# Designing a mobile application for the trading of used books at a university: A DSR approach

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**DECLARATION**

I, Isaac Senga Lupanda declare that

**Designing a mobile application for the trading of used books at a university: A DSR approach**

is my own work and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references and that this dissertation has not previously been submitted by me for a degree at any other university.

Signature: 

Date: 30 May 2018

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## ABSTRACT

With the widespread rapid development of computers and wireless communication, mobile computing is fast growing as the communication and sales platform of choice. This study portrays the development of an artefact to assist with the selling and buying of used books among students at a specific university. Design science research (DSR) is the methodology implemented in the study and it is utilised to aid in the comprehension, design and creation of the artefact. The chosen artefact is a mobile application.

The South African Human Sciences Research Council uncovered that numerous students enlisted at South African tertiary establishments were from extremely poor families (Letseka, Cosser, Breier, & Visser, 2010). Letseka *et al.* (2010) indicated that the Higher Education SA (HESA) confirmed that the dropout rate in South African universities had escalated to as much as 40%. Various sources indicate that expensive textbooks is one of the factors that contribute to students being unable to attend universities, also influencing movements such as the #FeesMustFall campaign (Nelson, 2014; Ackroyd, 2015; Mothibi, 2015; Krugel, Viljoen, Joubert, & Kirsten, 2016; Tsimong, 2016; Lethoba, 2017). Selling and buying used textbooks may alleviate financial stress experienced by students.

A large number of South African universities do not have an electronic platform to encourage the process of selling and buying used books among students. The students of a specific university sell and buy used books by means of paper-based posters on notice boards.

This study discusses existing literature on DSR, in addition to mobile applications and human-computer interaction (HCI). The literature review formulates the descriptive and prescriptive knowledge used in the creation of the artefact. The artefact was designed using a combination of the six activities of the DSR approach.

The explored literature provides an overview of mobile application and human-computer interaction principles in order to inform the design of the artefact. Mobile applications and HCI experts were interviewed as part of a requirements analysis to direct the initial design of the artefact. Suggestions were made to address the problem domain and the artefact's development.

The design of the artefact was further informed using mobile application design principles and HCI design principles. The artefact was developed through multiple design cycles into a mobile application prototype that can aid in the selling and purchasing of used books among students at a specific university.

A focus group was conducted in a semi-structured and open ended manner to evaluate the artefact prototype for usability. Participants were able to exchange ideas and freely express themselves. The focus group was held at the university for which the mobile application was developed. It consisted of participants who were students at the university, from different fields of study and different ages. As a result, participants were able to offer comprehensive individual answers.

The study is concluded by elucidating its findings from the feedback obtained, highlighting limitations and looking into future possibilities for research. The DSR methodology is found to be a problem-solving research paradigm, where the researcher is interested in obtaining new knowledge through artefact development. DSR is the process followed in this study to better understand the rigorous design process to create a mobile application.

The study is presented according to a design science research approach. The chapters are logically structured according to the phases of the DSR process model (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007).

**Keywords:** design science research, mobile applications and human-computer interaction.

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# CHAPTER 1: INTRODUCTION AND BACKGROUND

## 1.1 Introduction

Mobile applications have become ubiquitous in the existence of people around the world (Buller, Berwick, Lantz, Buller, Shane, Kane, & Liu, 2015:3). As an intrinsic part of the daily routine of individuals, mobile applications have changed human beings' attitude towards their lives and is observable in various areas of people's behaviour (Cardamone, Eboli, Forciniti, & Mazzulla, 2016:52). Further, Cardamone *et al.* (2016:52) present different areas affected by the changes brought by mobile applications technology including communication, the collection of information, the allocation of time and attention and potentially how learning takes place. Nonetheless, Buller *et al.* (2015:2) state that the ever growing mobile landscape produces new opportunities for mobile device users, including access to the internet from any location and the use of social media. Time management and remote access to databases have improved with mobile applications (Buller *et al.*, 2015:3)

In this study, the aim is to design a mobile application for the trading of used books at a University by using a design science research (DSR) approach. A mobile application, commonly known as an app, is an application software developed to operate on a mobile device, such as a tablet or a smartphone (Cueto-Manzano, Gallardo-Rincon, Martinez-Ramirez, Cortes-Sanabria, Rojas-Campos, Tapia-Conyer, Martinez, Cerrillos, Andrade, & Medina, 2015:119).

This study examines HCI (human-computer interaction) in a manner that will elucidate principles that could help in the creation of an effective mobile application. HCI is known for its multidisciplinarity which concentrates on the interaction between humans and computer systems, mobile devices and tablet computers. Perkins, Jordan, and Shepherd (1989:153) state that HCI investigates the design, the implementation and the evaluation of interfaces in the context of human beings interacting with the interface. A literature review of HCI, mobile applications, design science research, and also the development of an artefact in respect to the DSR paradigm will be conducted in this study. DSR is mainly the design and the assessment of an artefact created to answer an identified question by understanding the problem (Hevner, 2007:10).

The purpose of this chapter is to orientate the study. This is achieved by discussing the following sections: Section 1.1 presents a brief introduction of the research topic; Section 1.2 explores the aspects central to the study; Section 1.3 discusses the research problem and objectives of the study; Section 1.4 discusses the research methodology; Section 1.5 addresses participants and

the ethical considerations; Section 1.6 addresses the data analysis; Section 1.7 presents the layout of the study; and finally, the conclusion is presented in Section 1.8.

## 1.2 Aspects central to the study

This section explores the key concepts of the study, including HCI, mobile applications and DSR.

### 1.2.1 Human-computer interaction (HCI)

HCI practices are focused on designing interfaces that fulfil users' needs in their routine of everyday life, often known as user-centred design (Poole, 2013:403). HCI is the study of understanding how people interact with computers throughout their lives (Froese, Iizuka, & Ikegami, 2014:6). HCI is well known for its interdisciplinary area of research and practices, calling upon diverse disciplines such as sociology, human factors, information systems, computer science, psychology, and visual design (Poole, 2013:403).

An HCI approach gives insights into the usefulness, usability, and the capability of a computer interface to the satisfaction of users' needs (Perkins *et al.*, 1989:136). Also, HCI provides an explanation on pertinent preoccupations including understanding how technology works to engage a target audience in a given environment (Starren, Payne, & Kaufman, 2006). In short, HCI will offer complementary meaning into activities ranging from the design to the development and the evaluation of an application. Additionally, HCI provides a sense on the impact of computers and technology on society and people. HCI will provide insight on how to effectively design a useful, usable, and enjoyable computer interface.

A detailed discussion of HCI is explored in Chapter 4. The purpose of the literature review in Chapter 4 is to investigate HCI and its principles to inform the design of a mobile application for the trading of used books at a university.

