), and Whitenton (2013), whereas the continuance use questions were derived from Alanazi (2013) and Hsu and Lin (2020). The questionnaire validation is discussed further in Section 3.8.1.

The questionnaire consisted of closed-ended questions to obtain usability, UX, and continuance use data from the participants' viewpoints for the Company X mobile application and online portal. It was administered online through the online survey hosting provider (Questionpro.com). The consideration for the online distribution of the questionnaire was informed by the Coronavirus pandemic and the geographical spread of the potential participants. The online questionnaire was available from 1 July to 27 August 2021. An e-mail invitation containing an introduction and overview of the study, ethical clearance information, and the Company X permission letters was sent to the potential participants requesting them to complete the online questionnaire. The online version of the consent form (see Appendix A) was embedded in the online

questionnaire, as the questionnaire submission link was only activated upon the participants' consent to participate by checking the 'consent' option and reading the information letter. The consent form itself is provided in Appendix D.

3.7.3.2 Semi-structured interviews

Berger (2020) asserts that there are four types of interviews: informal, structured, semi-structured, and unstructured. An informal interview often introduces the researcher or the study and may be suitable for observations. Structured interviews (or structured questionnaires), structured content analysis, or structured observations have a common weakness in that they cannot provide more than a descriptive answer to a research question.

Structured interviews represent a structured questionnaire, except that the questions and predetermined answers are verbally communicated (Babbie, 2021). Unstructured and semi-structured interviews are used to generate qualitative responses from participants. The difference between the two is that the researcher does not use questions to guide the interview in an unstructured interview, whereas, in a semi-structured interview, the researcher has a set of questions to direct the interview. On the other hand, semi-structured or unstructured interviews give insight, context, and a rich description of the phenomenon from the participant's perspective. According to Matthews and Ross (2010), unstructured interviews are suitable for exploratory purposes, whereas semi-structured interviews are suitable for explanatory purposes.

The semi-structured interview was considered appropriate since this study employed an explanatory sequential design with qualitative data being used to further explain the quantitative data obtained through the self-administered questionnaire. Morgan (2014) and Williamson and Johanson (2018) concur that the follow-up interviews from the questionnaire can result in providing the researcher with the opportunity to gain meaning and insight into the unanticipated results from the quantitative analysis.

The qualitative phase used an interview protocol (Appendix B) consisting, mainly, of open-ended questions to solicit further explanation for a deeper understanding of participants' usability, UX, and continuance use opinions of the Company X mobile application and its online portal. The interviews were conducted with 13 participants over three weeks in October 2021. Most interviews were conducted over the telephone, except one conducted via a Zoom Meeting application. The participants

were reminded of the purpose of the study and their applicable rights throughout the interview. Upon obtaining consent to record the interview conversation, the interview continued.

3.7.4 Data analysis methods

Once data is collected, the analysis process gives insight into the collected data, irrespective of the data type or approach followed. According to Damayanthi (2019), data analysis methods help the researcher identify and determine patterns and relationships between the variables or constructs, depending on the purpose of the study. Emerging patterns depend on the data analysis process (i.e., quantitative or qualitative). The analytical approach for qualitative and quantitative studies involves data preparation/pre-processing, data analysis, and data interpretation (Creswell & Clark, 2018; Marczyk *et al*., 2005).

3.7.4.1 Quantitative data analysis

Quantitative data analysis requires quantifying the collected data (Babbie, 2017). This implies that the data needs to be converted into a form suitable for data analysis. Data conversion forms part of the data preparation process (Babbie, 2017; Creswell & Clark, 2011; Williamson & Johanson, 2018). The data preparation process also includes codebook development, which consists of data description before capturing such data into a computer programme for analysis. According to Babbie (2017), the codebook describes the attributes and provides the possible assignment values for each attribute.

Quantitative data comes from different sources, such as interviews, questionnaires, and observations (Williamson & Johanson, 2018). Thus, the data source dictates the extent of data preparation required for analysis.

The collected data for this study was transformed and/or pre-processed to be suitable for analysis using the Statistical Package for Social Sciences (SPSS, version 27). The coding scheme was created, and the data was exported into the programme for further processing. This included data cleaning, identifying erroneous data inputs, recoding, and computation of variable scores. In addition, the data consisted of scores ranging from 1 to 7, where 1 represented the lowest score and 7 represented the highest score. The scores were recoded from -3 to +3 to resemble the scores depicted in the online

questionnaire. In addition, scores for negatively worded statements were recoded where the score of 1, for example, was recoded to -3. Scores from the statements for the same construct were aggregated and averaged accordingly.

The core feature of quantitative data analysis (i.e., statistical analysis) is performed upon completing the data preparation and transformation process. Creswell and Clark (2011) posit that data analysis is informed by the purpose and research questions addressed. The broad categories of quantitative data analysis include descriptive and inferential statistics (Creswell & Clark, 2011; Williamson & Johanson, 2018).

Descriptive statistics involve visualising data using frequency distribution tables, measures of central tendency and dispersion. According to Leedy and Ormrod (2021), descriptive statistics help the researcher to understand what the data looks like in terms of distribution (e.g., normal or non-normal distribution), centrality (i.e., a measure of central tendency), and spread (i.e., dispersion). The frequency distribution tables, graphical presentations, mean scores, and standard deviations were used to summarise, analyse, and present the collected data.

Inferential statistics go beyond data description. Inferential statistics examine whether the observed pattern and differences in the data occurred by chance or reflect the study population (Williamson & Johanson, 2018). The conclusions and inferences derived from the inferential statistics are prone to chance factors other than a true reflection of the population. The confidence level is used to measure the significance of the derived conclusions and inferences. Confidence levels are typically 99%, 95% or 90% (Leedy & Ormrod, 2021; Albert & Tullis, 2022). The researcher has a choice between parametric and non-parametric tests. The parametric test assumes the normality of data, a representative sample, and an interval scale, whereas non-parametric tests do not have these assumptions.

For this study, the parametric test used was the paired *t*-test sample, because the same group of participants was used to compare the UX, usability, and continuance use of the Company X mobile application and online portal. A paired *t*-test sample is suitable for the participants when they (their results) are compared to themselves (Hinton *et al.*, 2014; Lazar *et al.*, 2017; Sauro & Lewis, 2016). The collected data met the requirements of a parametric test, except for the normal distribution requirement. However, Sauro and Lewis (2016) maintain that normality is not a concern where the

sample size *n*>30. The central limit theorem suggests that the sample distribution is normally distributed where the sample size *n*>30 (Kothari & Garg, 2019). A confidence level of 95% (α=.05) was used throughout the quantitative analysis process.

3.7.4.2 Qualitative data analysis

In a sequential design, quantitative and qualitative methods are "integrated through the goal of using the strengths of one method to produce data that guide another method" (Morgan, 2014, p.79). The latter implies that the methods used serve different yet related purposes. Thus, it makes sense to integrate the qualitative and quantitative data during the analysis phase, because the qualitative phase depends on the quantitative phase, particularly in a sequential mixed-methods design. Additionally, qualitative data analysis follows a non-linear pattern and is treated as an iterative process at any stage for most qualitative studies (Tashakkori *et al.*, 2021). According to Creswell (2013), data collection, analysis, and report writing are not treated distinctly. Rather, these processes are interwoven when they are implemented.

The data generated from qualitative methods consist mainly of text and images (Creswell & Clark, 2011). Irrespective of the data type, the following broad steps form part of the analysis process: organising data, reading and memoing, describing, classifying, and interpreting (Creswell, 2013). Data may come from, for example, handwritten notes, audio, or video recordings. As a result, organising data (or data preparation) includes transcribing and loading the data into the computer analysis programme, if any. One then reads the captured data to fully understand what the data entail. Only upon completing the preceding steps may one get into the business of coding, identifying patterns, and creating themes. According to Williamson and Johanson (2018), during the coding process, the researcher condenses the qualitative data into codes and then identifies themes.

In this study, the analysis of data generated from the semi-structured interviews followed a thematic analysis method. Braun and Clarke (2013) suggest that the analysis uses a seven-step process. The analysis process consists of transcribing, reading and familiarisation, coding, searching for themes, reviewing themes, defining themes, and finalising the analysis (Braun & Clarke, 2013; Damayanthi, 2019). The application of the preceding steps is not always linear, as some steps may be done

concurrently and in any order. The latter was applicable during the qualitative phase of this study.

The analysis process may be data- or theory-driven. The theme development process is open-ended in a data-driven process, where themes emerge purely from the data (Braun & Clarke, 2013). On the other hand, a theory-driven process uses a theory to guide the thematic analysis process. Since the qualitative data analysis was meant to explain the quantitative results, the theme development followed a theory-driven approach based on the quantitative results.

The analysis was initiated with the transcription of interview responses, followed by thorough reading and familiarisation, coding, searching, and identifying the emerging themes. The NVIVO 12 software was used to assist with the qualitative data analysis. In addition, the qualitative data analysis considered the results from the quantitative analysis since the qualitative analysis was meant to be explanatory of the quantitative results. Consequently, the qualitative and quantitative data interpretation was integrated.

3.8 Research validity, reliability, and trustworthiness

Since this study followed a mixed-methods approach, the validity and reliability of the quantitative and qualitative phases were handled differently. According to Leedy and Ormrod (2021), qualitative studies often refer to trustworthiness as a measure of the validity and reliability of the study, whereas in quantitative studies, research validity and reliability are treated distinctly.

Research reliability is the extent to which consistency can be obtained when the study is repeated under the same conditions, whereas validity is the extent to which the study results can be generalised (Babbie, 2021; Leedy & Ormrod, 2021), and when the scales measure what they intended to measure (Mellinger & Hanson, 2020). Johnston and Smith (2010) maintain that measuring validity and reliability in non-experimental studies is trickier than in experimental studies, where the environment is more controlled for experimental studies than in other types of study.

In this study, research validity (i.e., content and construct validity) was used to establish whether statements for different constructs were measuring the same constructs, while research reliability was used to ensure the internal consistency of the

statements. Validity and reliability, to be followed by trustworthiness, will therefore be discussed in more detail.

3.8.1 Research validity

There are four primary types of validity in quantitative studies, namely face, content, criterion, and construct validity (Bryman & Bell, 2019; Grønmo, 2020). Face validity relates to the relevance of the data collection instrument on face value in relation to the objectives of the study. On the other hand, content validity refers to the adequacy and the scope of the operational definition of concepts, considering their theoretical definition (Grønmo, 2020). In criterion validity, a study is considered valid when there is consistency between the collected data and the established criteria for the study concepts. Construct validity involves “seeing whether the concepts used in the research relate to each other in a way that is consistent with what their theories would predict” (Bryman & Bell, 2019, p. 83).

The following discussion will further expand on content validity and construct validity, as applicable to this study.

3.8.1.1 Content validity

The measuring instrument for the UX part of the questionnaire consisted of the User Experience Questionnaire (UEQ) (https://www.ueq-online.org), and no modifications were made to the questionnaire. Laugwitz *et al.* (2008), Rauschenberger *et al.* (2012), and Laugwitz *et al.* (2009) have confirmed the validity of the UEQ for measuring UX. Owing to its validity, Santoso *et al.* (2016) maintain that the UEQ is most appropriate when one evaluates the UX of an interactive product. As the Company X mobile application and online portal are interactive products that take input from the user and return the output, the UEQ seemed appropriate.

The usability questionnaire applied to usability evaluation was the Computer System Usability Questionnaire (CSUQ), as developed by James Lewis in 1995 and 2002 (Sauro & Lewis, 2016). The CSUQ questionnaire was used in studies by Alhadetri (2021), Al-Hassan *et al.* (2021), and Lewis (2018), and its validity was confirmed throughout these studies.

For this study, additional items to measure continuance use and cognitive load were developed and included in the questionnaire. The items were based on the operational

definitions derived from the existing literature regarding what constitutes cognitive load (Harrison *et al*., 2013; Shaban *et al.*, 2021; Whitenton, 2013) and continuance use (Alanazi, 2013; Hsu & Lin, 2020), respectively. The internal consistency of the items was then tested using Cronbach's alpha (discussed below in Section 3.8.2 and presented in Table 3.4). Furthermore, factor loadings confirmed the items' association with the cognitive load and continuance use constructs (see Appendix F).

3.8.1.2 Construct validity

The statistical test used to measure construct validity was factor analysis. Factor analysis is used for dimension reduction to explore patterns in the variables (Sürücü & Maslakçi, 2020). The analysis was conducted in three steps: suitability of factor analysis, factor extraction, and factor rotation and interpretation (Pallant, 2016).

Firstly, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity was used to determine the suitability of factor analysis. Secondly, Principal Component Analysis (PCA) was used for factor extraction. Factor extraction used the fixed number of factors associated with the number of constructs, as defined in the conceptual framework in Chapter 2. Thirdly, factor rotation and interpretation used the Varimax method. Factor analysis was conducted separately for the mobile application and online portal constructs, inclusive of all items related to usability, user experience, and continuance use to be found on the questionnaire presented in Appendix A.

Table 3.2. KMO and Bartlett's Tests for mobile application and online portal

		Mobile application	Online portal
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.94	0.91
Bartlett's Test of Sphericity	Approx. Chi-Square	17513.726	19849.644471
	Df	2145	2145
	Sig.	.000	.000

The inspection of KMO (0.94 and 0.91) and Bartlett's Test of Sphericity (p=.000), as presented in Table 3.2, confirm the suitability of factor analysis, as KMO for both the mobile application and online portal exceeded 0.6, and Bartlett's Test of Sphericity was statistically significant (Pallant, 2016).

Table 3.3(a). Total Variance Explained for the mobile application

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	33.146	50.222	50.222	33.146	50.222	50.222
2	7.929	12.013	62.235	7.929	12.013	62.235
3	3.057	4.631	66.866	3.057	4.631	66.866
4	1.857	2.813	69.680	1.857	2.813	69.680
5	1.515	2.296	71.976	1.515	2.296	71.976
6	1.293	1.960	73.936	1.293	1.960	73.936
7	1.095	1.660	75.595	1.095	1.660	75.595
8	1.035	1.569	77.164	1.035	1.569	77.164
9	.896	1.357	78.521	.896	1.357	78.521
10	.802	1.216	79.737	.802	1.216	79.737
11	.784	1.188	80.925	.784	1.188	80.925
12	.732	1.109	82.035	.732	1.109	82.035
13	.677	1.026	83.061	.677	1.026	83.061

Table 3.3(b). Total Variance Explained for the online portal

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	26.439	40.060	40.060	26.439	40.060	40.060
2	9.256	14.024	54.084	9.256	14.024	54.084
3	7.221	10.940	65.025	7.221	10.940	65.025
4	3.686	5.585	70.610	3.686	5.585	70.610
5	2.514	3.809	74.419	2.514	3.809	74.419
6	1.777	2.692	77.111	1.777	2.692	77.111
7	1.205	1.827	78.938	1.205	1.827	78.938
8	1.011	1.531	80.469	1.011	1.531	80.469
9	.979	1.483	81.952	.979	1.483	81.952
10	.871	1.320	83.272	.871	1.320	83.272
11	.771	1.168	84.440	.771	1.168	84.440
12	.702	1.064	85.504	.702	1.064	85.504
13	.660	1.000	86.503	.660	1.000	86.503

PCA extracted 13 components each for the mobile application (Table 3.3(a)) and online portal (Table 3.3(b)), explaining the variance as per the cumulative % columns of the respective tables. All extracted components had initial eigenvalues of 1.0 or more, and the extracted components constituted cumulative % of 83% (Table 3.3(a)) and 86% (Table 3.3(a)), respectively. The total variance explained meets the minimum threshold of 60% for the extracted PCA (Hair *et al.*, 2018).

The inspection of communalities gives an indication of common variance among items (Pallant, 2016). The communalities of the questionnaire items showed significant common variance, as such that each item was associated with at least one factor. According to Young and Pearce (2013), each factor must have at least three items. Where there are only two items, the said items must correlate with each other. A total of 11 items were excluded from PCA, as they had a low correlation with other items in the applicable factors. The exclusion of 11 items also considered the factor loading for each extracted factor. The factor loading cut-off value is usually between 0.3 and 0.5 (Finch, 2020). This study used a factor loading cut-off value of 0.32, as suggested by Tabachnick and Fidell (2013).

According to Mehmetoglu and Mittner (2022), factor loading determines the strength of each item or observed variable in relation to the associated factor or latent variable. Moreover, factor loadings are negatively correlated to the unique variance for items that load on a particular factor (Finch, 2020). Items that exhibit unique variance are eliminated for the given factor. As presented in Appendix F, all factor loadings for the associated items and factors exhibited scores greater than the determined cut-off value, thus showing a simple factor structure. The thirteen loaded factors represented UX (6), usability (6), and continuance intentions (1). This was consistent for both the online portal (Appendix F: Part A) and the mobile application (Appendix F: Part B).

3.8.2 Research reliability

The reliability of the quantitative phase of this study was measured using Cronbach's Alpha as a measure of internal consistency. Internal consistency entails designing a measuring instrument so that multiple items are used to measure the same construct (Johnston & Smith, 2010).

Various statements in the questionnaire were constructed to measure each construct relevant to this study. A case in point was the use of varying statements to measure one aspect of usability, like effectiveness. Positive and negative worded statements were included to mitigate against random responses from participants. There is no standard minimum score associated with the coefficient alpha test. However, the literature suggests that a score of 0.6 or higher is sufficient to confirm the internal consistency of the scales (Pallant, 2016).

Table 3.4. Cronbach's alpha for cognitive load, usability, UX and continuance use

	Cronbach's Alpha	N of Items
Mobile application UX	0.987	26
Mobile application usability	0.954	15
Mobile application continuance use	0.962	15
Online portal UX	0.990	26
Online portal usability	0.879	14
Online portal continuance use	0.859	15
Online portal cognitive load	0.748	5
Mobile application cognitive load	0.683	5

All Cronbach's Alpha scores for cognitive load, usability, UX, and continuance use for the Company X mobile application and online portal exceeded 0.6, as shown in Table 3.4, indicating that the statements for each construct measured the applicable construct.

3.8.3 Trustworthiness

Trustworthiness in qualitative studies implies both validity and reliability (Leedy & Ormrod, 2021). The trustworthiness of the qualitative part of this study was intrinsically related to the quantitative phase. Part of the consideration for the qualitative phase of the study was to establish outliers in the quantitative results to further explain the obtained results during the qualitative phase. The latter approach conforms to the analysis of outliers as one strategy for establishing the trustworthiness of a qualitative study (Leedy & Ormrod, 2021).

The selection of participants for the qualitative phase of the study consisted of participants who had a combination of positive and negative experiences with the mobile application and online portal, and consequently found one or both of these applications either usable or non-usable, respectively.

3.9 Ethical consideration

The ethical implications are considered sacrosanct to the overall research endeavour (Babbie, 2021). Studies differ in terms of ethical considerations that one needs to consider. However, certain ethical considerations are common across studies. De Vaus (2013) identifies the following ethical considerations in relation to a study in

which people are involved as respondents: voluntary participation and informed consent, no harm to participants, and confidentiality and anonymity.

As mentioned before, all participants in this study were at least 18 years old, as Company X customers are required to be 18 years or older to transact on any Company X system. Thus, all participants were competent in providing informed consent about their participation. The Informed Consent Form (Appendix D) was embedded in the online questionnaire where participants indicated their consent to participate in the study by checking the appropriate button before the Questionnaire Start Button was activated. The form was also attached in the e-mail invitation to the potential participants. As part of the quantitative phase, the first part of the questionnaire (refer to Appendix A) provided an introduction outlining the purpose of the study and the rights of participants in relation to their participation and withdrawal. Participation in the study was entirely voluntary, and no real or subtle coercion was used to force respondents to participate.