### 1.2.2 Mobile applications

According to Langrial, Lehto, Oinas-Kukkonen, Harjumaa, and Karppinen (2012:3) mobile devices will eventually become the most valuable platform for changing the behaviour of people. Mobile devices have reversed the way people interact with technology and with one another (Buller *et al.*, 2015:9). Further, Buller *et al*. (2015:10) stated that mobile devices have emerged from single-purpose communication devices to an effective tool that provides their users with a wide range of functions such as accessing remote databases, tracking time and locations, and integrating users input while providing tailored health data. The mobile application support is provided through mobile application interfaces that are designed for an appropriate function and

downloaded, by way of an application store, onto the user's mobile devices (Buller *et al*., 2015:11). A mobile application, commonly known as an app, is a kind of application software developed to work on mobile devices, such as tablets and smartphones (Cueto-Manzano *et al.*, 2015:119). Mobile applications include internet applications that operate on smartphones and various mobile devices (Beal, 2017). Further, Beal (2017) stated that mobile apps may include mobile web site bookmarking utilities, a mobile-based instant messaging client, Gmail for mobile, and many other applications. White (2013:8) stated that mobile applications are categorised into three types which are: native applications, non-native applications or browser applications, and lastly hybrid applications.

Mobile applications will be discussed in more detail in Chapter 3 to ascertain which type of mobile application will be a suitable choice for the trading of used books at a university.

### 1.2.3 Design science research (DSR)

Hevner and Chatterjee (2010:3) stated that DSR is research that develops inexistent and innovative knowledge using designing, analysing, examining, and abstraction. This is to say, DSR is the know-how knowledge for developing artefacts to fulfil a number of functional requirements. Similarly, Hevner, March, Park, and Ram (2004:77) declared that DSR is research that aims to extend the boundaries of people and organisation capabilities by developing non-existing and innovative artefacts. In addition, Hevner *et al.* (2004:82) stated that in the design science research methodology, awareness and understanding of a phenomena domain is reached in the design of the artefact.

According to Vaishnavi and Kuechler (2004:30), DSR also analyses the performance of a designed artefact with the aim of understanding and improving the artefact. Hevner and Chatterjee (2010:6) stated that the priority of DSR is to create and evaluate an artefact in order to acquire the solution to the identified organisational problem by understanding it. Quantitative and qualitative empirical methods are used for the evaluation of these artefacts (Hevner *et al.,* 2004:84).

Various approaches are provided to direct researchers in conducting DSR. However, the design science research methodology approach suggested by Peffers *et al.* (2007:54) provides a process model of DSR which is composed of six activities. Figure 1.1illustrates the six phases of the design science research process (DSRP) model adapted from Peffers *et al.* (2007:54).

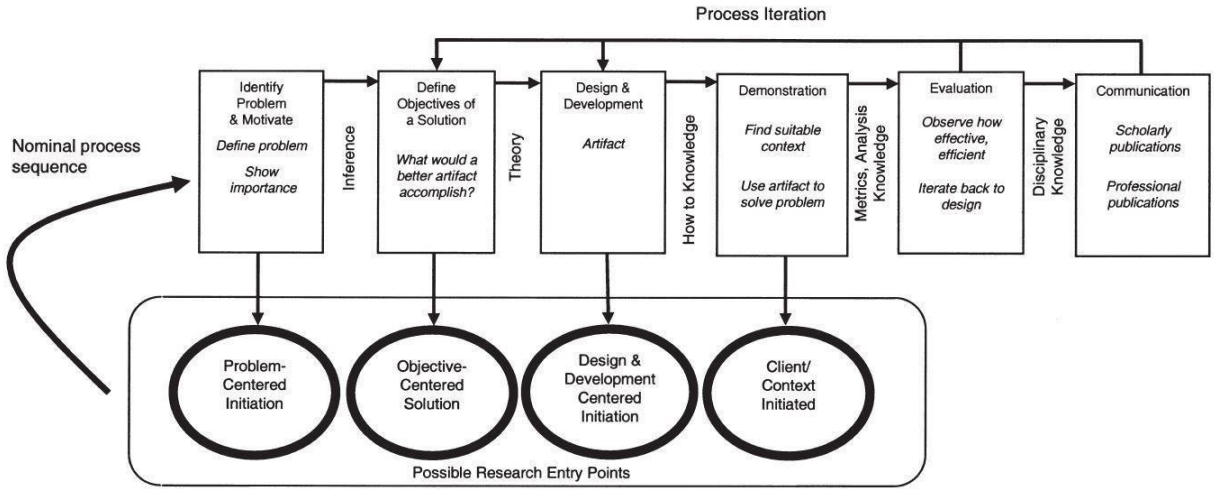


**Figure 1-1:** Design science research process model (Peffers *et al.*, 2007:11)

The DSR process model proposed by Peffers *et al*. (2007:54) will be used as a research approach in this study. Design science research will be discussed in detail in Chapter 2.

## 1.3 Research problem and objectives

The following section discusses the research problem of this study.

### 1.3.1 Research problem

The South African Human Sciences Research Council uncovered that numerous students enlisted at South African tertiary establishments were from extremely poor families (Letseka *et al.*, 2010). Letseka *et al.* (2010) indicated that the Higher Education SA (HESA) confirmed that the dropout rate in South African universities had escalated to as much as 40%. Various sources indicate that expensive textbooks is one of the factors that contribute to students being unable to attend universities, also influencing movements such as the #FeesMustFall campaign (Nelson, 2014; Ackroyd, 2015; Mothibi, 2015; Krugel *et al.*, 2016; Tsimong, 2016; Lethoba, 2017).

Purchasing used books may allow students to save on university expenses. Students do trade books via posters or advertisements. The problem, however, is that a large number of South African universities do not have an electronic platform to encourage the process of selling and buying used books among students. An electronic platform for this process may encourage faster trading, by providing a platform that is easily accessible, a database of available textbooks at a fraction of the cost and a medium through which any unwanted books can be traded.

The students of a specific university sell and buy used books by means of paper-based posters on notice boards. Figure 1.2 shows an image of students at a specific university at a notice board in a quest for less expensive books.

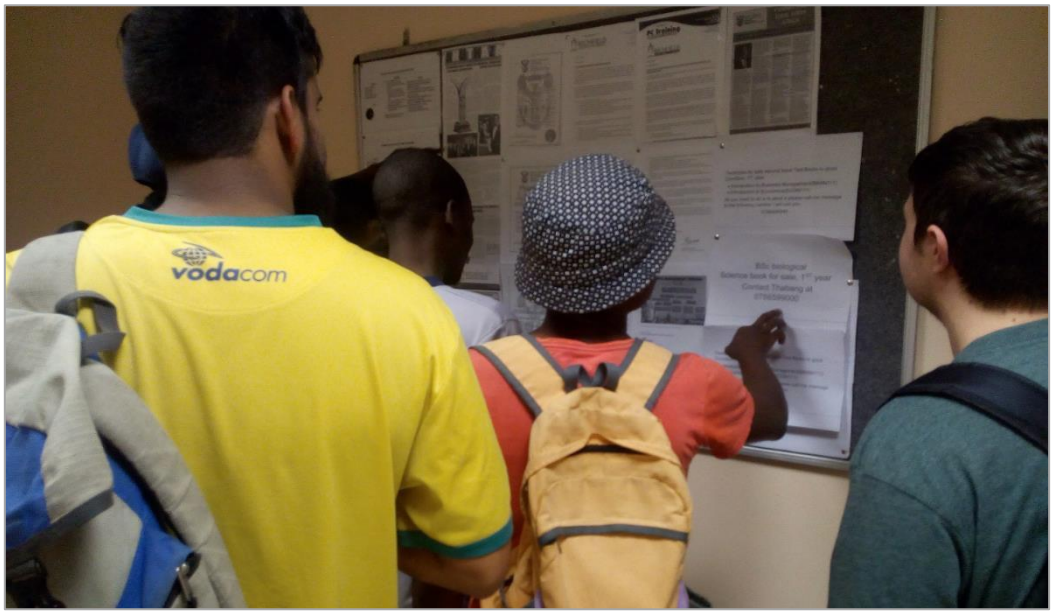


**Figure 1-2: Image of students in a quest for less expensive books.**

Students also create selling points on campus during the first few weeks of the academic year where used books are sold on the lawns of the university. Figure 1.3 depicts a selling point of used books at a specific university during the 2017 registration process. However, students are discouraged from selling books in this manner.