In the qualitative phase (phase two) of the study, each participant was thoroughly informed before the interview commenced to allow them to decide whether to continue to participate. These participants had previously voluntarily opted to be part of phase two of the study during their participation in phase one. At this stage, they were offered an opportunity to confirm their initial consent.

The identities of the participants were kept confidential throughout and beyond the study. The analysis and reporting of results consisted of aggregated data and/or results without any personal association with the participants. In addition, participants did not incur any harm by participating in the study.

Permission to conduct a study at Company X was obtained from the Commissioner of Company X (Appendix E), and access to customer details was used for the study only, which was in line with the permission granted. The study also complied with the provisions of the Protection of Personal Information Act (Act No. 4 of 2013). Moreover, the General/Human Research Ethics Committee (GHREC) of the University of the Free State approved this study (approval letter included as Appendix C).

3.10 Summary

The preceding discussion detailed the design and methodology followed in the study. Among the discussion were the principles, techniques, and procedures that logically bound different components of the research process. The research onion was used to structure the chapter. The study employed pragmatism as its philosophical grounding, whereas the approach to theory development consisted of deductive and inductive reasoning. The methodological choice followed was the mixed-methods approach. In terms of the research strategy, a single case study was used as the overall strategy for the study. The selection of participants used the systematic random sampling for the quantitative phase, and purposive judgment sampling for the qualitative phase of the study. Moreover, the data collection tools used were a self-administered questionnaire and semi-structured interviews by means of the interview protocol. The collected data was analysed using statistical analysis (i.e., descriptive and inferential statistics) and thematic analysis. Research validity, reliability, and trustworthiness were also discussed.

The next chapter discusses the analysis, presentation, and discussion of the research findings.

CHAPTER 4: DATA ANALYSIS, PRESENTATION, AND DISCUSSION

4.1 Introduction

The preceding chapter extensively described and justified the research design, principles, techniques, and procedures followed in the study. This chapter presents the findings as derived from the collected data. For this explanatory sequential design study, the data analysis, presentation, and discussions are presented for both quantitative and qualitative data. Therefore, the findings are presented in two sections, namely quantitative and qualitative data analysis.

The presentation of findings (Sections 4.2 and 4.3) is guided and informed by the research objectives based on the research questions, as indicated in Chapter 1 (Sections 1.4 and 1.5). The first subsidiary objective of this study was to determine the performance and satisfaction metrics applicable to the usability, user experience, and continuance use of mobile applications and online portals, which was addressed in the literature review in Chapter 2 (Section 2.8). The remaining three subsidiary objectives will, therefore, be addressed in this chapter.

As a reminder, the subsidiary research objectives were stated as follows:

- to determine the performance and satisfaction metrics that are applicable in comparing the usability, UX, and continuance use of a mobile application and its associated online portal;
- to compare the usability of a mobile application and its associated online portal in terms of performance;
- to compare the UX of a mobile application and its associated online portal in terms of user satisfaction; and
- to compare the continuance use of a mobile application and its associated online portal in terms of continuance intentions.

In Section 4.4, the quantitative and qualitative findings are integrated and discussed to present a consolidated picture of the overall findings. The Section, additionally, relates to the findings of previous studies and the conceptual framework presented in Chapter 2.

4.2 Quantitative data analysis

The analysis of the quantitative data considered the questionnaire structure in Appendix A. The data was analysed by means of descriptive and inferential statistics using the Statistical Program for Social Sciences (SPSS version 27). Data pre-processing was performed to identify erroneous data. According to Williamson and Johanson (2018), it is important to ensure that data is free of errors before analysis. Data pre-processing therefore includes data cleaning, transformation, and integration.

This section will first discuss the response rate, followed by a presentation of the demographic and quantitative data.

4.2.1 Response rate

The sample for this study consisted of 1 423 potential participants to whom an e-mail invitation was sent. Of the 577 (40.03%) responses, only 209 (36.22%) questionnaires were fully completed. Most of the participants initiated the questionnaire, but never completed it. Therefore, the analysis was based on the remaining 209 valid questionnaires.

4.2.2 Demographic data

The demographic composition of the sample consisted of gender, educational level, computer literacy level, and age. Figures 4.1 to 4.4 depict the frequency distribution of these four variables, based on Section 2 of the questionnaire (Appendix A). These figures report the 209 completed questionnaires received, thus excluding incomplete ones.

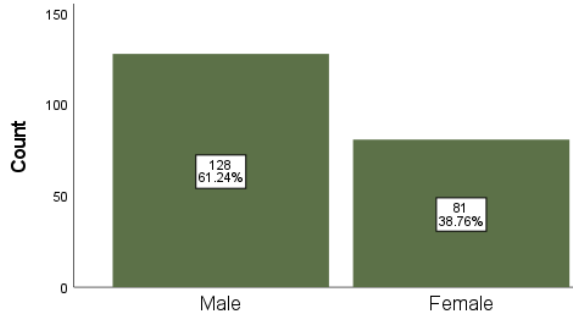

Figure 4.1. Gender distribution

Figure 4.1 reveals that 61.24% (n=128) of the participants were male, while 38.76% (n=81) were female. There were no participants who classified themselves as 'other', and thus the 'other' category was excluded from this gender distribution. Thus, the majority of the participants were male.

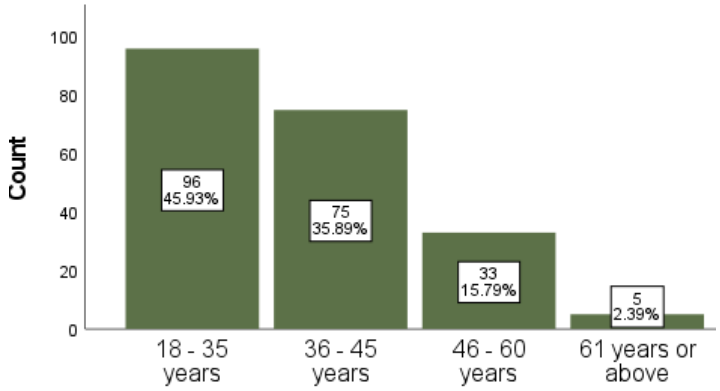

Figure 4.2. Age distribution

The age distribution (Figure 4.2) of the sample indicates that most participants were between the ages of 18 and 35 years (45.93%, n=96), followed by participants between the ages of 36 and 45 years (35.89%, n=75). One may assert that 81.82% (i.e., 45.93%+35.89%) of the participants were between 18 and 45 years old. On the other hand, 15.79% (n=33) were between the ages of 46 and 60, while a small fraction (2.39%, n=5) were 61 years old, or older.

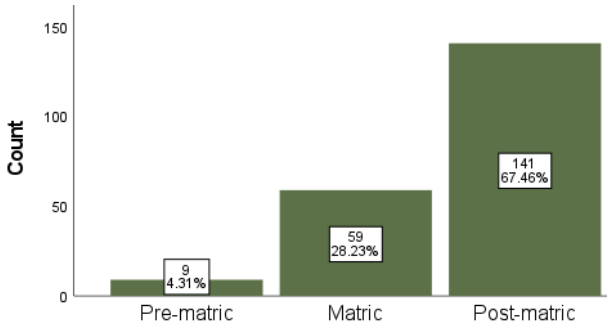

Figure 4.3. Education level

The education distribution data (Figure 4.3) indicates that the majority of participants (67.46%, n=141) have post-matric qualifications, whereas 28.23% (n=59) indicated that they have obtained a matric qualification. A small portion of the participants (4.31%, n=9) did not have a matric qualification.

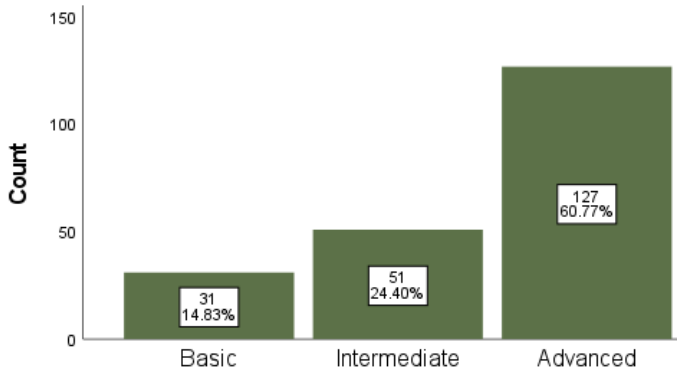

Figure 4.4. Computer literacy level

In terms of computer literacy levels, as depicted in Figure 4.4, the majority of participants (60.77%, n=127) indicated advanced computer literacy levels, followed by those with intermediate level (24.4%, n=51) and basic level (14.83%, n=31), respectively.

To summarise: the majority of study participants were male, younger than 46 years old, possessed a post-matric qualification and had advanced computer literacy skills.

4.2.3 Questionnaire results

Findings from the quantitative data are clustered in terms of the three constructs for this study, namely usability, UX, and continuance intentions. Since this study compared the mobile application and online portal, the presentation of data starts with these three constructs in relation to the mobile application, followed by the online portal. The two platforms are then compared accordingly.

The main objective of this study was to compare the usability, UX, and continuance use of a mobile application and an online portal in terms of performance, user satisfaction, and continuance intentions. The main objective was deconstructed into four additional objectives. As explained before, this section is structured in terms of the second, third and fourth additional objectives (Refer to Section 4.1).

Participants were required to evaluate the usability, UX, and continuance intentions of the mobile application and online portal using a seven-point Likert scale (Sections 3.2, 3.3, 4.2, and 4.3) and semantic differential scale (Sections 3.1 and 4.1) in the questionnaire, where one represented strongly disagree, and seven represented strongly agree. For interpretation purposes, the scores were converted to a range from -3 to +3. Tables 4.1 to 4.6 (excluding Table 4.3) present the data for the constructs

mentioned above. Scores for negative-worded statements were recoded before analysis and mean ($\bar{x}$) scores were then calculated for each construct.

4.2.3.1 Mobile application and online portal usability

The second subsidiary objective of this study was to compare the usability of a mobile application and its associated online portal in terms of performance.

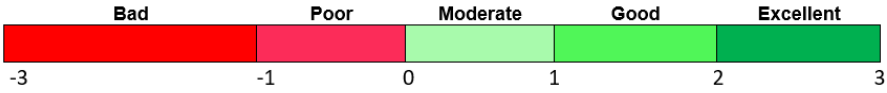

Figure 4.5. Usability scale (adapted from Bangor *et al.*, 2008)

The interpretation of the usability mean scores was based on a continuum scale (Figure 4.5) ranging from bad to excellent, where (1) Bad = $-3 \leq \bar{x} < -1$; (2) Poor = $-1 \leq \bar{x} < 0$; (3) Moderate = $0 \leq \bar{x} < 1$; (4) Good = $1 \leq \bar{x} < 2$; and (5) Excellent = $2 \leq \bar{x} \leq 3$.

Mobile application usability

Table 4.1 presents mean scores for the mobile application usability construct and its associated sub-constructs: satisfaction, effectiveness, efficiency, errors, cognitive load, and memorability.

Table 4.1. Mobile application usability

	$\bar{x}$ (n=209)	S
Mobile application usability	**0.943**	**1.297**
Satisfaction	0.711	1.361
Effectiveness	1.007	1.643
Efficiency	1.105	1.569
Errors	0.914	1.434
Cognitive load	0.961	1.120
Memorability	0.760	1.284

The data indicate that the mean score for mobile application usability was 0.943, which implies that participants found the mobile application moderate in terms of usability. Equally, the mobile application mean scores for satisfaction (0.711), errors (0.914), cognitive load (0.961), and memorability (0.760) were also moderate. The data further suggest that the mobile application efficiency (1.105) and effectiveness (1.007) were good. However, the standard deviation scores for all sub-constructs were higher than

the corresponding means, implying that the scores were spread away from the mean and largely polarised.

Online portal usability

Table 4.2 presents a mean score for the online portal usability constructs and the mean scores for its associated sub-constructs: satisfaction, effectiveness, efficiency, errors, cognitive load, and memorability.

Table 4.2. Online portal usability

	$\bar{x}$ (n=209)	S
Online portal usability	**1.266**	**1.144**
Satisfaction	0.622	1.711
Effectiveness	1.739	1.619
Efficiency	0.947	1.939
Errors	0.987	1.652
Cognitive load	1.834	1.095
Memorability	1.464	1.409

Table 4.2 depicts a mean score of 1.266 for online portal usability, meaning that the online portal was good in terms of its usability. This was indicated by the results for its effectiveness (1.739), cognitive load (1.834), and memorability (1.464). On the other hand, the online portal satisfaction (0.622), efficiency (0.947), and errors (0.987) were rated moderately. The scores for all the sub-constructs that were rated well, were clustered around the mean, since their standard deviation scores were less than the corresponding mean scores (unlike the moderately rated sub-constructs).

4.2.3.2 Mobile application and online portal user experience

The third subsidiary objective of this study was to compare the UX of a mobile application and its associated online portal in terms of user satisfaction. The UX construct was composed of attractiveness (Att.), efficiency (Eff.), perspicuity (Per.), dependability (Dep.), stimulation (Sti.), and novelty (Nov.). The interpretation of the UX for the mobile application and online portal considered the UX benchmark (Table 4.3). The benchmark rates the UX constructs on an ordinal scale ranging from bad to excellent in relation to the previous studies on similar products (Schrepp *et al*., 2017). On average, the benchmarked studies consisted of 40 participants, and 32% of the studies evaluated the mobile applications and web services.

Table 4.3. UX Benchmark (Schrepp *et al*., 2017)

	Att.	Eff.	Per.	Dep.	Sti.	Nov.
Excellent	≥ 1.75	≥ 1.78	≥ 1.9	≥ 1.65	≥ 1.55	≥ 1.4
Good	≥ 1.52 < 1.75	≥ 1.47 < 1.78	≥ 1.56 < 1.9	≥ 1.48 < 1.65	≥ 1.31 < 1.55	≥ 1.05 < 1.4
Above average	≥ 1.17 < 1.52	≥ 0.98 < 1.47	≥ 1.08 < 1.56	≥ 1.14 < 1.48	≥ 0.99 < 1.31	≥ 0.71 < 1.05
Below average	≥ 0.7 < 1.17	≥ 0.54 < 0.98	≥ 0.64 < 1.08	≥ 0.78 < 1.14	≥ 0.5 < 0.99	≥ 0.3 < 0.71
Bad	< 0.7	< 0.54	< 0.64	< 0.78	<0.5	< 0.3

Mobile application user experience

Table 4.4 presents a mean score for the mobile application UX constructs and the mean scores for its associated sub-constructs: attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty.

Table 4.4. Mobile application user experience

	$\bar{x}$ (n=209)	s
Mobile application UX	**0.546**	**1.553**
Attractiveness	0.549	1.637
Efficiency	0.621	1.641
Perspicuity	0.629	1.746
Dependability	0.568	1.543
Stimulation	0.519	1.657
Novelty	0.391	1.621

The data presented in Table 4.4 indicates that the mean score for the mobile application UX was 0.546, implying that participants had a bad experience with this application. Similarly, the data suggests that the UX for all the mobile application sub-constructs, namely attractiveness (0.549), efficiency (0.621), perspicuity (0.629), dependability (0.568), stimulation (0.519), and novelty (0.391), were rated from below average (i.e., Eff., Sti., and Nov.) to bad (i.e., Att., Per., and Dep.). However, their standard deviation scores were higher than their corresponding means, implying that scores were spread away from the mean and largely polarised.

Online portal user experience

Table 4.5 presents a mean score for the online portal UX constructs along with its associated sub-constructs: attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty.

Table 4.5. Online portal user experience

	$\bar{x}$ (n=209)	s
Online portal UX	**1.152**	**1.567**
Attractiveness	1.187	1.637
Efficiency	1.246	1.614
Perspicuity	1.224	1.686
Dependability	1.211	1.538
Stimulation	1.107	1.632
Novelty	0.939	1.667

The online portal's UX (Table 4.5) had a mean score of 1.152, implying that participants found the UX of the online portal above average. Moreover, online portal attractiveness (1.187), efficiency (1.246), perspicuity (1.224), dependability (1.211), stimulation (1.107), and novelty (0.939) were also scored above average. However, the standard deviation scores for all online portal UX sub-constructs were higher than the corresponding means, suggesting that scores were spread away from the mean and polarised.

4.2.3.3 Mobile application and online portal continuance intentions

The fourth subsidiary objective of this study was to compare the continuance use of a mobile application and its associated online portal in terms of continuance intentions. Table 4.6 presents a mean score for the online portal and mobile application continuance intentions construct.

Table 4.6. Mobile application and online portal continuance intentions

	$\bar{x}$ (n=209)	s
Mobile application continuance intentions	0.888	1.456
Online portal continuance intentions	1.553	1.048

The data in Table 4.6 depicts that the mean score for mobile application continuance intentions was 0.888, suggesting that participants had no intentions to continue using

the mobile application. However, the standard deviation score for mobile application continuance intentions (1.456) was higher than the corresponding mean, suggesting that the scores were spread away from the mean and largely polarised.

On the other hand, the mean score for the online portal continuance intentions was 1.553, indicating that the participants had intentions to continue using the online portal. Unlike the mobile application, the standard deviation score for the online portal continuance intentions construct (1.048) was less than the corresponding mean, implying that scores were largely clustered around the mean.

4.2.3.4 Comparing usability, user experience, and continuance intentions

The primary objective of this study, as indicated in Section 1.5, was to compare the usability, UX, and continuance intentions of the mobile application and online portal. To achieve this objective, a two-tailed paired sample t-Test was computed to determine whether there were statistically significant differences between the mobile application and the online portal mean scores, as presented in Tables 4.1 to 4.6.

The inferential statistical results for the t-Test are presented in Tables 4.7 to 4.9. The t-Test results are presented in terms of the mean difference score (MD), standard error of the mean ($\sigma\bar{x}$), t-Test score, degree of freedom (df), and probability value (p). An alpha level of 0.05 was used for this study. Therefore, $p<0.05$ indicated 95% confidence that the difference between the usability, UX, and continuance intentions of the mobile application and online portal was statistically significant. The standard error of the mean was used to establish the reliability of the sample mean in relation to the population mean. Also, the scores were rounded off to three decimal places, excluding t, df, and p scores.

The use of parametric tests like a paired sample t-Test requires the data to meet certain assumptions for the validity of the results. The data level of measurement must be on the interval scale, the data must be normally distributed (Williamson & Johanson, 2018), and the study sample must have been randomly selected (Hinton *et al.*, 2014). The data met the interval scale requirement since the data scale was converted from ordinal to interval scale before analysis. In addition, the random sample requirement was met, since participants in the study were randomly selected using a systematic random sample strategy. According to the central limit theorem, the distribution of the sample mean is approximately normal, where the sample size is

30 or more (Albers, 2017; Sauro & Lewis, 2016). Consequently, the normality requirement was considered met, since the sample size for this study comprised of 209 participants (Kothari & Garg, 2019).

Comparing mobile application and online portal usability

The comparison of the usability mean scores of the mobile application and online portal considered the individual mean scores for satisfaction, errors, effectiveness, efficiency, cognitive load, and memorability, and the composite usability score as presented in Tables 4.1 and 4.2. Table 4.7 compares the mobile application and online portal in terms of their usability to determine if the differences were statistically sound or happened by chance.

Table 4.7. Comparing mobile application and online portal usability

	MD	$\sigma_{\bar{x}}$	t	df	p
Online portal usability - mobile application usability	**0.323**	**0.1075**	**3.002**	**208**	**0.003**
Online portal satisfaction - mobile application satisfaction	-0.089	0.144	-0.618	208	0.537
Online portal effectiveness - mobile application effectiveness	0.732	0.145	5.035	208	0.000
Online portal efficiency - mobile application efficiency	-0.158	0.162	-0.975	208	0.331
Online portal memorability - mobile application memorability	0.504	0.122	4.139	208	0.000
Online portal errors - mobile application errors	0.073	0.139	0.528	208	0.598
Online portal cognitive load - mobile application cognitive load	0.874	0.096	9.119	208	0.000

As depicted in Table 4.7, the results indicated a statistically significant difference between the composite mean scores for the online portal's usability and the mobile application's usability ($t(208)=3.002$, $p<0.05$). The latter indicates that participants found the online portal more usable (good) than the mobile application (moderate).

Moreover, the results indicated statistically significant differences between the online portal and mobile application's effectiveness ($t(208)=5.035$, $p<0.05$), memorability ($t(208)=4.139$, $p<0.05$), and cognitive load ($t(208)=9.119$, $p<0.05$). There were no statistically significant differences between the online portal and mobile application's satisfaction, efficiency, and errors. The standard errors of the mean for the latter sub-constructs were higher than the corresponding mean difference scores, implying that the mean difference scores were not a reliable reflection of the population mean.

Comparing mobile application and online portal user experience

The data in Table 4.8 considered the data presented in Tables 4.4 and 4.5 in relation to the mobile application and online portal UX. In terms of the mobile application, the findings indicated that the participants had a bad experience with it. In contrast, the participants had a positive experience (i.e., above average) with the online portal, encompassing its UX sub-constructs, except for novelty. The comparison in Table 4.8 established if the differences between the mobile application and online portal UX were statistically significant.

Table 4.8. Comparing mobile application and online portal user experience

	MD	$\sigma\bar{x}$	t	df	p
Online portal UX - mobile application UX	**0.606**	**0.103**	**5.896**	**208**	**0.000**
Online portal attractiveness - mobile application attractiveness	0.638	0.423	5.855	208	0.000
Online portal efficiency - mobile application efficiency	0.626	0.110	5.689	208	0.000
Online portal perspicuity - mobile application perspicuity	0.595	0.115	5.162	208	0.000
Online portal dependability - mobile application dependability	0.642	0.101	6.365	208	0.000
Online portal stimulation - mobile application stimulation	0.587	0.116	5.066	208	0.000
Online portal novelty - mobile application novelty	0.548	0.108	5.070	208	0.000

The results indicated statistically significant differences between the online portal and mobile application's UX ($t(208)=5.896$, $p<0.05$). This indicates that the difference between the online portal and mobile application's UX did not happen by chance. Furthermore, the results indicated statistically significant differences between the online portal and mobile application's attractiveness ($t(208)=5.855$, $p<0.05$), efficiency ($t(208)=5.689$, $p<0.05$), perspicuity ($t(208)=5.162$, $p<0.05$), dependability ($t(208)=6.365$, $p<0.05$), stimulation ($t(208)=5.066$, $p<0.05$), and novelty ($t(208)=5.070$, $p<0.05$). In addition, the standard error of the mean scores for the online portal and mobile application's UX and its associated sub-constructs were all less than the corresponding mean scores, implying that the mean scores were a reliable reflection of the population mean for UX.

Comparing mobile application and online portal continuance intentions

The composite mean score for the mobile application's continuance intentions indicated that participants were less likely to use the mobile application in future than the online portal (see Table 4.6). In Table 4.9, the difference between the mobile

application and online portal's continuance intentions was tested to determine whether the difference in mean scores was statistically significant.

Table 4.9. Comparing mobile application and online portal continuance intentions

	MD	$\sigma\bar{x}$	t	df	p
Online portal continuance intentions - Mobile application continuance intentions	0.664	0.115	5.789	208	0.000

The results indicated a statistically significant difference between the online portal and mobile application's continuance intentions ($t(208)=5.789$, $p<0.05$). One may conclude with 95% confidence that participants were more likely to continue using the online portal than the mobile application. The standard error of the mean score for the online portal and mobile application's continuance intentions was less than the corresponding mean score, suggesting that the mean score was a reliable measure of the population mean in relation to continuance intentions.

The quantitative findings presented in Section 4.2 will be discussed in more depth in Section 4.4.

4.3 Qualitative data analysis

Since this study followed an explanatory sequential design, the qualitative results were used to further complement the quantitative results, as presented in Section 4.2. Consequently, this section sheds light on the obtained quantitative results in terms of the mobile application and online portal usability, UX, and continuance use.

A thematic analysis process was performed on the generated interview data. New themes were iteratively created whenever the corresponding interview extract could not fit into the already identified themes. The latter was iteratively done until all themes were created.

The first part of the analysis process was transcribing the audio recordings of the interviews. The transcripts were read repeatedly, and notes were made on the possible codes and themes. Then, codes were developed and attached to different segments of the texts using the NVIVO programme (version 12). As a result of the preceding process, themes were generated.

The coding process was executed in two stages. The first stage was to read the interview extract and then attach a broader code. All the related interview extracts were then attached to the same code. All interview extracts from the broader codes were further assigned to more specific codes in the second stage. Subsequently, some codes were merged to form a broad theme that explained the qualitative results regarding the mobile application and online portal usability, UX, and continuance use.

The qualitative analysis will first discuss the demographic data, followed by the thematic analysis.

4.3.1 Demographic data

Thirteen participants took part in the qualitative study. For analytical purposes, participants' identities were anonymised. Henceforth, they are referred to as participants 1 – 13.

Table 4.10 presents the composition of participants for the qualitative phase of the study. The sample consisted of seven male and six female participants. Most participants were from Gauteng (n=4), followed by the Free State (n=3), Eastern Cape (n=2), Limpopo (n=2), and KwaZulu-Natal (KZN) and North West, each with one participant. Except for one virtual meeting, the rest of the interviews were conducted over the telephone.

Table 4.10. The demographic composition of the sample

	Gender	**Province**	**Medium**
Participant 1	Male	Free State	Telephone
Participant 2	Male	Gauteng	Telephone
Participant 3	Male	Gauteng	Telephone
Participant 4	Female	KZN	Telephone
Participant 5	Female	Limpopo	Telephone
Participant 6	Male	Free State	Telephone
Participant 7	Male	Eastern Cape	Virtual Meeting
Participant 8	Male	Eastern Cape	Telephone
Participant 9	Male	Limpopo	Telephone
Participant 10	Female	North West	Telephone
Participant 11	Female	Free State	Telephone
Participant 12	Female	Gauteng	Telephone
Participant 13	Female	Gauteng	Telephone

4.3.2 Interview results

This section reports on the outcome of the thematic analysis process based on semi-structured interviews. Theme development in this section is organised in terms of the mobile application and the online portal concerning their usability, UX, and continuance use. Themes 1, 3, and 5 related to the mobile application's usability, UX, and continuance intentions, whereas Themes 2, 4, and 6 related to the online portal's usability, UX, and continuance intentions, respectively. Each theme is pursuant to elaborate on the quantitative results presented in Section 4.2. The summary of themes is presented in Table 4.11.

Table 4.11. Summary of themes

Theme number	Description
1	Usability of the mobile application
2	Online portal usability
3	User experience with the mobile application
4	User experience with the online portal
5	Expectations and continuance use of the mobile application
6	Expectations and continuance use of the online portal

4.3.2.1 Theme 1: Usability of the mobile application

This theme relates to the usability of the Company X mobile application from the participants' perspective. Participants were asked to elaborate and share their experiences with the mobile application's usability. The analysis of the participants' responses was classified into two categories: usable and not usable.

Participants found the mobile application usable. Reasons provided included its ease of use and availability whenever they needed it.

> *[Participant 2] It is easy to use. It saves time. It is understandable. It uses simple English.*

> *[Participant 4] Okay, what makes me say the app works fine is that it happens that, like I usually use the smartphone, what I notice is that if I answer a call, usually you are offline every time you answer the call, and the network becomes offline. But, when I go back to the app, it allows me to continue, unlike requiring me to start from the beginning.*

[Participant 7] The usability of the mobile app, it is very easy to use it. It has more information on what you want to do because every step you want to go to gives you a header of what you want. So, the usability of it is like it is very innovative, and it is usable by everyone.

[Participant 9] The usability of the mobile app, I find that I am to use anytime. It does not have to limit me in doing my things. I can manage my own time. After normal time (08:00 - 16:00), I can use it. The availability is there.

However, there were some reservations about the mobile application, despite participants finding it usable. The suggested area of improvement was the mobile application's visual appeal.

[Participant 3] The app is usable. If I had to choose between keeping it or letting it go, I would choose to keep it. But it can be made better, especially what we are used to on the website. Looking at the Biz-portal is very clean, and the design, if it can be imported to the app, can help the app a lot.

Some participants shared their mobile application's non-usability experiences. Among the challenges shared were the errors and user-friendliness issues. Interestingly, the non-usability concerns were similar to the UX challenges cited as causes for the negative experience with the mobile application.

[Participant 1] I have mentioned the issue of user-friendliness because I used it and encountered such problems. Maybe the app there are aspects that need to be recoded so that it is easy and user-friendly for new users. I think it should be reviewed so that, I'd say, 100% accessible, usable, and efficient for everyone, even the new user. The last time I used the app was in 2020.

[Participant 10] Let's say you want to log in. For example, you log in but you can't get in, it gives you issues. It keeps on repeating the same thing. Let's say it gives you an error about the password or maybe an error about my username like it can recall. Let's say maybe I log in once. It can give an option to say 'remember me,' meaning that it will store that information so that next time when you log in, you just say log in with that information that is already there completed.

[Participant 11] The reason is, like I said, I tried to use the app even at times send e-mails to consultants to ask if, I give did screenshots if it is doing this how do I get through this and it isn't really take me anywhere whereby I ended having to go to the online e-services to get what I want.

4.3.2.2 Theme 2: Online portal usability

This theme relates to the usability of the Company X online portal from the participants' perspective. Based on participants' responses, the online portal was considered sufficiently usable. The participants cited understandability, efficiency, user-friendliness, and learnability as key aspects that made the online portal usable. In addition, some participants commended the online portal for its ease of use and learnability, even for the first-time user.

> *[Participant 1] I am more positive about it. Because its usability for me is simple and easy, I find it to be okay.*
>
> *[Participant 2] It saves time. Every time when I log in, the errors are less. The combination of ideas is 100%. It is much more usable.*
>
> *[Participant 3] I would say it is usable because a lot of features are available. If the thing I didn't know or thing where to go, but I find all of them. For example, sometimes I reserve the name, and I forget it on the cart. When I go back, I find that it is no longer on the cart. It is not the same like on Biz-portal and the app. Another example is when I register the name and paid. If the name is not attached to the name, it expires. When I go to the e-services, I can reserve the name again and use it. I use the e-services continuously. Even when I do not use it for some time, I can come back and remember to use it again. After a year, even if I spend a lot of time, I always forget other things I have forgotten. If it is, the system is made for me to remember to use the system.*
>
> *[Participant 4] Maybe it is that you can resend your documents. You can obtain the bank details from the system and also on display.*
>
> *[Participant 7] Everyone, even the first who enters the website for the first time, will be easy for him/her to use it. Everything will be given there. So the usability will be like that. Also, as I said, they provide information even to that person who is new. Everything is easy, and there is nothing hidden. If there is a link to follow, they tell you.*
>
> *[Participant 8] I can recommend the e-services because it does work on time without any problem. No errors were experienced.*
>
> *[Participant 9] The usability - I think they managed. When they re-launched it, I am satisfied. Even the bank issue has been sorted.*
>
> *[Participant 11] I never had a negative experience with the e-services. I can use the e-services wherever I like, whether on the desktop or the cell phone.*

However, a few participants did not find the online portal usable. Among the challenges indicated were the lack of user-friendliness and errors that occurred. The user-friendliness of the online portal featured as a reason for both sides of the same coin (i.e., usable and non-usable responses).

> *[Participant 6] Sometimes, when you do name reservations, it does not allow you to go forward. When you reserve the name, and when you want to submit other things, then you become stuck. It does not open on all computers - it depends on what computer or phone you use it. When you use the other phone, it does not work. It does not give errors, but you find yourself starting afresh every now and then. And you are going back where you were, and in the process, you lose money per reservation.*

> *[Participant 10] Sometimes it is not responding, and then when it finally responds, you will speak it so many times and open it over and over so many times.*

> *[Participant 13] It needs to be more user-friendly. I think I cannot put more explanatory in that it should be more accessible. If you are going to go and look for everything and then you got to follow directions. It is not instant. I think when you click on the icon, you should be able to see what to do with that icon.*

4.3.2.3 Theme 3: User experience with the mobile application

The discussion on this theme relates to the experiences that participants had with Company X's mobile application. Furthermore, participants were asked to elaborate on their experiences with the mobile application as per their accumulated scores for the mobile application UX during the study's first phase (i.e., the quantitative phase). The participants' experiences were negative, positive, or uncertain.

Based on their responses, participants were mainly negative about their experiences with the mobile application. They cited efficiency, errors, business process, limited functionality, and the lack of user-friendliness of the mobile application as the root causes of their negative experience. Efficiency is related to cases where the mobile application took a long time to respond to the user's actions, while errors were related to a situation where the mobile application showed errors or did not display any progress. Examples of the errors experienced include 'system timeout' due to prolonged processing time, business process-related errors where the application did not proceed without the user providing the related information, or the application did

not show progress or successfully completed a transaction. The limited features of the mobile application featured more than once in the participants' negative experiences.

To illustrate, a few examples of participant responses are given here. It should be noted that these narrations are presented in the participants' exact own words. Some responses refer to the Biz-portal which is another system administered by Company X.

> *[Participant 1] Okay, patterning the app, for me, it was kind of slow, and sometimes it shows error pages. So compared to the online system, I found it to be too slow and kind of in short of some of the components/features that are, I'd say online, they are easily accessible. I'd say it is moderately attractive. The main issue is the slow response and error pages.*
>
> *[Participant 3] Okay, Jah, the app is fine, but I often use the Company X website most of the time. What I use the app most of the time is for name reservations. When you do name reservation using the app, once done with, but I register the company using the Biz-portal because of the experience with the app, I do not know. I think it is limited. You need to make the mobile app better with more features, especially a person from the website. There are things that you cannot do on the app and find limited features. The app can be made better if you put steps like this is step one or how many steps. When I am on step 5, I find that I am not told what is needed then now, I am told to start from scratch, and when I come back, it takes me to the beginning.*
>
> *[Participant 4] When registering a company, you find that she cannot register without him. Even if the other is not needed in the company, you will still need the details of the other and the marriage information. The system will reject the app for people who do not have ID information corresponding with the Home Affairs database.*
>
> *[Participant 11] I downloaded the app and tried to process things, but it never really got me anywhere. I only got a chance to book a ticket which no one ever responded to, and it has limited what do you call it - it does not really have that much. So, I went to the e-services online. With the mobile app, I cannot really get things done.*
>
> *[Participant 12] It's not user-friendly*.

The participants who had a positive experience with the mobile application cited the mobile application's mobility, simplicity, and user-friendliness as reasons for the positivity. Some participants found the mobile application easy (simple) to use and the fact that it could be used irrespective of the space confinement (mobility). In addition,

user-friendliness featured prominently among positive experiences with the mobile application, despite some participants providing user-friendliness as the reason for their negative experience.

> *[Participant 2] All I can say is it is user-friendly and straightforward. If you understand English, then it is simple and easy to use.*

> *[Participant 7] The mobile app is the one that we use on our phones. Like most of us, they go to the internet and then get to the Company X website. But if you have the app on your phone, you can use it even if you are not in the office, like when you are going somewhere, and you are able to help that person because you've got this mobile app and it is easy also to log in because it works similar to the Company X website. There is nothing different there, I can say. The mobile app is very simple because it has everything. Every information that you want is given there.*

> *[Participant 9] Yeah, the mobile app is convenient for me because I am able to use my cell phone - sometimes, I move out of my own apartment. Before, when the app was not there, you used to go to an internet cafe from there. You need someone to do it on your behalf. But, now, using the app is very easy and then user-friendly.*

> *[Participant 10] Sometimes on the mobile app, as I say, it user friendly because sometimes when you go on the website by lecture ball computer, everything is there but on the mobile app is completely different, some icons are not there or some icons you can't even click on them they are not user friendly, some of them don't go straight to the point, so it is different for a person who uses a computer to access the website or the app, and it different with a person who uses it on a mobile, cause when I do it on my mobile or someone else who does a computer or on a laptop, we get different experiences in which is actually the same app but why different experiences.*

The experience one has with a product may change over time. Participants were therefore asked whether their experience had been stagnant or if it had changed over time (i.e., whether they had, at some point, a positive experience of the mobile application in case they gave a negative response, or vice-versa). Their responses suggested that their experience with the mobile application did not change from their initial perception. Also, the negative experiences seemed to prevail in the responses.

> *[Participant 1] The thing is, I have not realised if it changed or not because I partly stopped using the app, so I continued using the online app.*

> *[Participant 2] I have never had a negative experience towards the Company X app.*

[Participant 3] Like I said, I use the app a lot, but like I told you, I supplement it. There are things that you are not doing on the app. When I reserve the name, I go straight to the app.

[Participant 7] Because I have been using Company X for a long time, and I have never ever experienced a problem. So, I have never had a negative experience with the mobile app.

[Participant 10] Ever since I have tried to use it, I'm not satisfied with it because I don't get what I need, then I have to walk out of my house and go to an internet cafe just to be able to use the computer where I have a smartphone where I can just upload the app and do whatever I need to do on the app and get it done. Why do I have to go to an internet cafe to get a better experience with the app?

[Participant 11] It is just a negative experience. I even took out the app, and I thought I could never use it ever again unless they bring up a more modified one that communicates well with the person. The last I used the app, I think it was this year (2021) in April. I downloaded the app in September of last year (2020). I thought it would be better.

[Participant 12] It doesn't let me go into the app all the time, and sometimes it just kicks me out. No, I am just on the internet portal. My experience has always been negative.

4.3.2.4 Theme 4: User experience with the online portal

Participants mostly had positive experiences with the online portal, as per the results presented in Section 4.2. The interview questions further explored the source of the depicted positive experience. Therefore, the questions sought to elicit answers from participants who had positive and/or negative experiences with the online portal.

The online portal's efficiency, user-friendliness, expanded features (compared to the mobile application), and understandability featured prominently. The participants specifically linked their positive experiences to the online portal's full set of features that met their needs. In addition, when the system was under maintenance (i.e., offline), participants indicated that they received the notice of such planned maintenance and were thus not surprised by the online portal downtime.

[Participant 1] All the features that appear online, and then I'd say the last one would be when I registered a company, then the documents came earlier than is usually the case with the online services.

[Participant 2] The experience that I have with the e-services is effective and user-friendly. It uses simple English and saves time.

[Participant 7] I can say I am satisfied because of the e-services. It is more like teaching you when you use them. It gives you information on everything on how to use it. It also gives you a declaration of what you need to register a company successfully. So, e-services is very easy to use and more efficient for everyone.

[Participant 8] There are no delays, and the system response time is quick.