In order to protect the specific university against any liability (due to agreements with a bookstore on its campus), the name of the institute will remain anonymous in the study. The institution in question will be referred to as “the specific university” or “the university”.

There is a need for an electronic platform that will ease the process of purchasing and selling used books at the specific university. It can be suggested that creating a mobile application towards this end could be a suitable artefact for the problem.

The following research questions are formulated for this study:

- How can a mobile application be designed and developed to aid in the trading of used books at a university?

- Which literature on design processes need to be reviewed for the creation of a mobile application artefact that will aid in the trading of used books at a university?
- How can the research study be presented according to a design science research approach?

**Figure 1-3: Image of students selling used books on the lawns of a specific university.**

### 1.3.2 Objectives of the study

The following objectives have been formulated to support the research problem for this study. These objectives serve as a point of departure for the study. The objectives given here are further elaborated on in Chapter 2 Section 2.7, where they are expanded upon and structured according to the phases of a DSR approach.

#### 1.3.2.1 Primary objective

The primary objective of this study is to design a mobile application for the trading of used books at a university by following a design science research (DSR) approach.

#### 1.3.2.2 Theoretical objectives

To achieve the primary objective, a number of theoretical objectives are proposed for the study, including:

- To achieve an understanding of design science research.

- To achieve an understanding of human-computer interaction and its principles.
- To achieve an understanding of mobile applications and its design principles.
- To form a conceptual link between appropriate mobile application principles and HCI principles.
- To present the study according to a design science research approach.

#### 1.3.2.3 Empirical objectives

In accordance with the primary objective of this study, the following empirical objectives were formed:

- To perform a requirements analysis for development of a mobile application.
- To develop a mobile application for the trading of used books following a DSR approach.
- To do usability testing on the artefact in order to make recommendations for the improvement of the artefact.

## 1.4 Research methodology

Kothari (2004:27) defines research methodology as a systematic method of solving a research problem. Further, research methodology is perceived as a branch of knowledge that scientifically analyses how to conduct research through processes (Kothari, 2004:28). According to Vaishnavi and Kuechler (2004:10) the development of an artefact falls within the DSR paradigm.

As previously discussed in Section 1.2.3, design science research will be used to guide the research process of this study. The DSR approach of Peffers *et al.* (2007:11) will be used to formulate a structure for the study. Figure 1.2 presents this design science research process model and the activities that will orientate the research. DSR and its application will be explored in greater detail in Chapter 2.

## 1.5 Participants and ethical considerations

The next sections discuss the participants of the study and also explain the ethical considerations.

### 1.5.1 Participants

As part of a requirements analysis for the mobile application the participants consisted of subject matter experts. These participants included staff of the specific university that are experts in the fields of HCI, mobile applications and design science research. Subject matter experts were

subjected to a semi-structured interview. The data was used to determine which requirements are important for the design of the initial prototype.

As part of the usability testing of the artefact a focus group was conducted with students at the university as they will be the target audience of the application. The data will be used to make recommendations for improvements in the design of the artefact.

Saturation of information for the initial requirements analysis of the proposed artefact was achieved after four interviews with subject matter experts. One focus group consisting of 6 students was conducted as part of the usability testing of the artefact prototype. The interviews and focus group delivered interpretive qualitative data.

### 1.5.2 Ethical considerations

Sales and Folkman (2000) stated that preserving the privacy of individuals and their right to confidentiality is a major concern for every research project. Again, Sales and Folkman (2000) describe idiosyncrasy as the main reason for multiple privacy issues to the research participants. Smith (2003:56) identifies five ethical rules that a researcher should consider when conducting a study, including:

- Discussing the intellectual property frankly.
- Becoming conscious of multiple roles.
- Following informed consent rules.
- Respecting confidentiality and privacy, and tapping into ethics resources.

Researchers are faced with an array of ethical expectations, such as meeting professional, institutional and regional standards for conducting research with human participants (Smith, 2003:57). Therefore, a number of ethical principles was adopted for this study. These principles adhere to the recommendation and requirements of the International Development Research Centre (Smith, 2003:57). The ethical considerations for this study were:

- The participants were informed of the methods, objective, and anticipated benefits of the research,
- Participants had the right not to participate or be part of the research, and to terminate their participation in the study at any point in time for whatever reason,
- Ensuring the confidentiality of participants,
- Acquiring permission to use participant feedback.

As this study follows a DSR approach with artefact creation it is important to include ethical considerations for DSR. A proposed set of ethical principles for design science research considered in this study are (Myers & Venable, 2014:806):

- The public interest: All stakeholders who may be affected by the artefact's development should explicitly be identified.
- Informed consent: All people involved in the research should receive a consent form. Concerning this study all participants (interviews and focus group) were issued with a consent form (refer to Appendix C & Appendix D).
- Privacy: The researcher should ensure that there are adequate measures in place to protect privacy of all stakeholders.
- Honesty and accuracy: No plagiarised idea should be allowed in a DSR study but researchers should acknowledge inspiration from other sources. Furthermore, research findings should be reported honestly pertaining to newly created artefacts.
- Property: Ownership of the intellectual property of all research information should be agreed upon at the beginning of the project.
- Quality of the artefact: The quality of the artefact should be the researcher's priority. The artefact should be sufficiently and rigorous tested to ensure safety.

Other ethical considerations of the tertiary institution where the research took place, were:

- To review and submit the form for ethical clearance at a specific university,
- To obtain approval from the ethics committee at the university to collect data from participants (Appendix B – ethical clearance number ECONIT-2017-071),
- To complete the code of conduct for researchers (Appendix A).

### 1.6 Data analysis

Kothari (2004:34) describes an interview as a method of data collection where an interviewer can ask questions to one person individually or to a group of people, in a structured or unstructured manner. Further, Kothari (2004:34) describe a focus group as a group of interacting people possessing common interest, guided by a moderator in order to collect data on a specific topic. Moreover, Lazar, Feng, and Hochheiser (2010b:193) confirm that a semi-structured or unstructured interview is used in focus group for data collection. According to Dilshad and Latif (2013:195), a focus group provides a more engaging environment where interviewees inform the thought processes of one another. This study made use of individual interviews and a focus group for data collection.

According to DeCuir-Gunby, Marshall, and McCulloch (2011:2), to make sense of interviews, researchers must engage in the process of coding data. Mayring (2010) states that information gathered from the interviews will subjectively be examined using interpretive content analysis. Miles and Huberman (1994:57) stated that the purpose of qualitative data analysis is to recognise basic subjects, which are basic examples, themes or regularities which may show through the procedure of data coding. Additionally, Miles and Huberman (1994:56) declared that data coding involves marking sections of the interpretations to sort out these sections to allow themes and conclusion emerging from the organised themes. Corbin and Strauss (2008) identified two significant levels of coding which are open coding and axial coding. Concerning this study, an open coding approach for data analysis was used. An adapted model of developing a code book according to DeCuir-Gunby *et al.* (2011:7) is presented in Figure 1.4.