[Participant 12] Before, I think there was a change recently, about a couple of weeks ago, and then it works a little bit better after it was changed. I did struggle to get the journey when I logged on to it, but after that was done, all went quite well.

Amongst the participants who had positive experiences with the online portal, some identified concerns that projected the portal's shortcomings. These concerns included the efficiency of the portal compared to the mobile application, system problems (including system downtime), and the online portal being oriented to techno-savvy users. However, participants found these concerns easy to ignore, taking into account the full set of features available to them compared to other products, and that when there were system problems, they were notified.

[Participant 3] E-services is the best, even though it is not fast as Biz-portal and the mobile app. But for the full complement, the full menu, I go for e-services. I like that it has all the features. I can go to a lot of features. E-services if fine if you have time for it, unlike the mobile app.

[Participant 6] That one (e-services) is user-friendly. No, sometimes it happens once in a while you have a problem, but you'd get a notice that they are working on the site.

[Participant 11] With the e-services, I am okay. I never really had a problem with the e-services. It is just the beauty of it. Especially for my own business, it will be only an issue whereby you have to help someone who is maybe technologically challenged, and it is required to the person registered and get their own page, especially when you have to apply for BEE and request their documents.

Generally, participants had hardly any negative experiences with the online portal. However, the participants who did have negative experiences, mainly cited the business process-related challenges (e.g., a rejection of an application due to unclear submitted documents and late receipt of approval documents). The aspect related to

the online portal itself, was the challenge of the visibility of the disabled icons, which confused the participants. One participant highlighted user-friendliness as well.

> *[Participant 4] It has a lot of problems. You do company registration and require documents. If your documents are not clear, and you stay far from the centre, then you will have a problem because they won't accept unclear documents beyond 30 days. If you do not have e-mail knowledge, you have to go to people with resources.*
>
> *[Participant 5] No, sometimes you get the documents late, and I don't know what could be the problem. On some days, they were having a system problem, and thus documents were delayed.*
>
> *[Participant 9] The e-services, as I said, there was this issue of going to the bank first, and then you put the money. If you struggle with the e-services, the support is not good from the office for assistance.*
>
> *[Participant 10] It's not that easy to understand what e-services are used for. Because I had to click into e-services and check what I can do on services, but whereby it actually has an icon when you click on the e-services, it must have a clear icon to say on the e-services you can do this and do this and do this. So, but then when you click on e-services, you may have confusion like you have to keep on going in to see what e-services is, and then the other thing is that e-services should have more options like if you don't want to do this, you do that. I use e-services for registration, an app like when I'm looking for stuff, I have to check under everything.*
>
> *[Participant 13] It wasn't that user-friendly, especially when I first started using it. I couldn't find the forms and could understand how to download them. So, it wasn't straightforward. The documents were the problem. The issue was to download them. The page just went blank.*

One follow-up question in terms of the online portal's UX was posed to understand the state of the participants' current experiences in relation to their previous experiences. This was meant to establish if their previous experiences had any bearing on their current online portal experiences. The participants who responded to this question reported mixed feelings about the online portal. However, the prevailing feeling was that participants had a positive experience with the online portal.

> *[Participant 2] Since I am not using it on a daily basis, I have never had a problem with it.*

[Participant 3] I do not know, maybe there was a time that I was negative, but I don't remember. Once, I had a negative experience with the e-services, when I came back, you find that you have made a plan to fix such.

[Participant 4] I am not happy. Even when you are on the system, you get 100s of OTP codes. If you have to call someone (using the same phone for connection), when you come back, you have to start from the beginning because the system will disconnect.

[Participant 7] At some point during the weekend, the system is not working when they have a fault on the website. That is the only thing that interrupts the e-services. Otherwise, I am always happy with it.

[Participant 13] It went from being negative to just satisfying. I think, in the beginning, they were still trying to figure out how to do it online, and it was very difficult because it wasn't self-explanatory. I had to go and figure it out myself. I mean, as the years progressed, it just became more user-friendly.

4.3.2.5 Theme 5: Expectations and continuance use of the mobile application

The development of this theme took into account the expectations that participants had with the mobile application and its associated future use. Participants' expectations served as a prelude for future mobile application use.

Based on their experience, they were requested to identify the areas of excellence and areas where improvement was needed in terms of the mobile application's usability. Three sub-themes were identified from the generated interview data: areas of improvement, areas of excellence, and future use of the mobile application.

Based on the interview data, the mobile application’s efficiency appeared to be the prominent area of excellence for the participants, whereas, to a lesser extent, the visual appeal was also identified.

[Participant 1] All the features that appear online, I will say the last one will be when I registered a company, and that it may come excellently than it usually comes when I use the online services.

[Participant 2] If the system is working, it is very fast, and you get your certificate immediately.

[Participant 3] Yeah, I can say it exceeds my expectations when it comes to things like registering a business. If you want a business, it is easy, and I always recommend the

app. If they want to have their business in their name quickly, I always recommend the app.

[Participant 4] So far, what I expected is that the app's colour is attractive alone, it is fast, and there is no need to type the link.

[Participant 9] It manages to meet my expectations the way I am satisfied. You can say that maybe the fastness of the app can be something that one may experience. It gives a time frame for whatever you are doing.

Following the areas of excellence, participants were required to identify aspects of the mobile application where their expectations were not met. It was anticipated that participants might have been exposed to other mobile applications, which influenced their expectations before using the Company X mobile application. Expectations were also related to other Company X products that participants knew or used before, including the online portal.

Participants identified limited features, efficiency, errors, and business processes as the aspects that should be considered for improving the mobile application. Notably, efficiency appeared as both an area of improvement and as an area of excellence.

[Participant 1] On the features, overall, the app is okay and pretty much does what the Company X services offer. Maybe it is errors that I experienced when I tried retrieving the certificates for certain companies because I am running a consulting company.

[Participant 2] Okay, the app does not meet my expectation when the system is slow and you cannot get in.

[Participant 3] Like I said, once you access the website. Once you have a bigger menu like that, when you get to the app, you are disappointed. There are very limited features on the app, unlike on the website. Trademark, for example, is on the website but not on the app. You would think the app is designed for first-timers. It is like for people to register a lot of businesses.

[Participant 10] when you go on the app, and you look at the top part, not everything is there; not the whole page is there, but when you open it on your laptop, you don't need to navigate around to check everything there are different options, but on the mobile app there's nothing even though you scroll the left or to the right there's nothing. On the website, it is complete, and on the laptop, it is complete.

[Participant 12] I use an app on the side where I am in between meetings, or I don't have access to my laptop to check something, and then it kicks me out, or the information is different from when I go on to my laptop. It hasn't been too well. The internet portal is very efficient than the app. I am not sure if it doesn't integrate correctly, but I don't actually use it at all. I actually deleted it.

[Participant 4] The thing happens on the app in the domain name under Company X. It gives you a way forward for you to begin the process, but when you do more than 10 domain names, there won't be progress. After you've paid, only then are you told that the domain name is not hosted by Company X.

Participants were also required to indicate and elaborate on whether they would consider using the mobile application in future. Most participants indicated their interest in using this application again, notwithstanding the areas identified for improvement. The key considerations for future use of the mobile application were its effectiveness and efficiency.

[Participant 2] Yes, 100% [I will use the app again]. It saves time. Queuing and taking a taxi to go to the centre. With the app, you can do it at any time, even at midnight. So, it saves time.

[Participant 3] If you have to register the business now and name reservation, my start is the mobile. For other processes, I go to the website. I would say I use them every day.

[Participant 4] Yes, I can still use the app in the future because of Its fast speed.

[Participant 7] Yes, I am using it continuously because it is easy to use without any challenges. Secondly, they respond in time because you are an existing customer. Thirdly when you deposit the money, it is very easy to deposit when you use the mobile app because everything is displayed.

[Participant 9] Definitely, I am actually now on the app and the online system because I am trusting them for it is fast and user-friendly, unlike those ages when you have to do it on paper. Nowadays, it is fine now doing it on the app.

Some participants who had reservations regarding the mobile application, signalled their interest in using it again in future, provided that the application is improved in terms of its ease of use and elimination of errors.

[Participant 10] when I log in to the app and when I'm on the page so that I can find everything that I need, then I will be more than happy to use the app again. It must be simple enough to use.

[Participant 11] If the structure is simple enough to use, I can even start using it today. They should just make it easy to communicate with people and give options that are straight to the point.

[Participant 12] Yes, it is just the effectiveness of using it on my cell phone because I don't always have my laptop with me. So, I will try it when the bugs are off.

4.3.2.6 Theme 6: Expectations and continuance use of the online portal

The concept of continuance use considered the participants' expectations, areas of improvement, and excellence in terms of the online portal. The preceding aspects then informed the anticipated future use of the online portal, as expressed by the participants.

The purpose of the questions posed during the interview intended to understand the quantitative results pertaining to the participants' continuance intentions for future use of the online portal, considering its usability and UX. The participants identified online portal features (as opposed to the mobile application and Biz-portal), the fast processing, and the easy navigational design as the online portal's aspects that exceeded their expectations.

[Participant 3] On this one, it exceeded my expectations once I saw the mobile and the Biz-portal. When I used it alone, I took it for granted. Once you see the features of the app, you become grateful for what you have on e-services.

[Participant 4] The fast processing once things have been approved. Once generating documents, it is very fast even less than a minute, you get your documents.

[Participant 9] Annual returns, you get them as soon as possible. In terms of the name reservation, you get a quick response. Everything is super.

[Participant 10] It that whole button, when you click on it, it shows you the whole big map of everything there. I didn't expect that as I just thought that when I'm going home, it will take me back to the beginning, but then wow, when you've got no hope, it gives you more direction, more like here's what you need. Whereby now you are used to when you click home it takes you back to the homepage, or it takes you back to the

beginning, but this one, when you click home, it takes you further. It is actually great. When you click on it, it gives more options about e-services.

[Participant 13] I think the landing page immediately gives icons on what you need to do.

On the areas of improvement, participants had to identify aspects within the online portal where their expectations were not met, referring specifically to their UX and usability perceptions. Prevalent among these concerns were issues related to the business processes (i.e., business rules implemented in the online portal).

[Participant 4] What is missing is the submission of documents and communication between the people who are using the system and those processing from the system. There must be a way for effective communication.

[Participant 6] I was only able to do one cooperative with that site. When I was trying to do other cooperatives, I was not able to. I followed the same steps as indicated, but for the second time, it did not allow me. Maybe it allows one to register a cooperative once in a period. I don't know.

[Participant 7] When you want to search for somebody's company, but you know only the name of the company. So those things are more like they are important because you want to know, I want to register with this name, but you find out that the name is taken by somebody else, and the company is in the de-registration process. So, you want the person to give the name to you automatically because it is an old company. The information is not there.

[Participant 8] The payment part of the e-services is problematic.

One participant was concerned about the visual display of the buttons and the absence of the progress bar (or similar) to indicate that task execution was underway upon clicking a specific button.

[Participant 10] It must show that you clicked on the option. It must perhaps show that countdown thing that is loading, that shows that you have clicked on it, but because other than this now, at the moment when I click on it, I can't even notice I clicked on it or not until I click again and again and again, that's when it responds, it must show that you clicked on me just wait.

Participant 13 expected the online portal to be quick and instantly accessible, which was not the case in his/her view. "*I expected it to be quicker and instantly accessible.*"

Participants were asked to indicate whether they would consider using the online portal in future, and subsequently to provide their reasons. The majority of participants indicated their interest in using the online portal in future. The main reasons cited were the online portal's stability, efficiency, and effectiveness.

> *[Participant 1] I would consider using the app [i.e., online portal] more than I would consider using the new e-services. I have encountered more problems with the new e-services.*
>
> *[Participant 4] I will use the system in the future for those who still have a problem with their ID information for verification at Home Affairs, whereas, with the e-services, you can submit the documents without the verification with Home Affairs.*
>
> *[Participant 7] Yes, I will consider using the e-services again. As I am a customer of Company X, it is very easy and efficient for me. It works very fast, and it makes my work very easy.*
>
> *[Participant 8] Yes, I will continue using the e-services because I am happy with it, and it works fine.*
>
> *[Participant 9] Definitely, if SARS can do the same, income tax filing would be high. When it comes to the Company X system, it is super.*
>
> *[Participant 11] Yes, totally, I would consider using the e-services again, and the communication with it is out of this world.*

Another participant highlighted his/her familiarity with the online portal as a driver for his/her continued use of the online portal.

> *[Participant 2] Yes, no problem, I will consider it again. I am familiar with it already. I know this and that about it. I know when the network is down, it is a little bit slow. But if everything is above board, then the response is quick, and I do not have a problem with it.*

However, Participant 3 indicated that s/he might continue using the online portal, provided that no alternative exists with the similar features.

> *[Participant 3] I would always use it… it is always on my laptop. If the features that are*

on the e-services can move to the app or Biz-portal, I will stop using the e-services.

Other participants, however, indicated that they would continue to use the online portal merely because they did not have any other choice. The lack of choice arose from the nature of the participants' work, which involved assisting their clients with cooperative registrations (i.e., the online portal is used at work).

> *[Participant 6] I will use it again because my work is to assist cooperation. I will use it because I still need it.*
>
> *[Participant 12] Yes, I use it about daily because I need to use it. I do not have any other choice. I don't like Biz-portal, I won't lie, and it is just that I am not used to it.*
>
> *[Participant 13] Jah, I have to use the e-services. I have no choice. I don't know if the e-services are easier than the Company X system because I have not used the others.*

The quantitative and qualitative results are discussed in more depth below.

4.4 Discussion

Sections 4.2 and 4.3 presented the quantitative and qualitative results, respectively. Data were presented based on each data collection method used. In this section, an integrated approach is used to cross-reference, compare, and contrast the results to understand the extent to which the data complement each other towards addressing the study objectives.

According to Wilmot (2019), the pinnacle of an empirical study is to provide an understanding of the presented results by means of interpreting the 'raw' data and deriving implications from the findings. Along the same lines, Mosweu (2018) posits that data interpretation attaches meaning to the findings, and one derives meaning from the data alongside the associated research questions. The discussion and interpretation of the results make sense when the discussion is related to the study objectives, research questions, previous literature, and the underpinning theoretical framework (Chawinga, 2019).

The following discussion will integrate the qualitative and quantitative findings by relating them to the study objectives, previous literature on the research phenomena, and the underlying conceptual framework (as discussed in Chapter 2).

4.4.1 Mobile application and online portal usability

This study considered the People At the Centre of Mobile Application Development (PACMAD) model to compare the usability of the mobile application and the online portal of Company X. The PACMAD model incorporates the International Organization for Standardization (ISO 9241-11:2018) standard on usability (i.e., effectiveness, efficiency, and satisfaction), and Nielson's usability attributes (i.e., learnability, efficiency, memorability, errors, and satisfaction). As indicated in the conceptual framework for this study in Chapter 2 (Figure 2.3), the additional attribute, namely the cognitive load, was included for the usability evaluation of the mobile application and online portal. In addition, learnability was excluded as a usability attribute.

This study was informed by the unexpectedly low usage of the Company X mobile application compared to its counterpart, an online portal – also known as the e-services system – considering that the mobile application was newer than the online portal. The mobile application saw fewer participants using it over 12 months since its launch, whereas the online portal has sustained a prolonged use among Company X customers. Hoehle and Venkatesh (2015) indicate that poor usability and UX challenges are key drivers of product non-use, despite the product's perceived benefits from the perspective of product designers.

It was found in this study that the online portal was more usable than the mobile application, with a significantly high difference margin between these two products. This finding was somewhat supported by Gazzawe (2017), whose study found that website flexibility and accessibility resonate with its usability, whereas mobile applications lacked the flexibility of use – thus, the perception that websites were more useful than mobile applications. In contrast, the studies of Nikou and Economides (2019) and Nik *et al.* (2021) on the evaluation of a web and a mobile application, found a lack of usability for both the web and the mobile applications. In another related study, Purkayastha *et al.* (2020) found a Cognitive Behavioural Therapy Mobile Application more usable than web-based Cognitive Behavioural Therapy. The participants identified the ease of navigating the mobile application as the main factor for its high usability, while difficulties with navigation in the web-based version of the cognitive behavioural therapy was the reason for its low usability evaluation. In their study on the usability of websites and their associated mobile applications, Carvalho *et al.* (2018) similarly found that the websites were not usable as opposed to the mobile

applications, in this case, among visually impaired and good-sighted users. The authors found the ease of navigating the mobile application to be the contributing factor to the mobile application's usability.

The preceding studies that contradict the study findings on Company X's mobile application and online portal usability, could be explained by a statement made by Nikou and Economides (2019), that contradictory results for usability often arise from different contexts of use. The context of use may mean a variety of scenarios, for example, the nature of users and the industry in which the product/system operates.

In the current study, the effectiveness, memorability, and cognitive load of the online portal were indicated as the main factors in the positive usability results of the online portal compared to the mobile application. Moreover, participants praised the online portal's understandability, efficiency, user-friendliness, and learnability in the interviews. Compared to the mobile application, participants cited errors and the unfriendliness of the mobile application as contributors to its moderate usability.

However, the findings from the quantitative analysis signalled a significant spread of results across participants who found the online portal somewhat non-usable and those who found the mobile application somewhat usable. This spread was also confirmed by the interviews, as participants who found the online portal non-usable, cited its lack of user-friendliness and errors as the root causes thereof. On the other hand, users who found the mobile application usable, provided the ease of use and availability of the mobile application as reasons for its usability.

While one may deduce that the online portal was more usable as opposed to the mobile application, participants shared similar sentiments about errors, as participants saw both products as moderately erroneous. In addition, participants found the products' satisfaction and errors equally moderate, as the difference in satisfaction and errors between the mobile and the online portal was not statistically significant. Nurhudatiana *et al*. (2018) posit that errors contribute to product usability. Also, Saleh *et al*. (2017) found a correlation between the error rate and user satisfaction. The interviews conducted in this study also confirmed these sentiments, as participants linked their negative experiences of both products to errors and lack of user-friendliness.

In terms of the context of use (which was measured through the cognitive load in this study), the significant difference confirmed that the cognitive load for the mobile application was worse than that of the online portal. The findings suggest that participants devoted their time (i.e., low cognitive load) when transacting on the online portal than with the mobile application (i.e., high cognitive load). This finding associates cognitive load mainly with mobile application usability when compared to online portal usability (Afif, 2021; Faudzi *et al.,* 2022; Harrison *et al*., 2013).

The overall usability findings suggest that participants were willing to forego online portal satisfaction, errors, and its efficiency for usability, thus prioritising effectiveness, memorability, and cognitive load. These findings coincide with Nik Ahmad *et al*. (2021), as they highlighted efficiency and effectiveness as primary factors for the web and mobile applications' lack of usability. However, one should bear in mind that the online portal in the Nik Ahmad *et al*. study did not have an alternative. In the current study, Company X is empowered to render its available services through both an online portal and mobile application platforms.

As noted in Chapter 1, mobile applications are often launched quite some time after the initial launch of the associated online portal. The major implication of this practise is that users may implicitly assess the usability of the mobile application against the existing online portal. In this study, no causal link was investigated between the time of introducing the mobile application and the online portal in relation to their usability.

4.4.2 Mobile application and online portal user experience

Like usability, UX challenges contributed to product non-use, as indicated in Section 4.4.1. According to Makama (2021), systems development should view UX as the ultimate goal beyond system usability. This view not only regards a positive UX of a system as a desired outcome; it considers it as an extension of the system’s usability. In this dissertation, UX was attached to the product's usability, as indicated in the conceptual framework in Chapter 2 (Figure 2.3). Vermeeren *et al.* (2010) concur that system usability and UX are entangled.