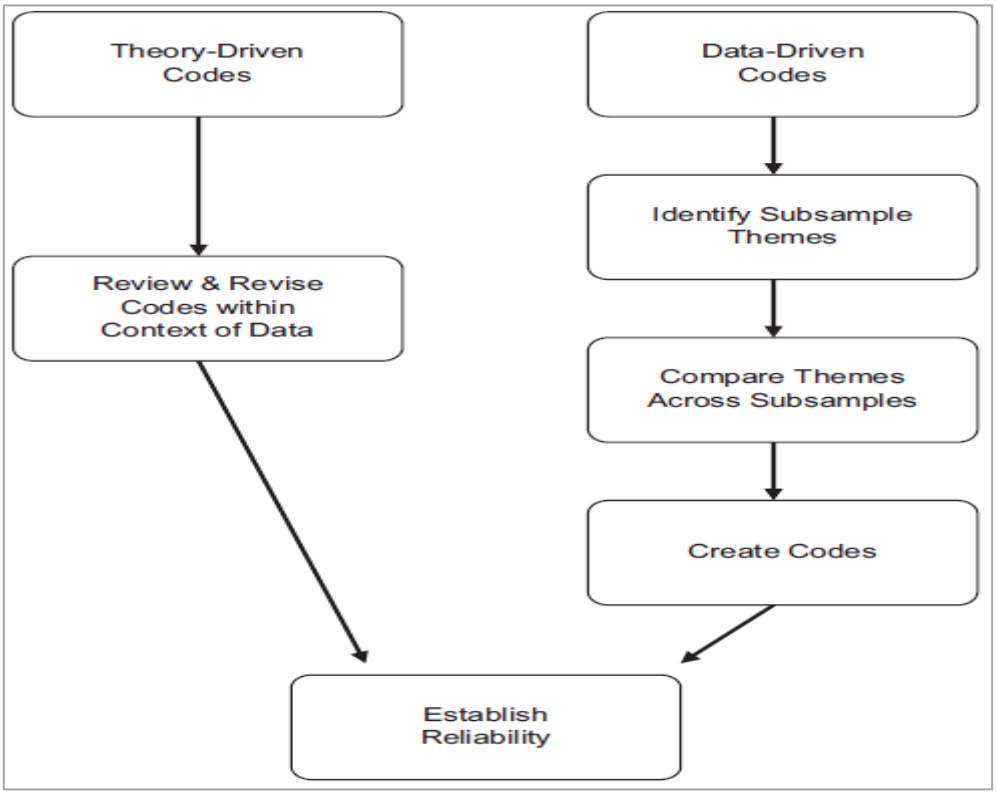


**Figure 1-4: Steps for developing a codebook (DeCuir-Gunby *et al.*, 2011:7).**

Straus and Corbin (1990:2) defined coding as the analytical processes whereby data are fractured, conceptualised and combined to form a theory. Further, Straus and Corbin (1990:12) identified procedures that will assist to standardise the coding process. Straus and Corbin (1990:12) coding procedures are presented in Table1.1.

**Table 1-1: Coding procedures adapted from Straus and Corbin (1990:12).**

| Coding procedures |
|---|
| 1. Building rather than testing theory.<br>2. Providing researchers with analytic tools for handling masses of raw data.<br>3. Helping analyst to consider alternative meanings of phenomena.<br>4. Being systematic and creative simultaneously.<br>*5.* Identifying, developing and relating the concepts that are the building blocks of the theory. |

The data analysis methods are discussed in greater detail in Chapter 2. The next section presents the layout of this study.

## 1.7 Layout of the study

The study consisted of the following chapters that were structured according to the design science research process model proposed by Peffers *et al.* (2007:11) in Table 1.2.

**Table 1-2: Chapter classification.**

| Activities in the DSRP model | Chapter headings | Chapter content |
|---|---|---|
| Problem identification and motivation | Chapter 1: Introduction and background | The context and scope, as well as the problem statement and research objectives of the study is introduced. |
| Objectives of a solution | Chapter 2: Research methodology | This chapter reviews the design science research paradigm. The chapter describes in detail the manner in which a DSR approach is followed in this study. |
| | Chapter 3: Mobile applications | This chapter reviews the background and characteristics of different concepts of mobile applications that may be relevant to this study. The chapter produces a table with applicable design principles for mobile applications. |
| | Chapter 4: Human-computer interaction | This chapter reviews the background and characteristics of the various concepts of human-computer interaction that are relevant to the study. The chapter produces an enriched table that includes both applicable design principles for mobile |

| | | |
|---|---|---|
| | | applications, as well as appropriate HCI principles for mobile application design. |
| | Chapter 5: Requirements analysis | This chapter presents and analyses the data obtained from interviews with subject matter experts. The feedback is used as part of a requirements analysis for the artefact design. |
| Design and development | Chapter 6: Design, development and demonstration | This chapter depicts the design and development process of the mobile application artefact, based on the literature reviews conducted and the feedback obtained during the requirements analysis. |
| Demonstration | | |
| Evaluation | Chapter 7: Usability testing | This chapter presents and analyses the data obtained from a focus group with students at the specific university. The feedback is used to make recommendations for the improvement of the design of the artefact. |
| Communication | Chapter 8: Discussion and conclusion | This chapter provides a summary of the study by communicating new knowledge created from the DSR research process, limitations of the study and possibilities or opportunities for future research. |

## 1.8 Conclusion

The purpose of this chapter was to orientate the study. This chapter included the motivation for the study, elucidating the aspects that are central to this study, describing the research objectives, and finally providing a chapter classification. A primary objective, as well as theoretical and empirical objectives, have been formulated to assist the research process.

The students of the chosen university sell and buy used books by means of paper- based methods on notice boards. The research problem will be addressed by designing a mobile application which could aid the process of purchasing and selling used books at the specific university.

Figure 1.6 provides an adaptation of the design science research process to represent the research structure of this study.

The next chapter discusses the research methodology, with a specific focus on design science research which informs the approach of this study.

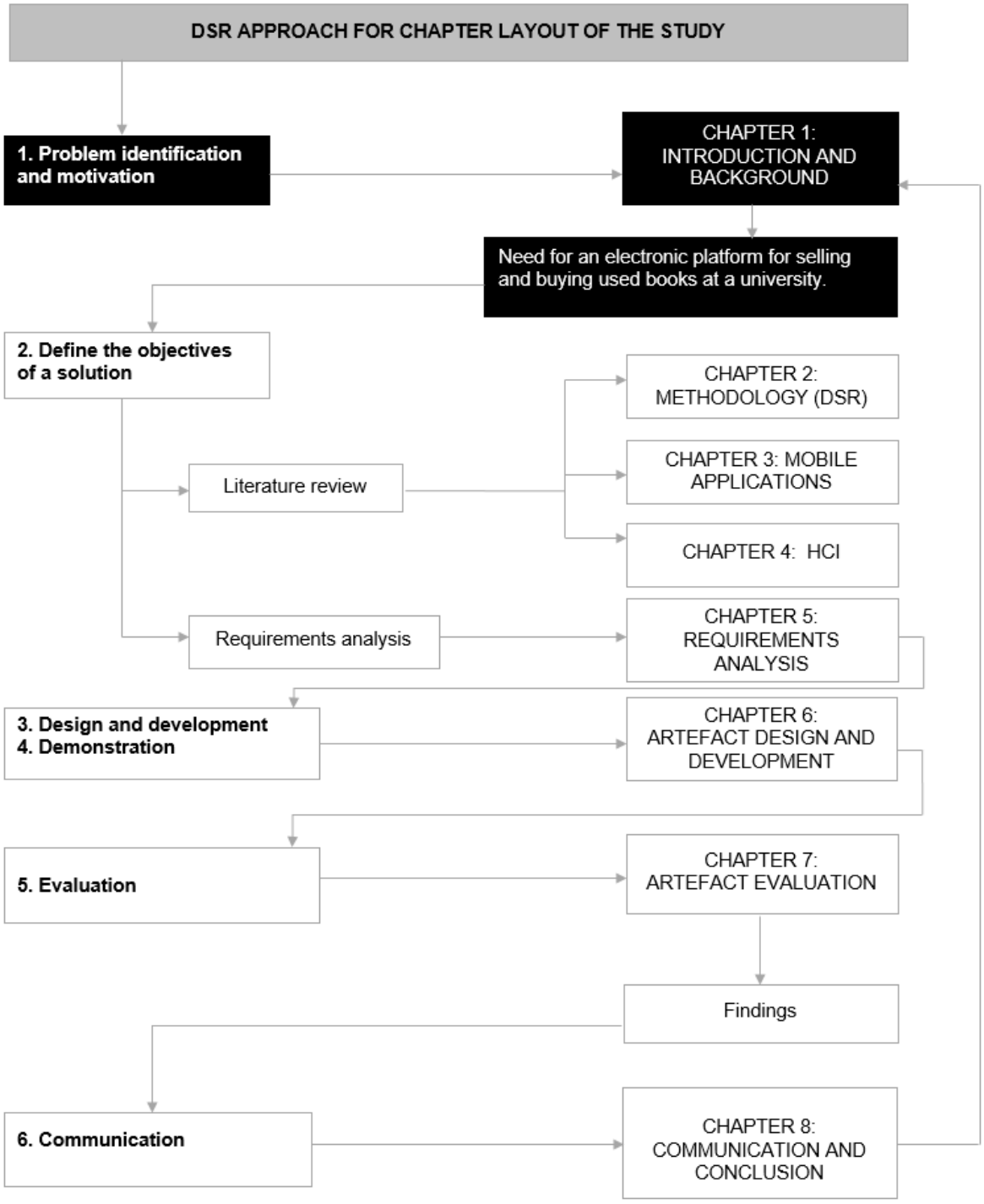


**Figure 1-5: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

# CHAPTER 2: RESEARCH METHODOLOGY

## 2.1 Introduction

The goal of this study is to design a mobile application for the trading of used books at a university by following a design science research approach. A discussion of literature on research methodologies is required in order to achieve the goal of this chapter.

In 1937, Woody (1937:150) stated that a research study should include the following:

- Characterisation and reclassification of issues
- Specification of theory or proposed arrangements
- Collecting, organising and evaluating data
- Making deductions and reaching conclusions
- And lastly, carefully testing the conclusions to determine whether they fit the formulating hypothesis.

Research objectives fall into one of the following general groupings according to Kothari (2004:19) and is supported by Balasubramani (2015:8):

- To accomplish a new understanding and gain familiarity of phenomena or to create new bits of knowledge based on the phenomena (research studies falling within this category are known as formulate or exploratory research).
- To precisely depict the qualities and characteristics of a specific individual, circumstance or a group (research studies falling within this category are known as descriptive research).
- To determine the recurrence with which something happens or with which it is connected to (research studies located within this category are known as diagnostic research).
- To examine a hypothesis of causal relationships among variables (research studies falling within this category are known as hypothesis-testing research).

Oates (2006:16) gives reasons for conducting research as:

- Adding new information to the body of knowledge
- Solving a specific problem
- Determining the outcomes after completing the research
- Finding evidence to inform practice
- Creating a greater understanding of people and their world

- Predicting, planning and controlling phenomena
- Contributing to the well-being of others
- Contributing to personal needs
- Testing or disproving theories
- Suggesting better ways of approaching phenomena
- Understanding other point of views

This study aims to accomplish a new understanding and familiarity surrounding the phenomena of buying and selling used books at a university using a mobile application. This research is an exploratory study and the personal motivation for conducting the research was to solve a problem by suggesting a better way to approach the phenomena.

Knowledge contribution in research is of great importance due to various reasons, including achieving the study objectives and also for the publication of research (Straub, Ang, & Evaristo, 1994:23). Furthermore, Saunders, Lewis, and Thornhill (2009:5) stated that research should have an apparent goal in order to come up with new knowledge on the investigated phenomena using systematic data compilation and a detailed interpretation of the collected information.

Checkland and Holwell (1998:13) described the three crucial constituents of any piece of research, the area of concern (A), the framework of ideas (F) and the methodology (M), as:

- The area of concern (A): represents a distinctive dilemma in a discipline or area of study, a real-world phenomenon situation, or a system of benefit.
- Framework of ideas (F): is considered as particular link where the knowledge about the area of concern is explained. The framework of ideas includes the existent theories, the collection of knowledge, heuristics, as well as implied knowledge.
- The methodology (M): represents a container that embodies the framework (F) by incorporating tools, techniques and methods in a particular way to the area of study that uses them to explore the area of concern.

Figure 2.1 illustrates the fundamental constituents for portraying any fragment of research according to Checkland and Holwell (1998:13).

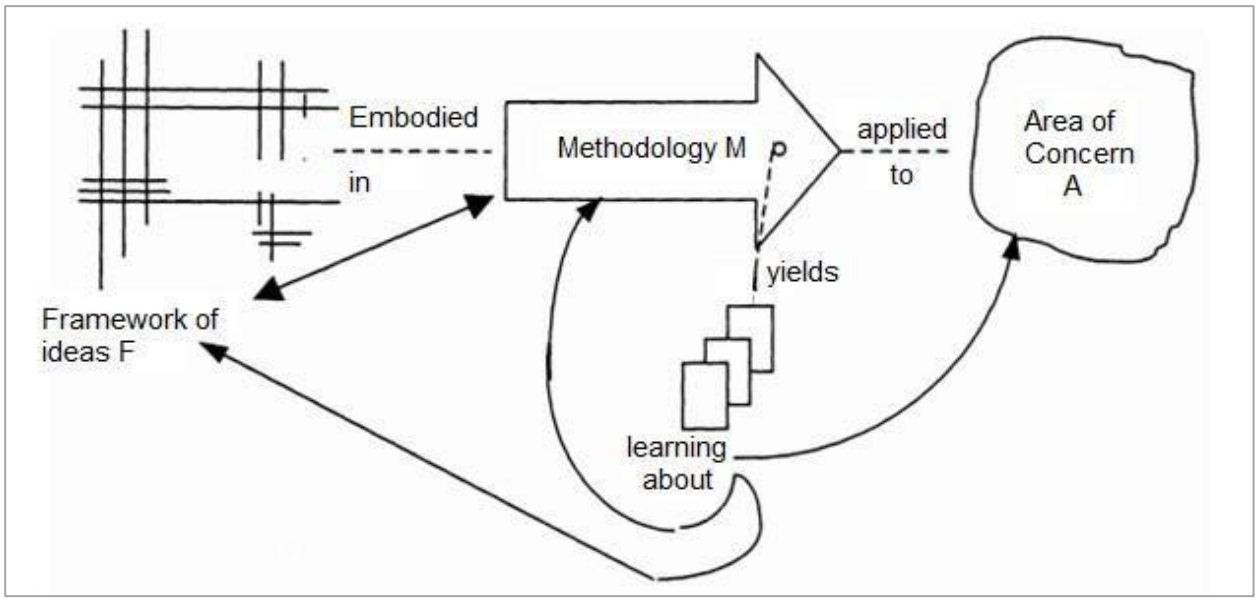


**Figure 2-1: Relevant elements to any research (Checkland & Holwell, 1998:13).**

Figure 2.2 portrays the elements of the study based on the three elements of a research study according to Checkland and Holwell (1998:13).