The comparison of the Company X mobile application and online portal in terms of UX was measured using the User Experience Questionnaire (UEQ), as indicated in Chapter 2. The following UX constructs were considered: perspicuity, efficiency, dependability, attractiveness, stimulation, and novelty.

The study findings on the UX of the mobile application and online portal revealed that participants had a positive experience with the online portal and a negative experience with the mobile application. No known study has compared the UX of a mobile application with its associated online portal. However, previous studies on website UX pinpointed the importance of hedonic qualities in website UX (Wani *et al.*, 2017). For instance, Ritonummi (2020) found that, in their study, the company's website was usable, yet the UX was poor due to design problems. In contrast, the current study found that Company X's online portal scored high in both cases (i.e., usability and UX), notwithstanding that the relationship between product UX and usability does not arise naturally (Haaksma *et al.*, 2018).

User perception and attitude play a significant role in determining the UX of websites (Hsu *et al.*, 2017). In the case of this study, the online portal scored positively for the hedonic (novelty and stimulation) and pragmatic (perspicuity, efficiency, and dependability) qualities, as well as for pure valence dimension (attractiveness). However, this finding is contrary to the findings of Merčun and Žumer (2017), who established that, in respect of UX, the pragmatic aspects of the product resonated more with the participants than the hedonic aspects. The pragmatic aspects of UX are associated with product usability. The anticipated logic is that a usable product should yield a positive UX. This view was somewhat confirmed by the UX study findings of the online portal, where participants had a positive UX in line with a good rating of its usability. The same is also true for the mobile application's usability and UX, as participants had a bad experience with the mobile application and rated its usability moderately. The reverse was true in the findings of Paramitha *et al*. (2018), where a web-based academic IS had a positive UX, yet the system was not usable.

The experience with the online portal, as per the interview results, was largely positive. Participants pointed to the portal's user-friendliness, understandability, and efficiency in this regard. Ferreira *et al.* (2016) contend that a product that resonates with users' expectations and needs, results in a positive UX. The main drawbacks of the online portal were the business processes, including the processing of documents by the officials and the implemented business rules. In addition, participants were frustrated by the visibility of the icons, whose functionality was disabled, despite the fact that they could see them as part of the menu items.

Unlike the mobile application, participants always had a positive experience with the online portal. The exception, however, was that some participants with a negative experience with the online portal later changed their views to a positive experience. The participants' experiences in terms of all the UX factors measured for the mobile application were negative in this study. In addition, the interview results corroborated these findings, as participants were mainly negative about their experience with the mobile application. Among the causes of these negative experiences were, to a larger extent, the mobile application's inefficiency, errors, limited functionality, and lack of user-friendliness. To a lesser extent, the participants had concerns about the business processes (e.g., communication between the Company X and its customers).

Similar studies on mobile application UX contradicted this study's findings. Instead, the users portrayed a positive experience with the mobile applications investigated (Astuti *et al*., 2021; Davidavičienė *et al.*, 2019; Setiaji *et al.*, 2020; Wicahyono *et al.*, 2019). Setiaji *et al*. (2020), in their study of a secured mobile examination application, associated the mobile application's UX solely with the application's quality. In addition, despite obtaining positive UX ratings, Wicahyono *et al*. (2020) identified novelty and efficiency as areas of improvement for the Pregnancy Monitoring Mobile Application.

Notable for this study was that participants found the mobile application moderately usable. However, no correlation was tested between the mobile application’s usability and UX. Among participants who had a positive experience with the mobile application, its simplicity, mobility, and user-friendliness were provided as motivation, based on the interviews. While the participants were mainly negative about the mobile application, it was interesting that user-friendliness appeared as part of both positive and negative experiences with the application.

Comparing to the mobile application and online portal’s usability, the findings suggested that the online portal was considered usable, and participants had a positive experience. In contrast, participants found the mobile application moderately usable, and they had a negative experience with it. The interview results corroborated these results in both cases.

4.4.3 Mobile application and online portal continuance intentions

As discussed in Chapter 2, continuance intentions predict the future use of a product depending on users' perceptions and anticipated future benefits. Continuance

intentions are therefore based on UX or expectations. The investigation of continuance intentions in this study involved comparing the Company X online portal and mobile application, and subsequently considering the UX and usability of these products. The continuance intentions were positioned at the innermost layer of the conceptual framework, as indicated in Chapter 2 (Figure 2.3).

The findings on the mobile application and online portal's continuance intentions revealed that participants were more likely to consider using the online portal in future than the mobile application. This finding was supported by the interview results concerning the online portal. The prevailing reasons for future use of the online portal were its effectiveness, stability, efficiency, navigational ease, and the availability of sufficient features, as opposed to the mobile application and its limited features.

Various studies (Ambalov, 2021; Vatanasombut *et al.*, 2008) have identified trust in technology as a precursor for continuance intentions on web-based applications. In addition, subjective norms, enjoyment, usefulness, and ease of use significantly impacted the continuance intentions for information systems (Almutairi *et al*., 2021). While other studies pin continuance intentions on user satisfaction (Almutairi *et al*., 2021; Franque *et al*., 2020), Zareravasan and Ashrafi (2019) established no correlation between satisfaction and continuance intentions for the future use of their learning management system. The latter resonates with the findings of this study on online portal satisfaction, as it was rated moderately. In addition, participants had misgivings about business processes (e.g., back-office communication and implemented business rules), and indicated this as their hindrance to a positive UX with the online portal. This, therefore, relates to their dissatisfaction with the online portal.

Regarding the mobile application, the interview results somewhat contradicted the questionnaire findings. In their interview responses, participants indicated their willingness to use the mobile application in future, owing to its efficiency and effectiveness. However, the mobile application's limited features, errors, and efficiency appeared prominently as areas for improvement for the mobile application's future use. In contrast, Mubarokah and Hidayanto (2020) identified user satisfaction as a determining factor for continuance use intentions of the Internal Activity Report Application. Also, Alanazi (2013) found a correlation between the continuance use of e-government services and user satisfaction, service quality, and intention to use. The

preceding findings had user satisfaction as a common factor for continuance intentions for the investigated products.

There is a diversity of factors associated with the continuance intentions, depending on the adopted model. For example, trust, attitude, subjective norms, and perceived behavioural control contributed to the continuance intentions of open data websites (Liébana-Cabanillas *et al.*, 2021; Resti Fitriani *et al.*, 2019).

4.5 Consolidated research findings

The study objectives discussed in Section 1.5 were deconstructed into subsidiary objectives. Table 4.12 summarises the study findings in relation to its objectives.

Table 4.12. Summary of the research findings

Research objectives	Findings
Subsidiary Objective 2: To compare the usability of a mobile application and its associated online portal in terms of performance	The online portal was found more usable than the mobile application. Furthermore, effectiveness, memorability, and cognitive load were found to contribute to the online portal's usability more than the mobile application. However, no statistical differences were established for the online portal and mobile application satisfaction, errors, and efficiency.
Subsidiary Objective 3: To compare the user experience of a mobile application and its associated online portal in terms of user satisfaction	A positive UX for the online portal was established compared to the mobile application. Moreover, the online portal recorded a positive experience with all UX sub-constructs measured, namely attractiveness, efficiency, perspicuity, dependability, stimulation, and novelty. On the other hand, the mobile application was negatively scored for all sub-constructs.
Subsidiary Objective 4: To compare the continuance use of a mobile application and its associated online portal in terms of continuance intentions	The participants showed the likelihood of using the online portal in future, as opposed to the mobile application. In addition, the difference between the continuance intentions for the online portal and mobile application was found to be statistically significant.

4.6 Summary

The presentation of findings in this mixed-methods study was informed by the sequential design and duality of the data types, namely statistical and textual data. The statistical data were obtained from the quantitative phase, whereas the textual data were derived from the qualitative phase of the study.

The initial part of the data analysis, presentation, and discussion concentrated of the quantitative data obtained from the questionnaires. Descriptive and inferential statistics were used to summarise and address the study objectives. Secondly, qualitative data were obtained from the interviews to give insight into the findings obtained in the quantitative phase of the study. The remaining section integrated the results from both study phases, and discussed and related the findings to the previous studies and the conceptual framework.

The upcoming chapter will provide a study overview, and revisit the main and subsidiary research questions, contributions of the study, validity, reliability, and trustworthiness concepts, and conclude with the study's limitations and recommendations for future studies.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The preceding chapter presented, discussed, and analysed the raw data obtained from the self-administered questionnaires and the semi-structured interviews. In this chapter, the conclusion and recommendations are presented. The initial discussion includes an overview of the research process through the different chapters, representing the research steps followed. Secondly, the answers to the research questions are addressed in relation to the study objectives presented in Chapter 1 (Section 1.5). This is followed by the contributions and limitations of the study, considering the discussion in Chapter 1 regarding the anticipated study contributions to the Human-Computer Interaction (HCI) body of knowledge and practice, and the identified limitations. Lastly, the recommendations for future studies are discussed, particularly from the perspective of the identified study limitations.

5.2 Study overview

This dissertation comprises five chapters, and each chapter unpacked one or more aspects of the research process. The research problem arose from the practical problem experienced by Company X with the unsatisfactory use of its mobile application compared to its online portal (i.e., the e-services system). The literature showed a knowledge dearth regarding comparing usability, user experience (UX), and continuance use of mobile applications and their associated online portals. As a result, this study intended to compare, as a case study, the usability, UX, and continuance use of the mobile application and online portal of Company X. Subsequently, the research questions and objectives, along with the expected limitations and contribution of the study, were discussed.

In Chapter 2, the related literature was reviewed to establish the existing gap, locate the historical context of the study, and develop a conceptual framework on which the study was based. The review delved into interaction as a mediator for usability and UX, coupled with the conceptualisation, models, and attributes associated with usability and UX. Previous studies on usability, UX, and continuance use were also reviewed. The last segment of the review considered usability, UX, and continuance use evaluation, including the evaluation methods and metrics.

The research design and methodology were detailed in Chapter 3. Among the aspects discussed were the philosophical grounding of the study, which was a pragmatic approach, along with the research approach, namely the mixed-methods approach. Within the mixed-methods approach, the study was based on an explanatory sequential design, the first phase being quantitative, followed by a qualitative phase. The research strategy selected for this study was a single case study, and the data collection methods were a self-administered questionnaire and semi-structured interview. The selection of participants for the quantitative phase used systematic random sampling, and the qualitative phase used purposive sampling strategies. The initial sample size for the questionnaire administration was 1 423, while 13 participants took part in the interviews. In addition, data analysis for the quantitative phase used descriptive and inferential statistics, whereas thematic analysis was used for qualitative data analysis.

Chapter 4 presented, analysed, and discussed the data wherein descriptive statistics (i.e., the mean and standard deviation) and inferential statistics (i.e., paired t-test sample) were used. In addition, the qualitative data obtained from the interviews were analysed using thematic analysis, as described in Chapter 3. The results were integrated and discussed in relation to the existing literature and previous studies.

5.3 Addressing the research questions

The main aim of this study was to address the primary research question, which was: *How does the usability, user experience, and continuance use of a mobile application and online portal compare in terms of performance, user satisfaction, and continuance intentions?*

The response to the primary research question addressed the primary research objective, which was to compare the usability, UX, and continuance use of the mobile application and online portal in terms of performance, user satisfaction, and continuance intentions. Four subsidiary questions were derived to address the primary question. Each subsidiary question is addressed below.

5.3.1 First subsidiary research question

The first subsidiary question was related to the performance and satisfaction metrics applicable to compare the usability, UX, and continuance use of online portals and mobile applications. The question was phrased as follows: *Which performance and*

satisfaction (self-reported) metrics are applicable in comparing a mobile application's usability, user experience, and continuance use with its associated online portal?

This question was addressed in the literature review, as presented in Chapter 2. The reviewed literature considered the available performance and satisfaction metrics used in measuring the usability, UX, and continuance use of mobile applications and online portals. The dominant performance metrics found for mobile applications and online portals were product effectiveness and efficiency. However, the terminology for the same metrics differed among models and contexts. In the case of satisfaction metrics, user perceptions, emotions, opinions, and thinking constituted critical aspects of satisfaction metrics for mobile applications and online portals. In terms of continuance use, expectations, confirmation, and satisfaction were dominant continuance use metrics.

5.3.2 Second subsidiary research question

The second subsidiary question was: *How does the usability of a mobile application and its associated online portal compare in terms of performance?*

The objective of this question was to compare the usability of a mobile application and its associated online portal in terms of performance. The comparison took into account the effectiveness, satisfaction, efficiency, errors, cognitive load, and memorability of the mobile application and online portal.

The findings showed that the online portal was more usable than the mobile application in terms of the metrics used. However, the mobile application was found to be moderately usable. There was no statistical difference between the online portal and the mobile application in terms of satisfaction, efficiency, and errors. Notwithstanding the mobile application's moderate usability, participants found it effective and efficient. The interview results concurred with these findings, as participants had a mixed perception of the mobile application’s usability.

5.3.3 Third subsidiary research question

The third subsidiary question was related to the UX of the mobile application and online portal, and was stated as follows: *How does the user experience of a mobile application and its associated online portal compare in terms of user satisfaction?*

This subsidiary research question was intended to achieve the following objective: to compare the UX of a mobile application and its associated online portal in terms of user satisfaction. The comparison considered the attractiveness, dependability, efficiency, perspicuity, stimulation, and novelty of the mobile application and online portal.

The study found that users had a more positive experience with the online portal compared to the mobile application. The identified key contributors to the online portal's positive UX were its efficiency, attractiveness, perspicuity, novelty, dependability, and stimulation. The interview data supported the positive UX with the online portal.

In contrast, the negative UX with the mobile application stemmed mainly from its lack of novelty, attractiveness, perspicuity, stimulation, efficiency, and dependability. While the mobile application's perspicuity was better than other attributes, it nonetheless contributed to the negative experiences. Equally, the interview data concurred with users' negative experiences with the mobile application.

5.3.4 Fourth subsidiary research question

The last subsidiary question was related to the continuance use of the mobile application and online portal, and the question was stated as follows: *How does the continuance use of a mobile application and its associated online portal compare in terms of continuance intentions?* In answering this question, the continuance use of a mobile application and its associated online portal had to be compared in terms of continuance intentions.

The findings indicated that participants were more likely to use the online portal in future than the mobile application. However, the interview data contradicted the quantitative results regarding the mobile application, since some participants showed interest in future use, despite its identified challenges. On the other hand, the interview data for the online portal confirmed the quantitative findings.

5.4 Contribution of the study

This study contributed to the HCI body of knowledge and practice with specific reference to the HCI evaluation domain. Both the theoretical as well as practical contributions will now be discussed.

5.4.1 Theoretical contribution

The literature search identified limited mixed-methods studies comparing mobile applications and online portals' usability and UX. Furthermore, no known study has compared the usability, UX, and continuance use of a mobile application and online portal. Therefore, this study gave insight into the fact that the usability, UX, and continuance use phenomena were applicable to mobile applications, as well as online portals (e.g., usability, UX, and continuance use are as important for the mobile application as they are for the online portal). To the best knowledge of the researcher, the application of the People At the Centre of Mobile Application Development (PACMAD) model was not considered before for the usability of online portals. The application of the PACMAD model in this study therefore validated its suitability for the evaluation of the online portal's usability. A conceptual framework was developed to guide the logical flow of the study. The framework consisted of three layers, namely usability, user experience, and continuance use to successfully compare the mobile application and online portal. However, the framework was not tested. Future studies may use the framework to evaluate the causal relationship between usability, user experience, and continuance use.

The User Experience Questionnaire (UEQ) has been used extensively in previous studies on mobile applications and online portals alike (Astuti *et al*., 2021; Isnainiyah & Triwahyono, 2021; Izabal *et al*., 2018; Martono, 2021). Its use, though, was mainly limited to individual products (i.e., mobile applications or online portals, with no comparison). The use of UEQ in comparing the mobile application and online portal confirmed its relevance in such comparisons.

5.4.2 Practical contribution

By comparing a mobile application and an online portal, this study provided empirical evidence to extend the importance of usability and UX in a product's continuance use. Practitioners may use the findings to re-examine the importance of usability and UX as part of product development, not as a standalone component, irrespective of whether it is for a mobile application or an online portal. The relevance of this study to decision-makers relates to the cognisance of the evidence-based strategic importance of usability and UX in the product's continuance use. The development of mobile applications, compared to online portals, should consider the pain points identified by

the participants in relation to both usability and UX, as continuance use hinges on these aspects.

Decision-makers should consider the order of introducing a mobile application and online portal patterning to their continuance use. This study revealed that the online portal had better usability and UX than the mobile application, and participants were inclined to continue using the online portal more than the mobile application. By evaluating UX and usability, a company can determine which interface to prioritise. It will be detrimental to prioritise the one with usability and UX issues.

It is recommended that Company X redesign its mobile application, concentrating on its visual appeal and attempting to reduce errors, as pointed out by the participants. Company X should also pilot the mobile application with its users before availing it for public use. Improvements to the online portal may include the removal of icons that are unusable, redesigning the online portal to reduce errors, and providing a progress bar in all services to indicate to the users how far they are in the process. It is further recommended that services that are available on the online portal, should also be included in the mobile application, except those that are practically impossible for a mobile device.

5.4.3 Summary of the contributions

Table 5.1 summarises the theoretical and practical contributions of the study presented in Sections 5.4.1 and 5.4.2 above.

Table 5.1. Summary of the study contributions

Theoretical contribution	**Practical contribution**
Insight into the usability, user experience (UX), and continuance use phenomena for mobile applications and online portals.	Empirically established the importance of usability and UX in products' continuance for a mobile application and an online portal.
Validation of the PACMAD model's suitability to evaluate the online portal's usability.	The importance of usability, UX, and continuance use as an integral part of product development for a mobile application and an online portal.
Confirmation of the UEQ's relevance in comparing mobile applications and online portals.	The evidence-based strategic importance of usability and UX in the product's continuance use.
A new conceptual framework was developed to	Identified the usability and UX attributes associated

compare the usability, user experience, and continuance use of a mobile application and an online portal.	with mobile applications and online portals. The mobile application's usability attributes that were rated well: effectiveness and efficiency; and rated moderately: satisfaction, errors, cognitive load, and memorability. Online portal's usability attributes that were rated well: effectiveness, cognitive load, and memorability; and rated moderately: satisfaction, efficiency, and errors. In terms of mobile application's UX, all attributes were rated badly, namely, attractiveness, dependability, efficiency, perspicuity, stimulation, and novelty. For online portal's UX, novelty, stimulation, efficiency, perspicuity, and dependability were rated above average, whereas the attractiveness was rated well.

5.5 Validity, reliability, and trustworthiness

The self-administered questionnaire consisted mainly of items from previously validated tools. Additional items derived from the existing literature and theories were incorporated. Exploratory factor analysis was then performed on the questionnaire items to determine their construct validity. The factor loadings confirmed the association of items to the identified factors (Mehmetoglu & Mittner, 2022). Cronbach's alpha test was performed to determine the items' internal consistency. The results exceeded the minimum threshold of 0.6 (Pallant, 2016), and the questionnaire was deemed reliable.

Since this was a mixed-methods study, quantitative and qualitative data were used to complement the results arising from different study phases. Outliers were identified from the quantitative data. The qualitative data was subsequently used to further explain the results obtained from the quantitative phase of the study.