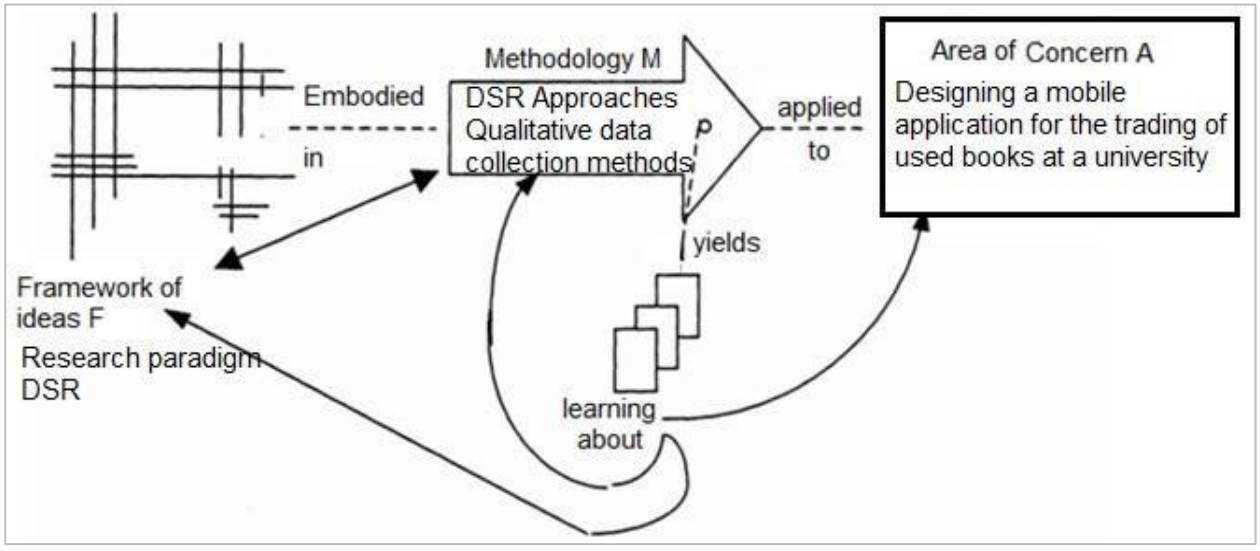


**Figure 2-2: Relevant elements of the study**

The design science research paradigm informs the framework of ideas of the study, which is embodied in the methodology of DSR approaches, applied to the area of concern which is to design a mobile application for the trading of used books at a university. The process yields new knowledge and informs an understanding relevant to each element.

This chapter is divided into the following sections: Section 2.2 discusses the ontological, epistemological, methodological, and axiological assumptions of available research paradigms; Section 2.3 reviews the methodological guidelines of the selected paradigm in order to explore guidelines that will direct the research process of this study. Section 2.4 positions the study; while Section 2.5 investigates the practical application of the approaches relevant to the research paradigm. Data collection techniques and analysis are discussed in Section 2.6. An overview of the research process of this study is elaborated on in Section 2.7; and finally, a conclusion of the chapter is drawn in Section 2.8.

## 2.2 Research philosophy

Saunders (2011:139) stated that a research philosophy relates to the development of knowledge and the nature of that knowledge. Research philosophy is a worldview that orientates the researcher to conduct a study through personal perception, beliefs and apprehension of various theories and practices (Cohen, Manion, & Morrison, 2000; Morgan, Gliner, Jorgenson, & Leyde, 2000:17). The research philosophy adopted in this study was influenced by practical considerations and assumptions made by the researcher. It reflects the way the researcher views the world (Saunders, 2011). Three philosophical assumptions are described by Blanche, Durrheim, and Painter (2006:6), namely, ontological, epistemological and methodological assumptions. Axiological is a fourth type of philosophical assumption discussed by Vaishnavi and Kuechler (2004).

Ontological assumptions are concerned with the nature of reality (Saunders, 2011:141). This raises questions of the assumptions researchers have about the way the world operates and the commitment held to particular views. Saunders (2011:141) describes the two aspects of ontology which are objectivism and subjectivism, as:

- Objectivism: understanding how social entities exist independently of social actors.
- Subjectivism: making sense of meanings that people attach to social phenomena.

Epistemological assumptions are concerned with what knowledge is acceptable in a particular field of study (Saunders, 2011:142). Saunders (2011:143) describes three aspects of epistemology which are positivism, realism, and interpretivism:

- Positivism: operating with an observable social reality and that the final result of such study obtains legitimacy from the reality of having been sanctioned by authority or of obtaining consistently from existing choices, instead of from any ethical considerations (Cooper, Schindler, & Sun, 2006).

- Realism: stipulates that what people see is what people get. The world accuracy is portrayed using human senses experience (McMurray, Scott, & Pace, 2004).
- Interpretivism: state about the importance for researchers to understand differences between humans in their roles as social actors (Goldkuhl, 2012:136).

Methodological assumptions advocate on understanding of various processes that researchers use to obtain new knowledge within a field of study and will be further explored in this chapter.

Axiological assumptions investigate roles played by human values in the selection of a research topic. In other words axiology is described as a study that examines judgements about value.

Research paradigms and philosophical assumptions are discussed in the coming section in order to position this study.

## 2.3 Research paradigms

Blanche *et al.* (2006:6) identified three classical types of research paradigms, namely, positivism, interpretivism and constructionism. Adebesin, Kotzé, and Gelderblom (2011:311) named the constructionist research worldview on occasion as critical social research. Vaishnavi and Kuechler (2004) describe design science research (DSR) as the fourth research paradigm which changes the state of the world through the development of an artefact. Table 2.1 presents a summary of the principal features and philosophical assumptions of the interpretive, positivist, critical social research and design research paradigms.