5.6 Limitations of the study

Despite the study's contribution, one must also consider its limitations. This study's scope was limited to comparing the usability, UX, and continuance use of a mobile application and its associated online portal. An observable relational pattern was noted between the mobile application and online portal's usability, UX, and continuance use. However, no correlation nor causality was tested. In addition, the study was purely descriptive, which presents limitations in terms of determining any relationship between the investigated constructs. The participants' level of experience with a mobile application and online portal was not measured, thus presenting a limitation,

since previous studies have shown differences between novice and experienced users in terms of usability and UX (Sauro, 2018).

Since this was a single case study, the findings may not necessarily be generalised to other cases. Additionally, the study only considered the online portal and mobile application, and therefore, the applicability of the findings to other products may not be confirmed. The study's cross-sectional nature confined the findings of the mobile application and online portal's usability, UX, and continuance use to the period of data collection. Thus, further improvement of the online portal and/or mobile application, after data collection was completed, could not be considered.

5.7 Recommendations for future studies

The limitations and findings of this study lay the foundation for future studies in usability, UX, and continuance use areas. Future studies may consider expanding the scope of the study beyond a single case to establish if the findings of this study apply to other cases, thereby improving the generalisability of the findings. Furthermore, one may embark on a longitudinal study to determine the changes in relation to the usability, UX, and continuance use of mobile applications and online portals over prolonged use.

Quantitative studies may use the findings to form and test tentative hypothetical relationships between usability, UX, and continuance use of mobile applications and online portals. The hypothetical relationships may include the differences in terms of usability, UX, and continuance use among novice and experienced users. The latter may significantly contribute to usability, UX, and continuance use since the current study did not investigate any correlational or causal relationship between these constructs in relation to the online portal and mobile application. Future studies should consider testing this observation to determine whether it does exist or occurred by chance. This should also include the validation of the conceptual framework that was developed in Chapter 2 of this dissertation. The results may then be used to devise an integrated usability, UX, and continuance use model.

5.8 Final summary

The primary objective of this study was to compare the usability, UX, and continuance use of a mobile application and online portal in terms of performance, user satisfaction, and continuance intentions. This study gave insight into the mobile application and

online portal UX, usability, and continuance use from the users' perspectives. The findings indicated that the online portal was considered more usable, with a positive UX, compared to the mobile application. The link between continuance use and the usability and UX of the mobile application and online portal, was limited. Study participants were more likely to use the online portal in future, which was not the case for the mobile application. The validity, reliability, and trustworthiness were established and detailed accordingly. Finally, theoretical and practical contributions were highlighted, along with the study's limitations and proposed future studies.

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APPENDICES

Appendix A: Questionnaire

QUESTIONNAIRE

DETERMINING USABILITY, USER EXPERIENCE, AND CONTINUANCE USE OF A MOBILE APPLICATION AND ONLINE PORTAL: A COMPARARTIVE CASE STUDY

Dear Sir/Madam

My name is Thobani Mhlongo, a student at the University of the Free State (UFS) within the Department of Computer Science and Informatics under the supervision of Prof. Lizette de Wet. I am conducting a study on the usability, user experience, and continuance use of the mobile application (app) and e-services system – from now on referred to as the online portal of Company X.

The purpose of this study is to compare the usability, user experience, and continuance use of the Company X mobile application with the Company X online portal, specifically from the perspective of its users. It was established that the use of the Company X mobile application is significantly lower than expected when compared to the online portal.

Approval to conduct this study was granted by the UFS Ethics Committee on 28 June 2021 with approval number: UFS-HSD2021/0319/21. Furthermore, permission to conduct this study at the Company X using its customer database was obtained from the Company X Commissioner on 18 August 2020.

Your name was randomly selected from the Company X customer database for users who have utilised the mobile app and online portal in the past 12 months. You are invited to participate in this study by completing this questionnaire on the usability, user experience and continuance use of the mobile application and the online portal. It is anticipated that the completion of this questionnaire shall not take more than 15 minutes of your time.

Please note that participation in this study is voluntary, and you have a right to withdraw your participation at any stage, with no adversities whatsoever. No physical, emotional or any harm is anticipated on your part as a result of your participation. Furthermore, no personal identifying data will be required from you or disseminated in the final report of this study. Only the principal investigator, supervisor(s) and/or directly linked officials of the UFS may have access to the raw data as obtained from the completed questionnaires. The raw data and analysed results will be stored securely in a password-protected computer and will be destroyed once the study is concluded.

Your completion of this questionnaire will imply that you acknowledge and agree to the content of this declaration and that you understand that participation in this study is completely voluntary.

Thank you very much for your participation.

Kind regards

Student name: Mr T Mhlongo

E-mail: 2016335271@ufs4life.ac.za

Supervisor name: Prof. L de Wet

E-mail: dwetl@ufs.ac.za

Participant name:

SECTION 1: PREVIOUS USE OF THE COMPANY X MOBILE APP AND ONLINE PORTAL

	Yes	No
1.1. Did you use the mobile app to transact with Company X at least once in the past 12 months?	☐	☐
1.2. Did you use the online portal to transact with Company X at least once in the past 12 months?	☐	☐

If you answered "No" to any question in Section 1 above, you do not need to complete the rest of the questionnaire and you may skip to the end of the questionnaire.

SECTION 2: DEMOGRAPHIC DETAILS

2.1 Please place a cross (X) next to the category that best describes you.

2.1.1 Gender	☐ Male	☐ Female	☐ Other	
2.1.2. Education	☐ Pre-matric	☐ Matric	☐ Post-matric qualification	
2.1.3. Computer literacy skills	☐ Basic	☐ Intermediate	☐ Advanced	
2.1.4. Age	☐ 18 – 35 years	☐ 36 – 45 years	☐ 46 – 60 years	☐ 61 years or above

SECTION 3: USE OF THE COMPANY X MOBILE APP

3.1 [1]Please mark with a cross (X) to indicate your experience with the Company X mobile app. The closer the mark appears to one of the two opposite indicated attributes, the more such an attribute represents your experience with the mobile app. There is no right or wrong answer.

Example:

Good	☐	X	☐	☐	☐	☐	☐	Bad

[1] Adapted from User Experienced Questionnaire. Link: https://www.ueq-online.org/

Your answer (above) means that you had a good experience with the Company X mobile app, as it is closer to the 'Good' attribute.

My experience with the Company X mobile app can be described as:

		1	2	3	4	5	6	7	
3.1.1.	Annoying	☐	☐	☐	☐	☐	☐	☐	Enjoyable
3.1.2.	Confusing	☐	☐	☐	☐	☐	☐	☐	Understandable
3.1.3.	Dull	☐	☐	☐	☐	☐	☐	☐	Creative
3.1.4.	Difficult to learn	☐	☐	☐	☐	☐	☐	☐	Easy to learn
3.1.5.	Inferior	☐	☐	☐	☐	☐	☐	☐	Valuable
3.1.6.	Boring	☐	☐	☐	☐	☐	☐	☐	Exciting
3.1.7.	Not interesting	☐	☐	☐	☐	☐	☐	☐	Interesting
3.1.8.	Unpredictable	☐	☐	☐	☐	☐	☐	☐	Predictable
3.1.9.	Slow	☐	☐	☐	☐	☐	☐	☐	Fast
3.1.10.	Conventional	☐	☐	☐	☐	☐	☐	☐	Inventive
3.1.11.	Obstructive	☐	☐	☐	☐	☐	☐	☐	Supportive
3.1.12.	Bad	☐	☐	☐	☐	☐	☐	☐	Good
3.1.13.	Complicated	☐	☐	☐	☐	☐	☐	☐	Easy
3.1.14.	Unlikable	☐	☐	☐	☐	☐	☐	☐	Pleasing
3.1.15.	Usual	☐	☐	☐	☐	☐	☐	☐	Leading edge
3.1.16.	Unpleasant	☐	☐	☐	☐	☐	☐	☐	Pleasant
3.1.17.	Unsecure	☐	☐	☐	☐	☐	☐	☐	Secure
3.1.18.	Demotivating	☐	☐	☐	☐	☐	☐	☐	Motivating
3.1.19.	Does not meet expectations	☐	☐	☐	☐	☐	☐	☐	Meets expectations
3.1.20.	Inefficient	☐	☐	☐	☐	☐	☐	☐	Efficient
3.1.21.	Confusing	☐	☐	☐	☐	☐	☐	☐	Clear
3.1.22.	Impractical	☐	☐	☐	☐	☐	☐	☐	Practical
3.1.23.	Cluttered	☐	☐	☐	☐	☐	☐	☐	Organised
3.1.24.	Unattractive	☐	☐	☐	☐	☐	☐	☐	Attractive
3.1.25.	Unfriendly	☐	☐	☐	☐	☐	☐	☐	Friendly
3.1.26.	Conservative	☐	☐	☐	☐	☐	☐	☐	Innovative

3.2 **[2]Please indicate with a cross (X) your agreement (or not) with each statement below in terms of the usability of the Company X mobile app, where 1 means you strongly agree, whereas 7 means you strongly disagree. There is no right or wrong answer.**

		Strongly agree	1	2	3	4	5	6	7	**Strongly disagree**
3.2.1.	Overall, I am satisfied with how easy it is to use the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.2.	It was simple to use the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.3.	I could effectively complete the tasks and scenarios using the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.4.	I struggled to complete the tasks and scenarios quickly using the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.5.	I was able to efficiently complete the tasks and scenarios using the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.6.	I felt comfortable using the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.7.	It was difficult to learn to use the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.8.	I believe I could become productive quickly using the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.9.	The mobile app gave error messages that clearly told me how to fix problems		☐	☐	☐	☐	☐	☐	☐	
3.2.10.	Whenever I made a mistake using the mobile app, I could recover easily and quickly		☐	☐	☐	☐	☐	☐	☐	
3.2.11.	The information (such as online help, on-screen messages, and other documentation) provided with the mobile app, was clear		☐	☐	☐	☐	☐	☐	☐	
3.2.12.	It was difficult to find the information I needed in the app		☐	☐	☐	☐	☐	☐	☐	
3.2.13.	The information provided for the mobile app was easy to understand		☐	☐	☐	☐	☐	☐	☐	
3.2.14.	The information was effective in helping me complete the tasks and scenarios on the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.15.	The organisation of information on the app screen was clear		☐	☐	☐	☐	☐	☐	☐	
3.2.16.	The interface of the mobile app was unpleasant		☐	☐	☐	☐	☐	☐	☐	
3.2.17.	I liked using the interface of the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.18.	The mobile app has all the functions and capabilities I expect it to have		☐	☐	☐	☐	☐	☐	☐	
3.2.19.	Overall, I am not satisfied with the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.2.20.	I concurrently use the Company X mobile app along with other apps		☐	☐	☐	☐	☐	☐	☐	

[2] Adapted from Sauro, J. and Lewis, J.R. (2016). *Quantifying the User Experience: Practical Statistics for User Research*. 2nd ed. Amsterdam: Morgan Kaufmann

3.2.21.	I give this mobile app undivided attention when using it	☐	☐	☐	☐	☐	☐	☐	
3.2.22.	I complete my transactions on the mobile app while engaging with other activities in my life	☐	☐	☐	☐	☐	☐	☐	
3.2.23.	My internet connection is sufficient when transacting on this mobile app	☐	☐	☐	☐	☐	☐	☐	
3.2.24.	I switch between apps while transacting on this app	☐	☐	☐	☐	☐	☐	☐	
3.2.25.	My mobile device has sufficient processing capacity to operate this mobile app	☐	☐	☐	☐	☐	☐	☐	

3.3 Please indicate with a cross (X) the extent of your agreement (or not) with each of the statements below about the continuance use of the Company X mobile app, where 1 means you strongly agree, whereas 7 means you strongly disagree. There is no right or wrong answer.

		Strongly agree	1	2	3	4	5	6	7	**Strongly disagree**
3.3.1.	My experience of the mobile app is better than I expected		☐	☐	☐	☐	☐	☐	☐	
3.3.2.	The mobile app does exactly what I need it to do		☐	☐	☐	☐	☐	☐	☐	
3.3.3.	The mobile app fulfils my service needs		☐	☐	☐	☐	☐	☐	☐	
3.3.4.	I can access the services I need quickly and easily when using the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.3.5.	I find the mobile app to be useful		☐	☐	☐	☐	☐	☐	☐	
3.3.6.	The mobile app leaves me more frustrated than I was		☐	☐	☐	☐	☐	☐	☐	
3.3.7.	I see no point in using the mobile app again		☐	☐	☐	☐	☐	☐	☐	
3.3.8.	I did the right thing by using the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.3.9.	I will frequently use the mobile app in future		☐	☐	☐	☐	☐	☐	☐	
3.3.10.	I am very much confident in operating the mobile app to fulfil my service needs		☐	☐	☐	☐	☐	☐	☐	
3.3.11.	Using the mobile app was the worst decision I ever made		☐	☐	☐	☐	☐	☐	☐	
3.3.12.	I will never use the mobile app again		☐	☐	☐	☐	☐	☐	☐	
3.3.13.	It is frustrating to use the mobile app		☐	☐	☐	☐	☐	☐	☐	
3.3.14.	If given a choice, I would still consider using the mobile app again		☐	☐	☐	☐	☐	☐	☐	
3.3.15.	I have a complete faith in the mobile app		☐	☐	☐	☐	☐	☐	☐	

SECTION 4: USE OF THE COMPANY X ONLINE PORTAL

4.1 **[3]Please mark with a cross (X) to indicate your experience with the Company X online portal. The closer the mark appears to one of the two opposite indicated attributes, the more such an attribute represents your experience with the online portal. There is no right or wrong answer.**

Example:

Good	☐	☒	☐	☐	☐	☐	☐	Bad

Your answer (above) means that you had a good experience with the Company X online portal, as it is closer to the 'Good' attribute.

My experience with the Company X online portal can be described as:

		1	2	3	4	5	6	7	
4.1.1.	Annoying	☐	☐	☐	☐	☐	☐	☐	Enjoyable
4.1.2.	Confusing	☐	☐	☐	☐	☐	☐	☐	Understandable
4.1.3.	Dull	☐	☐	☐	☐	☐	☐	☐	Creative
4.1.4.	Difficult to learn	☐	☐	☐	☐	☐	☐	☐	Easy to learn
4.1.5.	Inferior	☐	☐	☐	☐	☐	☐	☐	Valuable
4.1.6.	Boring	☐	☐	☐	☐	☐	☐	☐	Exciting
4.1.7.	Not interesting	☐	☐	☐	☐	☐	☐	☐	Interesting
4.1.8.	Unpredictable	☐	☐	☐	☐	☐	☐	☐	Predictable
4.1.9.	Slow	☐	☐	☐	☐	☐	☐	☐	Fast
4.1.10.	Conventional	☐	☐	☐	☐	☐	☐	☐	Inventive
4.1.11.	Obstructive	☐	☐	☐	☐	☐	☐	☐	Supportive
4.1.12.	Bad	☐	☐	☐	☐	☐	☐	☐	Good
4.1.13.	Complicated	☐	☐	☐	☐	☐	☐	☐	Easy
4.1.14.	Unlikable	☐	☐	☐	☐	☐	☐	☐	Pleasing
4.1.15.	Usual	☐	☐	☐	☐	☐	☐	☐	Leading edge
4.1.16.	Unpleasant	☐	☐	☐	☐	☐	☐	☐	Pleasant
4.1.17.	Unsecure	☐	☐	☐	☐	☐	☐	☐	Secure
4.1.18.	Demotivating	☐	☐	☐	☐	☐	☐	☐	Motivating
4.1.19.	Does not meet expectations	☐	☐	☐	☐	☐	☐	☐	Meets expectations

[3] Adapted from User Experienced Questionnaire. Link: https://www.ueq-online.org/

4.1.20.	Inefficient	☐ ☐ ☐ ☐ ☐ ☐ ☐	Efficient
4.1.21.	Confusing	☐ ☐ ☐ ☐ ☐ ☐ ☐	Clear
4.1.22.	Impractical	☐ ☐ ☐ ☐ ☐ ☐ ☐	Practical
4.1.23.	Cluttered	☐ ☐ ☐ ☐ ☐ ☐ ☐	Organized
4.1.24.	Unattractive	☐ ☐ ☐ ☐ ☐ ☐ ☐	Attractive
4.1.25.	Unfriendly	☐ ☐ ☐ ☐ ☐ ☐ ☐	Friendly
4.1.26.	Innovative	☐ ☐ ☐ ☐ ☐ ☐ ☐	Conservative

4.2 [4]Please indicate with a cross (X) your agreement (or not) with each statement below in terms of the usability of the Company X online portal, where 1 means you strongly agree, whereas 7 means you strongly disagree. There is no right or wrong answer.

		Strongly agree	1	2	3	4	5	6	7	Strongly disagree
4.2.1.	Overall, I am satisfied with how easy it is to use the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.2.	It was simple to use the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.3.	I could effectively complete the tasks and scenarios using the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.4.	I struggled to complete the tasks and scenarios quickly using the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.5.	I was able to efficiently complete the tasks and scenarios using the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.6.	I felt comfortable using the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.7.	It was difficult to learn to use the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.8.	I believe I could become productive quickly using the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.9.	The online portal gave error messages that clearly told me how to fix problems		☐	☐	☐	☐	☐	☐	☐	
4.2.10.	Whenever I made a mistake using the online portal, I could recover easily and quickly		☐	☐	☐	☐	☐	☐	☐	
4.2.11.	The information (such as online help, on-screen messages, and other documentation) provided with the online portal was clear		☐	☐	☐	☐	☐	☐	☐	
4.2.12.	It was difficult to find the information I needed on the online portal		☐	☐	☐	☐	☐	☐	☐	
4.2.13.	The information provided for the online portal was easy to understand		☐	☐	☐	☐	☐	☐	☐	

[4] Adapted from Sauro, J. and Lewis, J.R. (2016). *Quantifying the User Experience: Practical Statistics for User Research*. 2nd ed. Amsterdam: Morgan Kaufmann

4.2.14.	The information was effective in helping me complete the tasks and scenarios on the online portal	☐	☐	☐	☐	☐	☐	☐
4.2.15.	The organisation of information on the online portal screens was clear	☐	☐	☐	☐	☐	☐	☐
4.2.16.	The interface of the online portal was unpleasant	☐	☐	☐	☐	☐	☐	☐
4.2.17.	I liked using the interface of the online portal	☐	☐	☐	☐	☐	☐	☐
4.2.18.	The online portal has all the functions and capabilities I expect it to have	☐	☐	☐	☐	☐	☐	☐
4.2.19.	Overall, I am not satisfied with the online portal	☐	☐	☐	☐	☐	☐	☐
4.2.20.	I concurrently use the online portal with other programmes	☐	☐	☐	☐	☐	☐	☐
4.2.21.	I give the online portal undivided attention when using it	☐	☐	☐	☐	☐	☐	☐
4.2.22.	I complete my transactions on the online portal while engaging with other activities in my life	☐	☐	☐	☐	☐	☐	☐
4.2.23.	My internet connection is sufficient when transacting on the online portal	☐	☐	☐	☐	☐	☐	☐
4.2.24.	I switch between webpages while transacting on the online portal	☐	☐	☐	☐	☐	☐	☐
4.2.25.	My computing device has sufficient processing capacity to access and process transactions on the online portal	☐	☐	☐	☐	☐	☐	☐

4.3 Please indicate with a cross (X) the extent of your agreement (or not) with each of the statements below about the continuance use of the Company X online portal, where 1 means you strongly agree, whereas 7 means you strongly disagree. There is no right or wrong answer.

		Strongly agree	1	2	3	4	5	6	7	**Strongly disagree**
4.3.1.	My experience of the online portal is better than I expected		☐	☐	☐	☐	☐	☐	☐	
4.3.2.	This online portal does exactly what I need it to do		☐	☐	☐	☐	☐	☐	☐	
4.3.3.	The online portal fulfils my service needs		☐	☐	☐	☐	☐	☐	☐	
4.3.4.	I can access the online portal I need quickly and easily		☐	☐	☐	☐	☐	☐	☐	
4.3.5.	I find the online portal to be useful		☐	☐	☐	☐	☐	☐	☐	
4.3.6.	The online portal leaves me more frustrated than I was		☐	☐	☐	☐	☐	☐	☐	
4.3.7.	I see no point in using the online portal again		☐	☐	☐	☐	☐	☐	☐	
4.3.8.	I did the right thing by using the online portal		☐	☐	☐	☐	☐	☐	☐	
4.3.9.	I will frequently use the online portal in future		☐	☐	☐	☐	☐	☐	☐	

4.3.10.	I am very much confident in operating the online portal to fulfil my service needs	☐	☐	☐	☐	☐	☐	☐
4.3.11.	Using the e online portal was the worst decision I ever made	☐	☐	☐	☐	☐	☐	☐
4.3.12.	I will never use the online portal again	☐	☐	☐	☐	☐	☐	☐
4.3.13.	It is frustrating to use the online portal way more than I expected	☐	☐	☐	☐	☐	☐	☐
4.3.14.	If given a choice, I would still consider using the online portal again	☐	☐	☐	☐	☐	☐	☐
4.3.15.	I have a complete faith in the online portal	☐	☐	☐	☐	☐	☐	☐

SECTION 5: PARTICIPATION IN THE NEXT PHASE

5.1 The next phase of this study will consist of the optional semi-structured interview. Please indicate if you are willing to be contacted for a follow-up discussion on your experience with the Company X mobile app and the online portal.

☐ Yes, I would be willing to participate ☐ No, thank you

If your answer is "Yes" in 5.1, please enter your contact number: _____

Thank you very much for participating in this study.

Appendix B: Interview Protocol

INTERVIEW PROTOCOL

DETERMINING USABILITY, USER EXPERIENCE AND CONTINUANCE USE OF A MOBILE APPLICATION AND ONLINE PORTAL: A COMPARATIVE CASE STUDY

INTRODUCTION

Good day and thank you for taking my call. My name is Thobani Mhlongo, and I am a Master's student registered in the Department of Computer Science & Informatics at the University of the Free State. In the past few weeks, I requested you to complete a questionnaire in relation to your experience, the usability and continuance use of the Company X's mobile application and online portal.

You indicated in the questionnaire that you would like to also participate in the second phase of the study. Please confirm if you would still like to participate.

[If "no," I will thank the participant and end the call. By saying "yes", I will continue with the conversation as follows.]

Thank you very much. Before we continue, please take note of the following:

- You are reminded that Ethical Clearance was obtained from the official UFS Ethical Clearance Committee.
- Your participation in this study is completely voluntary and you are free to withdraw at any stage.
- With your permission, I will record this conversation to facilitate note taking and for reference purposes.
- Your responses will not be personalised i.e., no mention of personal identifying information will be included in the analysis of responses and/or in the final report.
- You are free to let me know at any time if you find one or more questions to be too intrusive.

As mentioned, note that I will record this conversation. Please advise whether you give your consent to proceed with this interview.

[If "no," I will thank the participant and end the call. If "yes", I will continue with the conversation.]

QUESTIONS

1. What is your province of residence?

2. How would you rate your overall experience with Company X as an institution on a scale from 1 – 5, where 1 means very bad and 5 means very good? **What are your experiences with the Company X systems in general?**
3. In your answers to the questionnaire, you rated the Company X mobile app with a score of **[score]** in terms of your experience with it which means that you had a **[positive/negative]** experience.
   [Experience here entails **attractiveness, efficiency, dependability, stimulation, novelty, and the ease of using the app**]. **Please elaborate on this by providing reasons for your rating.**

4. Has your experience fluctuated over time? If so, what informed these fluctuations?
5. Which areas of user experience with the Company X mobile app would you consider very important? [The areas of user experience include the **attractiveness, efficiency, dependability, stimulation, novelty, and the ease of using** the app]
   Please explain why these aspects are important to you.

6. Which areas of user experience with the Company X mobile app would you consider least important? [The areas of user experience include the **attractiveness, efficiency, dependability, stimulation, novelty, and the ease of using the app**]. **Please explain why these aspects are the least important.**

7. You have rated the Company X mobile app in terms of its usability with a score of **[score]** in terms of its usability which means that the app is **[usable/not usable]**. **[Usability entails the ability to use the app and complete the intended task(s) successfully]. Please elaborate on what informed this rating. You may also provide specific examples, if any.**

8. Where do you think the Company X mobile app fell short of your expectations?
9. Where do you think the Company X mobile app exceeded your expectations?
10. Would you consider using the app again? Why/why not?
11. In your answers to the questionnaire, you rated the Company X online portal with a score of **[score]** in terms of your experience with it which means that you had a **[negative/positive]**

experience. [Experience here entails, for example, **attractiveness, efficiency, dependability, stimulation, novelty, and the ease of using the portal**].
Please elaborate on this by providing reasons for your rating.

12. Has your experience fluctuated over time? If so, what informed these fluctuations?

13. Which areas of user experience with the online portal would you consider very important? [The areas of user experience include the **attractiveness, efficiency, dependability, stimulation, novelty, and the ease of using** the online portal]. **Please explain why these aspects are important to you.**

14. Which areas of user experience with the online portal would you consider least important? [The areas of user experience include the **attractiveness, efficiency, dependability, stimulation, novelty**, and **the ease of using the online portal**]. **Please explain why these aspects are the least important.**

15. You have rated the online portal in terms of its usability with a score of **[score]** in terms of its usability which means that the portal is **[usable/not usable]**. **[Usability entails the ability to use the online portal and complete the intended task(s) successfully]. Please elaborate on what informed this rating. You may also provide specific examples, if any.**

16. Where do you think the online portal fell short of your expectations?

17. Where do you think the online portal exceeded your expectations?
18. Would you consider using the online portal again? Why/why not?

CONCLUSION

We have reached the end of our conversation. Thank you very much for your kind participation and your time. You may state your closing remark, if any, and/or ask any question thereto.

Thank you very much and have a blessed day further.

Appendix C: Ethical Approval

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS UV

GENERAL/HUMAN RESEARCH ETHICS COMMITTEE (GHREC)

28-Jun-2021

Dear Mr Thobani Mhlongo

Application Approved

Research Project Title:
Determining the usability, user experience and continuance use of a mobile application and online portal: A comparative case study

Ethical Clearance number:
UFS-HSD2021/0319/21

We are pleased to inform you that your application for ethical clearance has been approved. Your ethical clearance is valid for twelve (12) months from the date of issue. We request that any changes that may take place during the course of your study/research project be submitted to the ethics office to ensure ethical transparency. furthermore, you are requested to submit the final report of your study/research project to the ethics office. Should you require more time to complete this research, please apply for an extension. Thank you for submitting your proposal for ethical clearance; we wish you the best of luck and success with your research.

Yours sincerely

Dr Adri Du Plessis
Chairperson: General/Human Research Ethics Committee

Adri du Plessis
Digitally signed by Adri du Plessis
Date: 2021.06.28 16:23:23 +02'00'

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Appendix D: Informed Consent Form

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

RESEARCH STUDY INFORMATION LEAFLET AND CONSENT FORM

DATE

2021/2022

TITLE OF THE RESEARCH PROJECT

Determining the usability, user experience and continuance use of a mobile application and online portal: A comparative case study

PRINCIPLE INVESTIGATOR / RESEARCHER(S) NAME(S) AND CONTACT NUMBER(S):

Thobani Mhlongo *2016335271* *0627331351*

FACULTY AND DEPARTMENT:

Faculty of Natural and Agricultural Sciences
Department of Computer Science and Informatics

STUDY LEADER(S) NAME AND CONTACT NUMBER:

Prof. Lizette de Wet (UFS staff member: 0085456 – Computer Science and Informatics)
051 401 3705

WHAT IS THE AIM / PURPOSE OF THE STUDY?

This study intends comparing the usability, UX and continuance use of the online portal and mobile application of the Companies and Intellectual Property Commissions (CIPC) in terms of performance, user satisfaction and continuance use.

WHO IS DOING THE RESEARCH?

The study is conducted by Thobani Mhlongo who is currently enrolled for a Master of Science in Computer Science and Informatics within the University of the Free State. Also, I am presently employed by CIPC as a Manager: e-Communications.

HAS THE STUDY RECEIVED ETHICAL APPROVAL?

This study has received approval from the Research Ethics Committee of UFS. A copy of the approval letter can be obtained from the researcher.

Approval number: UFS-HSD2021/0319/21

WHY ARE YOU INVITED TO TAKE PART IN THIS RESEARCH PROJECT?

The study targets CIPC customers who have used both the CIPC mobile application and the online portal at least once in the past 12 months. Customer contact details were obtained from CIPC for the purpose of this study. Participants to this study have been randomly selected, and the maximum number of participants is 250.

WHAT IS THE NATURE OF PARTICIPATION IN THIS STUDY?

This study has two phases. In the first phase, the participant is required to complete a questionnaire which is hosted online. The questions are related to the participant's experience of the CIPC mobile application and online portal in terms of usability, continuance use and user experience. The questionnaire is expected to be completed in approximately 15 minutes. The second phase will consist of participants who expressed their interest to participate in the second phase. Participants in the second phase will be required to answer open-ended questions about their experience of the CIPC mobile application and online portal. Participation in the second phase is voluntary much the same like in the first phase. The interview is expected not to exceed one hour.

CAN THE PARTICIPANT WITHDRAW FROM THE STUDY?

Participation to this study is completely voluntary. Participants will not be adversely affected by withdrawing and/or refusing to participate in this study in anyway whatsoever. Also, participants are free to withdraw at any stage of the questionnaire and/or interview process. However, completed questionnaires cannot be withdrawn, as each completed questionnaire cannot be traced to a participant.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

It is anticipated that this study will shed light on the usability, user experience and continuance use of the mobile application and online portal. The findings will contribute to the Human-Computer Interaction body of knowledge. Thus, the findings will, in turn, help in the design of mobile application and online portals that meet the usability and user experience expectations of its users.

WHAT IS THE ANTICIPATED INCONVENIENCE OF TAKING PART IN THIS STUDY?

It is anticipated that the completion of the online questionnaire shall take between 15 minutes and 25 minutes. The questionnaire shall be completed in one session at a time that is convenient to the participant. Where the participant opts to participate in the second phase of the study, the interview will not exceed one hour. No other inconveniences are expected on the side of the participant.

WILL WHAT I SAY BE KEPT CONFIDENTIAL?

No personal identifying data will be collected. Nonetheless, the online survey tool to be utilized is accessible by means of a username and password and can only be accessed by the researcher. Also, a

password-protected personal computer will be used throughout the study. Recorded interviews for the second phase will be kept on the same personal computer which is password-protected. The data collected will be aggregated and analysed without specific reference to each participant. In addition, the publication of the research results, whether in a journal, conference proceeding or any other academic forum, will maintain the anonymity of the participants.

HOW WILL THE INFORMATION BE STORED AND ULTIMATELY DESTROYED?

The data retrieved from the online survey tool will be transformed then stored in a format suitable for the Statistical Package for Social Sciences (SPSS) for analysis. The data will be stored in a password-protected personal computer. Data will be destroyed twelve months after analysis or as per the University Policies, whichever comes earlier.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICPATING IN THIS STUDY?

No payment or incentive will be given to participants for their participation in this study.

HOW WILL THE PARTICIPANT BE INFORMED OF THE FINDINGS / RESULTS OF THE STUDY?

Participants are more than welcome to request a final report of this study. The study results are available upon request. However, the results of the study will be available eight months after the study is completed. Nonetheless, the University publishes all completed study reports in the library page of the University website. Requests and/or further queries may be sent to Thobani Mhlongo (mhlongothobani@gmail.com). Should there be any concern about the way in which the research will be/has been conducted, one may contact Prof. L. de Wet on 051 401 3705.

Thank you for taking time to read this information sheet and for participating in this study.

CONSENT TO PARTICIPATE IN THIS STUDY

I, the undersigned,

_____ (*participant's full names to be included*), (the "**Participant**")

confirm that I voluntarily agree to participate in the research study referred to as the

"Determining the usability, user experience and continuance use of a mobile application and online portal: A comparative case study"
_____ (the "**Study**")

and which Study is being conducted by **Thobani Mhlongo**

_____

(*insert the name of the researcher*), (the "**Researcher**").

I, the undersigned Participant, further confirm that–

1. the Researcher has explained the nature, procedure, potential benefits and anticipated inconvenience of my participation in the Study;
2. I have read (or had explained to me) and understood the Study as explained in the attached information sheet;
3. I have had sufficient opportunity to ask questions and am prepared to participate in the Study;
4. I understand that my participation in the Study is entirely voluntary and that I am free to withdraw at any time without penalty (if applicable);
5. I voluntarily provide the UFS and the Researcher with my personal information and consent to the UFS and the Researcher collecting, disclosing and processing my personal information in order to conduct the Study and any related activities in relation thereto;
6. I hereby acknowledge and confirm that I understand the purpose for which the UFS and the Researcher may collect, store, use, delete, destroy, outsource, transfer or otherwise process, as the context and circumstances may require and as contemplated in terms of POPIA, my personal information as set out herein;
7. I am aware that the findings of the Study will be anonymously processed into a research report, journal publications and/or conference proceedings and that my personal information will be aggregated and deidentified at such stage;
8. I also give the UFS permission to share, without notification, the collected data with other researchers at the UFS or other Higher Education Institutions. This permission is dependent on the same principles of ethical research practices, anonymity/confidentiality, safekeeping of information, and other issues listed above applying.

I, the Participant, agree to the recording of the *questionnaire/interview*

Full Name of Participant: _____

Signature of Participant: _____ Date: _____

Full Name(s) of Researcher(s): _____

Signature of Researcher: _____ Date: _____

Appendix E: Research Site Permission

Office of the Commissioner
PO BOX 429
PRETORIA
0001

18 August 2020

To whom it may concern,

PERMISSION TO CONDUCT A RESEARCH STUDY

Principal investigator: Mr Thobani Mhlongo
Institution: University of the Free State
Programme: MSc in Computer Science and Informatics

I have reviewed your request to conduct a research study involving the Commission and took note of the following requirements for the project: access to contact details of customers, access to internal data in relation to customer transactions and use of electronic channels to reach out to potential participants to the study.

Permission is herein granted for the research study to be conducted at . Furthermore, permission is granted to the principal investigator to access the internal data for the purpose of fulfilling the research requirements. The following stipulations should be observed: access to internal data is for the duration of the research study, and the principal investigator is always expected to adhere to policies and research ethical standards.

Yours faithfully

Adv. R.W.
Commissioner:

The dti Campus (), 77 Meintjies Street, Sunnyside, Pretoria I P O Box 429, Pretoria, 0001
Tel: +27 12 394 9973 | Fax: +27 12 394 1015 | Call Centre: 086 100 2472
Email: tobeconfirmedbyclient@ | Website: www

Appendix F: Factor Loadings (Rotated Component Matrix)

PART A: ONLINE PORTAL

- **User experience**

Item		1	2	3	4	5	6
ATT	**ATTRACTIVENESS**						
4.1.1	ATT1	.877					
4.1.12	ATT2	.908					
4.1.14	ATT3	.920					
4.1.16	ATT4	.916					
4.1.24	ATT5	.887					
4.1.25	ATT6	.875					
PER	**PERSPIQUITY**						
4.1.2	PER1		.865				
4.1.4	PER2		.843				
4.1.13	PER3		.861				
4.1.21	PER4		.892				
NOV	**NOVELTY**						
4.1.3	NOV1			.872			
4.1.10	NOV2			.856			
4.1.15	NOV3			.801			
4.1.26	NOV4			.868			
STI	**STIMULATION**						
4.1.5	STI1				.883		
4.1.6	STI2				.880		
4.1.7	STI3				.906		
4.1.18	STI4				.898		
DEP	**DEPENDABILITY**						
4.1.8	DEP1					.813	
4.1.11	DEP2					.876	
4.1.17	DEP3					.795	
4.1.19	DEP4					.868	
EFI	**EFFICIENCY**						
4.1.9	EFI1						.847
4.1.20	EFI2						.862
4.1.22	EFI3						.905
4.1.23	EFI4						.889

- **Usability**

Item		1	2	3	4	5	6
EFF	**EFFECTIVENESS**						
4.2.3	EFF1	.920					
4.2.14	EFF2	.917					
EFI	**EFFICIENCY**						
4.2.5	EFI1		.566				
4.2.8	EFI2		.838				
ERR	**ERRORS**						
4.2.9	ERR1			.654			
4.2.10	ERR2			.675			
4.2.11	ERR3			.693			
MEM	**MEMORABILITY**						
4.2.13	MEM1				.545		
4.2.15	MEM2				.826		
4.2.18	MEM3				.695		
SAT	**SATISFACTION**						
4.2.1	SAT1					.782	
4.2.16	SAT2					.775	
4.2.19	SAT3					.754	
4.2.17	SAT4					.661	
COG	**COGNITIVE LOAD**						
4.2.24	COG1						.879
4.2.22	COG2						.733
4.2.23	COG3						.857
4.2.25	COG4						.835
4.2.21	COG5						.879

- **Continuance use**

Item		1
CON	**CONTINUANCE USE**	
4.3.2	CON1	.806
4.3.3	CON2	.899
4.3.4	CON3	.879
4.3.5	CON4	.463
4.3.9	CON5	.780
4.3.10	CON6	.778
4.3.15	CON7	.713
4.3.6	CON8	.866
4.3.8	CON9	.879
4.3.11	CON10	.870
4.3.14	CON11	.810
4.3.7	CON12	.807
4.3.12	CON13	.769
4.3.1	CON14	.622
4.3.13	CON15	.575

PART B: MOBILE APPLICATION

- **User experience**

Item		Component					
		1	2	3	4	5	6
ATT	**ATTRACTIVENESS**						
3.1.1	ATT1	.807					
3.1.12	ATT2	.869					
3.1.16	ATT3	.869					
3.1.24	ATT4	.808					
3.1.25	ATT5	.821					
3.1.14	ATT6	.843					
PER	**PERSPIQUITY**						
3.1.2	PER1		.835				
3.1.4	PER2		.818				
3.1.13	PER3		.859				
3.1.21	PER4		.847				
NOV	**NOVELTY**						
3.1.3	NOV1			.784			
3.1.10	NOV2			.791			
3.1.15	NOV3			.772			
3.1.26	NOV4			.812			
STI	**STIMULATION**						
3.1.5	STI1				.862		
3.1.6	STI2				.840		
3.1.7	STI3				.826		
3.1.18	STI4				.839		
DEP	**DEPENDABILITY**						
3.1.8	DEP1					.779	
3.1.11	DEP2					.883	
3.1.17	DEP3					.720	
3.1.19	DEP4					.784	
EFI	**EFFICIENCY**						
3.1.9	EFI1						.791
3.1.20	EFI2						.788
3.1.22	EFI3						.824
3.1.23	EFI4						.824

- **Usability**

Item		1	2	3	4	5	6
SAT	**SATISFACTION**						
3.2.1	SAT1	.692					
3.2.6	SAT2	.741					
3.2.17	SAT3	.758					
3.2.16	SAT4	.670					
3.2.19	SAT5	.508					
MEM	**MEMORABILITY**						
3.2.2	MEM1		.656				
3.2.13	MEM2		.754				
3.2.15	MEM3		.719				
3.2.18	MEM4		.798				
EFF	**EFFECTIVENESS**						
3.2.3	EFF1			.755			
3.2.14	EFF2			.810			
EFI	**EFFICIENCY**						
3.2.5	EFI1				.744		
3.2.8	EFI2				.731		
ERR	**ERRORS**						
3.2.10	ERR1					.702	
3.2.9	ERR2					.703	
COG	**COGNITIVE LOAD**						
3.2.20	COG1						.551
3.2.22	COG2						.754
3.2.24	COG3						.553
3.2.23	COG4						.825
3.2.25	COG5						.754

- **Continuance use**

Item		1
CON	**CONTINUANCE USE**	
3.3.1	CON1	.853
3.3.2	CON2	.777
3.3.3	CON3	.873
3.3.4	CON4	.850
3.3.5	CON5	.836
3.3.8	CON6	.774
3.3.9	CON7	.755
3.3.10	CON8	.790
3.3.14	CON9	.682
3.3.15	CON10	.800
3.3.11	CON11	.745
3.3.12	CON12	.701
3.3.13	CON13	.617
3.3.6	CON14	.695
3.3.7	CON15	.679

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 9 iterations.

Appendix G: Conference paper

IHIET 2023: Vol. XX, 2023
doi: 10.54941/ahfeXXXX

Determining the user experience and continuance use of a mobile application and an online portal: a comparative case study

Thobani Mhlongo[1], Lizette De Wet[1], and Silas Formunyuy Verkijika[2]

[1]University of the Free State, Bloemfontein, South Africa
[2]Sol Plaatje University, Kimberley, South Africa

ABSTRACT

The increasing number of users with access to the internet, computers, and mobile devices propels most institutions to avail their services through online portals and mobile applications. However, there are instances where users underutilise or completely opt out of these platforms. This is a cause for concern since funds are invested in their development, with the anticipated return on investment. Against this backdrop, this study aimed to compare the user experience and continuance use of a mobile application and online portal for an organization in South Africa. This single case study followed an explanatory sequential design, where the initial phase consisted of data collection using a self-administered questionnaire. For the second phase, the data was collected using an interview protocol. The results established that the study participants had a positive experience with the online portal but not so much with the mobile application. The contributing factors to the online portal's positive user experience were its efficiency, attractiveness, perspicuity, dependability, novelty, and stimulation. The interview results corroborated the quantitative results, as participants indicated overall positive experiences with the online portal. In contrast, participants had negative experiences with the mobile application, citing its limited features and lack of user-friendliness, understandability, and learnability. Regarding continuance use, the quantitative and qualitative results suggested that participants were keen to use the online portal in the future. However, the quantitative results for the mobile application indicated no participant interest in using the mobile application again in future, despite the interview results indicating otherwise. Participants identified improvement in efficiency and visual appeal as conditions for their future re-use of the mobile application.

Keywords: Continuance use; User Experience; Human-Computer Interaction; Mobile application; Online portal; Website

INTRODUCTION

Designing and developing user-friendly products is critical for the overall adoption and continuous use of the product. The usability and overall user experience (or UX as it is generally referred to) of a product are the cornerstones that determine whether the product will be used as intended or whether the users will consider the product as part of their daily lives (i.e., continuance use). The juncture between the user and the product lies in the user interface of the product (Reynoso and Romo, 2020). User interaction with these products is generally via a well-defined user interface. The interaction may evoke a positive or negative experience, perception, or attitude towards the product. According to Knijnenburg *et al.* (2012), the extent to which the user has a positive experience with the product depends on the user's need for self-reliance, the capability to perform tasks at hand, and stimulation invoked when one uses the product. These needs are more important for self-service oriented products due to the limited availability of user support.

The preceding discussion highlighted two concepts: user experience, and continuance use. There is a gap in the body of knowledge regarding studies that compare the different service platforms for similarities and differences, if any, in terms of UX and continuance use. This study intended to fill this gap with specific reference to a mobile and an online portal of a South African institution. The primary research questions for this study were: (1) How does the user experience of a mobile application and its associated online portal compare in terms of user satisfaction? (2) How does the continuance use of a mobile application and its associated online portal compare in terms of continuance intentions?

CONCEPTUALISING USER EXPERIENCE

The conceptualisation of UX is premised on the users' perceptions of the product. The definition of UX is often tied to the adopted model. The UX White Paper (Roto *et al.*, 2011) defines UX as "the outcomes and memories" the user has upon interacting with the product. The paper differentiates UX based on the time span the user interacts with the system, which can be a specific change of feeling during interaction (momentary UX), appraisal of a specific usage episode (episodic UX), views on a system as a whole after using it for a while (cumulative UX), or before using it (anticipated UX). This paper will focus on the cumulative timespan (i.e., the user's feelings about the product a while after use).

Similarly, ISO 9241-210:2010 defines UX as a "person's perceptions and responses that result from the use/anticipated use of a product, system or service" (International Organization for Standardization, 2010). The intrinsic nature of UX is such that there is an overlap between the factors of usability and UX, particularly with satisfaction and efficiency. This paper considers satisfaction and efficiency as part of both usability and UX. However, UX extends to attractiveness, perspicuity, dependability, stimulation, and novelty (Schrepp *et al.*, 2014).

User experience models

Multiple UX models give rise to multiple perspectives of what constitutes UX. Roto *et al.* (2011) identify user affect, interpretation, and meaning as attributes underscoring UX and attributes that inform it. Bevan (2008) approaches UX in terms of the goals and consequences of using the product. The product goals consist of pragmatic goals (i.e., effectiveness and efficiency) and hedonic goals (i.e., stimulation, identification, and evocation), whereas consequences include pleasure, likability and comfort, and trust. For Morville (2004), UX encapsulates how useful, usable, findable, credible, accessible, desirable, and valuable the system/product is.

The ideographic nature of UX results in different UX dimensions and interpretations. There are many different UX dimensions/models (Følstad, 2010; Hussain *et al.*, 2021). Each model/dimension presents and defines UX within the scope of the concerned model/dimension. Hassenzahl's UX model (Han *et al.*, 2018) has been widely used to assess UX. This model is premised on the user, the product and the interaction between the product and the user. For this study, the UX attributes identified by Schrepp *et al.* (2017) are considered determinants of product UX, as the accompanying User Experience Questionnaire (UEQ) has been extensively validated (Izabal *et al.* , 2018; Kusumo and Hartono, 2019; Isnainiyah and Triwahyono, 2021; Martono, 2021). These attributes consist of attractiveness,

perspicuity, novelty, stimulation, dependability, and efficiency. The identified attributes emanate from pragmatic and hedonic qualities from Hassenzahl's Model.

CONTINUANCE USE OF AN INFORMATION SYSTEM PRODUCT

The success of a product depends on its continuance use beyond the first encounter (Wangpipatwong *et al*., 2008). Even more critical is the prolonged use of an information system (IS) product *(Wu et al*., 2022). The continuance use mainly depends on how much the product meets the users' needs. It is also seen as an extension of customer loyalty.

Customer loyalty results from inertia, where the bond between the customer and the product is tied and indistinguishable, such that the user has no appetite to use or try alternative products. According to Wang *et al*. (2019), inertia is an attitudinal tendency where the user does not see the need to try available alternatives. In a non-competitive environment such as e-government, continuance use is a more applicable term and very important for IS success (Alanazi, 2013).

While the continuance use concept did not originate from the information systems discipline, the concept has been incorporated into the information systems field through models like the Expectation-Confirmation Model (ECM).

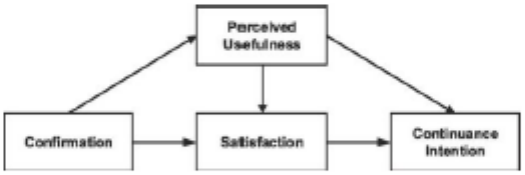

Figure 1: Expectation Confirmation Model (Ambalov, 2021)

In the ECM (see Figure 1), perceived usefulness relates to the first phase of the continuance intention. The critical part of the ECM is its confirmation aspect. In terms of confirmation, the user may have used the IS to be in a better position to determine whether the expectations are met or the extent to which they are met.

METHOD

This study followed a mixed-methods approach. The quantitative phase of this study was descriptive, whereas the qualitative phase further explained the descriptive results. This latter phase was used to overcome the shortcoming of the quantitative approach. For instance, quantification does not provide an explanation and/or understanding of the results beyond the visual presentation of numerical data (Leedy and Ormrod, 2021). A better understanding of behavioural patterns and establishing a deeper meaning of the phenomenon are achieved using a qualitative approach (Babbie, 2021).

Participants

The units of analysis for this study consisted of the existing users a mobile application and an online portal of a South African organization responsible for company, cooperative, and intellectual property registration, and maintenance. The inclusion criteria for this study were the following: participants should be at least 18 years old and must have used the organization mobile application and online portal within the past 12 months.

Procedure

Two data collection tools were used: a self-administered questionnaire and a semi-structured interview protocol. The questionnaire consisted of close-ended questions to obtain UX and continuance use data from the participants' viewpoint for the organization's mobile application and their online portal. It was administered online through the online survey hosting provider (questionpro.com) from 01 July to 27 August 2021. An e-mail invitation containing an introduction to and overview of the study, ethical clearance information, and the organization permission letters was sent to the potential participants requesting them to complete the online questionnaire. Two hundred and nine fully completed questionnaires were received, accounting for a 39% response rate.

The follow-up semi-structured interviews were conducted with 13 participants in October 2021 to solicit further explanation for a deeper understanding of participants' UX and continuance use opinions of the organization mobile application and its online portal. The follow-up interviews allowed the researchers to gain meaning and insight into the unanticipated results from the quantitative analysis (Morgan, 2014; Williamson and Johanson, 2018).

RESULTS

Mobile application and online portal user experience

The findings indicated that participants had a negative experience with the mobile application, including all UX sub-constructs: attractiveness, dependability, efficiency, perspicuity, stimulation, and novelty. In contrast, the participants had a positive experience with the online portal, encompassing its UX sub-constructs, except for novelty. The comparison in Table 1 established if the differences between the mobile application and online portal UX were statistically significant.

Table 1. Comparing mobile application and online portal user experiences

	$\bar{x}$	$\sigma\bar{x}$	t	df	p
Online portal UX - mobile application UX	.606	.103	5.896	208	.000
Online portal attractiveness – mobile application attractiveness	.638	.109	5.855	208	.000
Online portal efficiency - mobile application efficiency	.626	.110	5.689	208	.000
Online portal perspicuity - mobile application perspicuity	.595	.115	5.162	208	.000
Online portal dependability - mobile application dependability	.642	.101	6.365	208	.000
Online portal stimulation - mobile application stimulation	.587	.116	5.066	208	.000
Online portal novelty - mobile application novelty	.548	.108	5.070	208	.000

The results indicated statistically significant differences between the online portal and mobile application UX ($t(208)=5.896$, $p<.05$). This shows that the difference between the online portal and mobile application UX did not happen by chance. Furthermore, the results indicated statistically significant differences between the online portal and mobile application attractiveness ($t(208)=5.855$, $p<.05$), efficiency ($t(208)=5.689$, $p<.05$), perspicuity ($t(208)=5.162$, $p<.05$), dependability ($t(208)=6.365$, $p<.05$), stimulation ($t(208)=5.066$, $p<.05$), and novelty ($t(208)=5.070$, $p<.05$).

The interview responses corroborated these findings as the participants were mainly negative about their experience with the mobile application. They cited efficiency, errors, business process, limited functionality, and the lack of user-friendliness of the mobile application as the root causes of their negative experience. Examples of the errors experienced included the system timeout due to prolonged processing time, business process-related errors where the application did not proceed without the user providing the related information, or the application did not show progress or successful transaction completion.

The online portal's efficiency, user-friendliness, full features, and understandability featured prominently in their positive experience. In addition, when the system was under maintenance, the participants indicated that they received notices on time and thus were not surprised by the online portal downtime.

Mobile application and online portal continuance use

The composite mean score for the mobile application continuance intentions indicated that participants were less likely to use the mobile application in future than the online portal. In Table 2, the difference between the mobile application and online portal's continuance intentions was tested to determine whether the difference in mean scores was statistically significant.

Table 2. Comparing mobile application and online portal continuance intentions

	$\bar{x}$	$\sigma\bar{x}$	t	df	p
Online portal continuance intentions – Mobile application continuance intentions	.664	0.115	5.789	208	.000

The results indicated a statistically significant difference between the online portal and mobile application's continuance intentions ($t(208)=5.789$, $p<.05$). One may conclude that participants were more likely to continue using the online portal than the mobile application. The standard error of the mean score for the online portal and mobile application continuance intentions was less than the corresponding mean score, suggesting that the mean score was a reliable measure of the population mean in relation to continuance intentions.

From the interviews, the participants identified limited features, efficiency, errors, and business processes as the aspects that should be reconsidered for improving the mobile application. They also identified the features, fast processing, and easy navigational design as the online portals' aspects that exceeded their expectations. Most participants indicated their interest in using the online portal in the future. The main reasons cited were the online portal's stability, efficiency, and effectiveness.

DISCUSSION

Mobile application and online portal user experience

The organization mobile application and online portal comparison in terms of UX were measured using the UEQ. The findings on the UX of the mobile application and online portal revealed that participants had a more positive experience with the online portal than with the mobile application. No known study has compared the UX of a mobile application and its associated online portal. However, previous studies on website UX pinpointed the importance of hedonic qualities in website UX (Wani *et al.*, 2017). For instance, Ritonummi (2020) found in their study that the company's website was usable, yet the UX was poor due to design problems. In contrast, this study saw the organization's online portal scoring high in both cases (i.e., usability and UX), notwithstanding that the relationship between product UX and usability does not arise naturally *(Haaksma et al.*, 2018). In particular, the online portal scored positively for the hedonic and pragmatic qualities, namely attractiveness, novelty, stimulation, perspicuity, dependability, and efficiency, respectively. However, this finding is contrary to the findings of Merčun and Žumer (2017), who established that, in respect of UX, the pragmatic aspects of the product resonated more with the participants than the hedonic aspects. There was no evidence suggesting that the differences were attributed to to types of systems evaluated.

Unlike the mobile application, participants always had a positive experience with the online portal. The exception, however, was that some participants had a negative experience with the online portal, which later changed into a positive experience. The change to a positive experience arose from the fixed defects in the online portal that was problematic. The participants' experiences in terms of all the UX factors measured for the mobile application were negative in this study. In addition, the interview results corroborated these findings, as participants were mainly negative about their experience with the mobile application. Among the causes of these negative experiences were, to a larger extent, the mobile application's inefficiency, errors, limited functionality, and lack of user-

friendliness. To a lesser extent, participants had concerns about the business processes (e.g., communication between the organization and its customers).

However, similar studies on mobile application UX contradicted this study's findings. Instead, the users portrayed a positive experience with the mobile applications investigated (Davidavičienė *et al*., 2019; Wicahyono *et al*., 2019; Setiaji *et al*., 2020; Astuti *et al*., 2021). Setiaji *et al*. (2020), in their study of a secured mobile exam application, associated its UX solely with its quality. In addition, despite obtaining positive UX ratings, Wicahyono *et al*. (2020) identified novelty and efficiency as areas of improvement for the Pregnancy Monitoring Mobile Application.

Mobile application and online portal continuance use

The investigation of continuance intentions in this study involved comparing the organization online portal and mobile application, considering the participants' experience with these products. The findings on the mobile application and online portal's continuance intentions revealed that participants were more likely to consider using the online portal in future than the mobile application. This finding was supported by the interview results concerning the online portal. The prevailing reasons for future use of the online portal were its effectiveness, stability, efficiency, navigational ease and the availability of sufficient features, as opposed to the mobile application, which has limited features.

Various studies (Vatanasombut *et al*., 2008; Ambalov, 2021) have identified trust in technology as a precursor for continuance intentions on web-based applications. In addition, subjective norms, enjoyment, usefulness, and ease of use significantly impacted the continuance intentions for information systems (Almutairi *et al*., 2021). While other studies pin continuance intentions on user satisfaction (Franque *et al*., 2020; Almutairi *et al*., 2021), Zareravasan and Ashrafi (2019) established no correlation between satisfaction and continuance intentions for the future use of the learning management system. The latter resonates with this study's findings on online portal satisfaction. In addition, participants had misgivings about business processes (e.g., back-office communication and implemented business rules) as the hindrance to their positive UX with the online portal, which relates to their dissatisfaction with it.

Regarding the mobile application, the interview results somewhat contradicted the questionnaire findings, as participants indicated their willingness to use it in the future owing to its efficiency and effectiveness. However, the mobile application's limited features, errors, and efficiency appeared prominently as areas of improvement for the mobile application's future use. In contrast, Mubarokah and Hidayanto (2020) identified user satisfaction as a determining factor for continuance use intentions of the Internal Activity Report Application.

CONCLUSION

The primary objective of this study was to compare the user experience and continuance use of a mobile application and online portal in terms of user satisfaction and continuance intentions. This study gave insight into the mobile application and online portal user experience and continuance use from its users'

perspective. The findings showed that the participants had a more positive experience with the online portal than with the mobile application. Furthermore, the continuance use of the mobile application and online portal was somewhat linked to their experience with these products. Study participants were more likely to use the online portal in future, and not so for the mobile application. Therefore, this study gave insight into the fact that user experience and continuance use phenomena were applicable to mobile applications, as well as online portals (i.e., user experience and continuance use are as important for the mobile application as they are for the online portal). The UEQ has been used extensively to evaluate UX in previous studies. Its use, though, was mainly limited to individual products (i.e., mobile applications or online portals, with no comparison). The use of UEQ in comparing the mobile application and online portal confirmed its relevance in the comparison of mobile applications and online portals alike. This study further provided empirical evidence to extend the established importance of UX in products' continuance use through the comparison of a mobile application and an online portal. Practitioners may use the findings to re-examine the importance of developing products for user experience as part of product development, not as a standalone component irrespective whether it is for a mobile application or an online portal. The development of mobile applications, as compared to online portals, should take into account the pain points identified by the participants in relation to both usability and user experience, as continuance use hinges on these aspects.

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Appendix H: Language editing

Confirmation of Language Editing

3 July 2023

To whom it may concern,

CONFIRMATION OF LANGUAGE EDITING

In relation to the Thesis of Thobani Mhlongo, entitled:

DETERMINING THE USABILITY, USER EXPERIENCE, AND CONTINUANCE USE OF A MOBILE APPLICATION AND AN ONLINE PORTAL: A COMPARATIVE CASE STUDY

To be submitted in fulfilment of Master's Degree in Computer Science and Informatics at the University of the Free State, I, in my capacity as Language Practitioner, confirm that the abovementioned document has been edited with specific focus on the following:

- Language use and spelling (UK English)
- Coherence and linguistic flow
- Consistency of terminology

In relation to the above, Track Changes were used in MS Word to indicate changes, and comments were provided where deemed necessary. Please note that changes are made solely at the client's discretion and remain their own responsibility. Any comments provided are purely suggestions and reflect the best efforts and opinions of the Editor and not necessarily subject-specific expertise. It remains the responsibility of the client to confirm the content of their final submission.

For any questions, please feel free to contact me at guillaume.annam@gmail.com during normal business hours.

Kind regards,

A.M. Guillaume
LANGUAGE PRACTITIONER