**Table 2-1: Philosophical assumptions of four research paradigms (Adebesin *et al.*, 2011:5).**

| **Philosophical assumptions** | | | | |
|---|---|---|---|---|
| **Research paradigms** | **Ontology** | **Epistemology** | **Methodology** | **Axiology** |
| **Positivist** | • Single, stable reality<br>• Law-like | • Objective<br>• Detached observer | • Experimental<br>• Quantitative<br>• Hypothesis testing | • Truth<br>• Prediction |

| | | | | |
|---|---|---|---|---|
| **Interpretive** | • Multiple realities<br>• Socially constructed | • Empathetic<br>• Observer subjectivity | • Interactional<br>• Interpretation<br>• Qualitative | • Contextual understanding |
| **Constructionist /Critical social theory** | • Socially constructed reality<br>• Discourse<br>• Power | • Suspicious<br>• Political<br>• Observer constructing<br>• Versions | • Deconstruction<br>• Textual analysis<br>• Discourse analysis | • Inquiry is value-bound<br>• Contextual understanding<br>• Researcher's values affect the study |
| **Design science research** | • Multiple, contextually situated realities | • Knowing through making<br>• Context-based construction | • Developmental<br>• Impact analysis of artefact on composite system | • Control<br>• Creation<br>• Understanding |

### 2.3.1 Positivism

Positivism is often associated with Auguste Comte (1798-1857) but is found in earlier writings of Francis Bacon (1561-1626) (Crotty, 1998:19). Noor (2008:1) defined positivism as an approach that develops knowledge through research that uses the model of natural science. Positivism asserts that all authentic knowledge assumes that the only valid knowledge is scientific and that all legitimate knowledge allows verification (Comte, 1975; Larrain, 1979:197). In essence, an objectively observable reality is chosen by the researcher to be worked with. Positivistic thinkers take on scientific methods and systematise the knowledge development process through quantification to accurately enhance the illustration of variables and connection among them (Thomas, 2010:294). Positivistic thinkers focus on experimental and quantitative methods to collect broader data outside of readily measured variables (Gephart, 1999). Saunders (2011:129) declared that quantitative data are mostly used by positivistic thinkers in their studies.

### 2.3.2 Interpretivism

Crotty (1998:67) indicates that interpretivism is associated with Max Weber's (1864-1920) description that the human sciences are concerned with *understanding*. Furthermore Wilhelm Dilthey (1833-1911) added to the argument that natural and social reality require different methods of investigation to inform the process of understanding (Crotty, 1998:67). Interpretivists posit that it is vital to comprehend the distinctions in people's parts as social performing artists (Saunders, 2011:116). Gephart (1999) argues that interpretivist thinkers perceive that knowledge

and meanings are outcomes of interpretation, thus the non-existence of an objective knowledge which is not a result of thinking or reasoning. Additionally Parsons (2010) asserts that the approach to interpretivism is mainly employed by social science researchers, opposite to positivism, where the paradigm is mostly used by natural scientists. In essence, interpretivist thinkers go extra miles towards meaning (Noor, 2008:1). The emphasis is placed on conducting research among humans, instead of conducting research on objects such as trucks and computers (Saunders, 2011:111). Further, Saunders (2011:116) stated that qualitative data are frequently used in interpretive studies.

### 2.3.3 Constructionist/ Critical Social Theory

Constructionism is associated with critical theory (Crotty, 1998:140). Constructionists or basic social analysts state that the truth is socially developed and it's affected by the societal standards (Myers, 1997a:5). Essentially, the researcher is not isolated from the subjects of study; in this manner the elucidation of an event is impacted by a researcher's personal, social and historical experience (Mohrhoff, 2008). The constructionist routinely addresses the process of communication between people (Creswell, Plano Clark, Gutmann, & Hanson, 2003:9). The methodology often employed by IS constructionists is known as action research (AR). Rapoport (1970:449) states that AR aims to contribute both to the practical preoccupations of individuals in a prompt hazardous circumstance and to the objectives of social science by mutual cooperation inside a commonly satisfactory moral system.

### 2.3.4 Design science research

Weber (2010:3) contends that DSR has its roots in the architecture and the engineering disciplines. Design science is often associated with the work of Herbert Simon (Simon, 1996). Design is associated with the development of items that serve human purposes and thereby creates utility for the shareholders (Simon, 1969; March & Smith, 1995). Vaishnavi and Kuechler (2004) consider DSR as the fourth research paradigm and state that DSR transforms the condition of the universe through the presentation of novel artefacts. Gregor and Hevner (2013:337) stated that DSR has shown an expanding acknowledgment as a genuine approach for Information Systems (IS) studies. Baskerville (2008:442) expressed that design science is not action research and confirms that AR is plainly focused on revelation through action, while DSR is unmistakably fixated on disclosure through artefact development. DSR concentrates on the development of artefacts while AR is focused on the human interaction that wards the artefacts (Baskerville, 2008:442).

## 2.4 Positioning the study

The selection of a paradigm for this study assisted the researcher to choose an appropriate method for conducting this research. The value of the artefact is acknowledged to be important to this study, and therefore the paradigm opted for this research is design science research (DSR). The supervising, designing and understanding of the developed artefact are crucial. According to Gregor and Hevner (2013:342), DSR is the utilisation of an appropriate artefact to address a specific business problem; this key distinguishing feature supports the DSR placement in information systems research.

The goal of this study was to design a mobile application for the trading of used books at a university. As the research revolves around the creation of an artefact, the methods of DSR was used to inform the research process.

## 2.5 Design science research

Hevner and Chatterjee (2010:3) stated that design science research develops absent and innovative knowledge using designing, analysing, examining, and abstraction. This is to say, DSR is the know-how knowledge for developing artefacts to fulfil a number of functional requirements. Similarly, Hevner *et al.* (2004:77) declared that DSR is research that aims to extend the boundaries of people and organisation capabilities by developing non-existing and innovative artefacts. In addition, Hevner *et al.* (2004:82) stated that in the design science research methodology, awareness and understanding of a phenomena domain is obtained through the design of the artefact.

According to Vaishnavi and Kuechler (2004:30), DSR also analyses the designed artefact's performance with the aim of understanding and improving the artefact. Hevner and Chatterjee (2010:6) state that a DSR study's main goal is to create and evaluate an artefact in order to acquire the solution to the identified organisational problem by understanding it. Quantitative and qualitative empirical methods are used for the evaluation of these artefacts (Hevner *et al.*, 2004:84).

Hevner (2007:2) identifies three existing design science research cycles including: the relevance cycle, the rigour cycle and lastly the design cycle. Figure 2.3 presents the three design science research cycles.

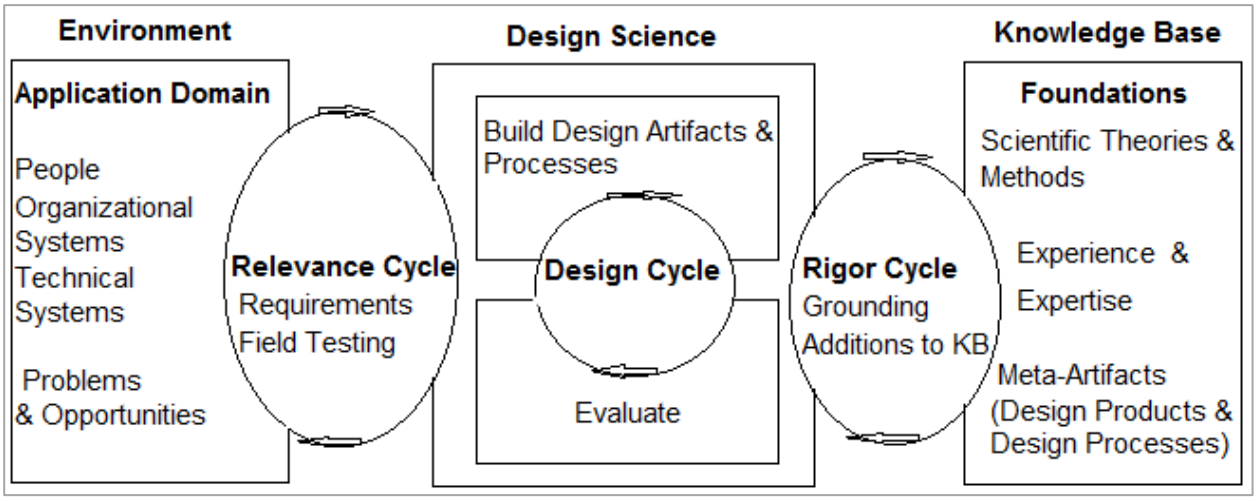


**Figure 2-3: Design science research cycles (Hevner, 2007:2).**

Hevner (2007:2) describes each cycle as follow:

- The relevance cycle: the logical environment of the research project spans with the design science activities.
- The rigor cycle: the connection of design science activities with the information base of logical establishments, experience, and aptitude that illuminates the research project.
- The central design cycle: iteration at intervals of the main activities of designing and evaluating the artefacts and activities of the research.

An overview of DSR is presented in the sections that follow, including: the concepts central to DSR; the process of DSR; different DSR approaches; and the available guidelines for practicing and evaluating DSR.

### 2.5.1 Concepts central to design science research

The role of knowledge and the knowledge innovation matrix (KIM) are the two concepts central to DSR. The following sections briefly explain the concepts central to DSR.

#### 2.5.1.1 Design science research knowledge

Design science research knowledge makes available the necessary materials for evaluating and constructing an artefact (Weber, 2010:3). Again, Hevner *et al.* (2004:9) confirmed that design science research knowledge is composed of research methodology and theoretical foundations. Moreover, the design science knowledge uses various techniques to represent IT problems to facilitate the discovery of efficient and effective solutions to the identified IT problems (Hevner *et*

*al.*, 2004:9). Hevner *et al.* (2004:17) name various techniques used by DSR knowledge to represent IT problems such as simulation, analytical modeling, grammars, set-theoretic and formal logic, and architectural representations. These techniques provide rigour in design science research, and also provide assistance in the recognition of "rigorous" research from *ad hoc* "system building" or artefact construction processes.

Gregor and Hevner (2013:340) stated that knowledge in DSR depends on the cost of accession and on how efficient the knowledge is. In addition, Vaishnavi and Kuechler (2004:5) stated that reflection and abstraction are major contributors to the building process of DSR knowledge. DSR contributions can be noticed on a scale of three maturity levels constructed on the framework. Table 2.2 presents DSR artefact models and illustrates the three levels of maturity.

According to Gregor and Hevner (2013:340) DSR knowledge should include reference to a kernel theory. Including kernel theory in DSR knowledge will assist researchers to emphasise how and why the artefact will operate said Gregor and Hevner (2013:340). Walls, Widmeyer, and El Sawy (1992:48) defined kernel theory as "theories from natural science, social sciences and mathematics".

**Table 2-2: DSR Contribution types adapted from Gregor and Hevner (2013:342).**

| | Contribution types | Example Artefacts |
|---|---|---|
| **More abstract, complete, and mature knowledge**  **More specific, limited, and less mature knowledge** | Level 3. Well-developed design theory about embedded phenomena | Design theories (mid-range and grand theories) |
| | Level 2. Nascent design theory-knowledge as operational principles/ architecture | Constructs, methods, models, design principles, technological rules. |
| | Level 1. Situated implementation of artefact | Instantiations (software products or implemented processes) |

Mokyr (2002) categorised useful DSR knowledge into two distinct types: descriptive knowledge (denoted Ω or omega) and prescriptive knowledge (denoted Λ or lambda). Gregor and Hevner (2013:343) defined descriptive and prescriptive knowledge as follows:

- DSR descriptive knowledge is known as the ‘what’ knowledge about the laws and natural phenomena as regularities among phenomena.
- DSR prescriptive knowledge is known as the ‘how’ knowledge of a human-built artefact.

Figure 2.4 presents both Ω knowledge and Λ knowledge for a particular DSR domain with a comprehensive knowledge adapted from Gregor and Hevner (2013:344).

Hevner and Chatterjee (2010:19) declared that the goal of DSR is to construct and contribute non-existent and interesting design science knowledge in a precise area of interest according to an acceptable metric. In other words, the success of a DSR project to produce significant and publishable knowledge depends on the researchers’ skills, who will appropriately extract knowledge from both descriptive and prescriptive sources and provide a relevant solution to the identified problem. In addition, Gregor and Hevner (2013:343) described two existing degrees of knowledge contributions, including incremental artefact construction and partial theory building. Both contributions are significant and publishable. Additionally, Gregor and Hevner (2013:343) confirmed that the performance of DSR is influenced by the relationships and interactions of descriptive and prescriptive knowledge.

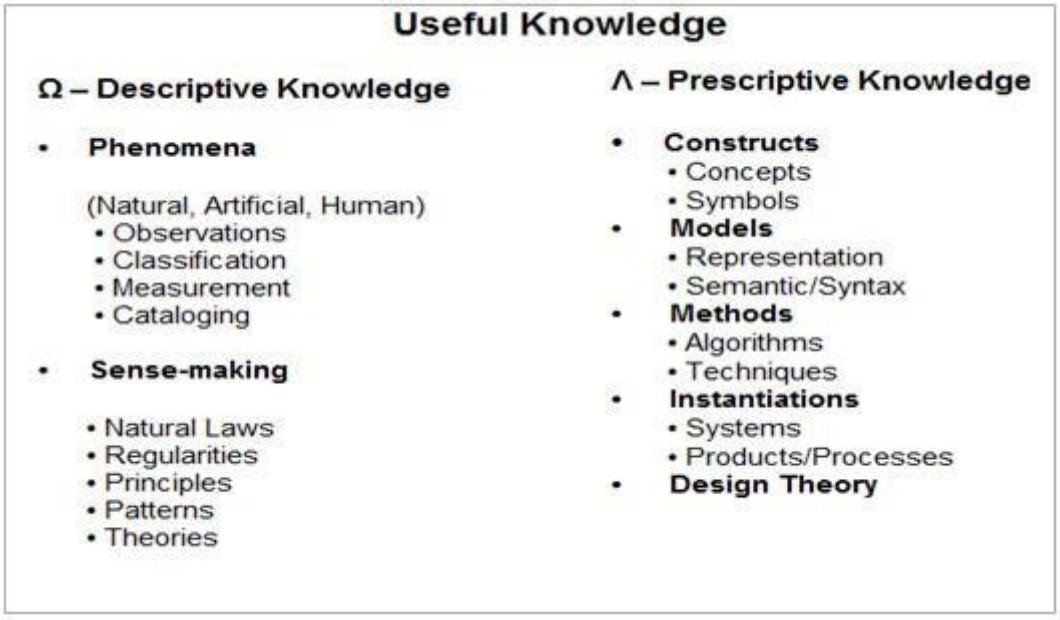


**Figure 2-4: The Design Science Research Knowledge Base adapted from Gregor and Hevner (2013:344)**

Figure 2.5 shows the relationships, the interactions and the DSR roles in the application environment related to descriptive and prescriptive knowledge.

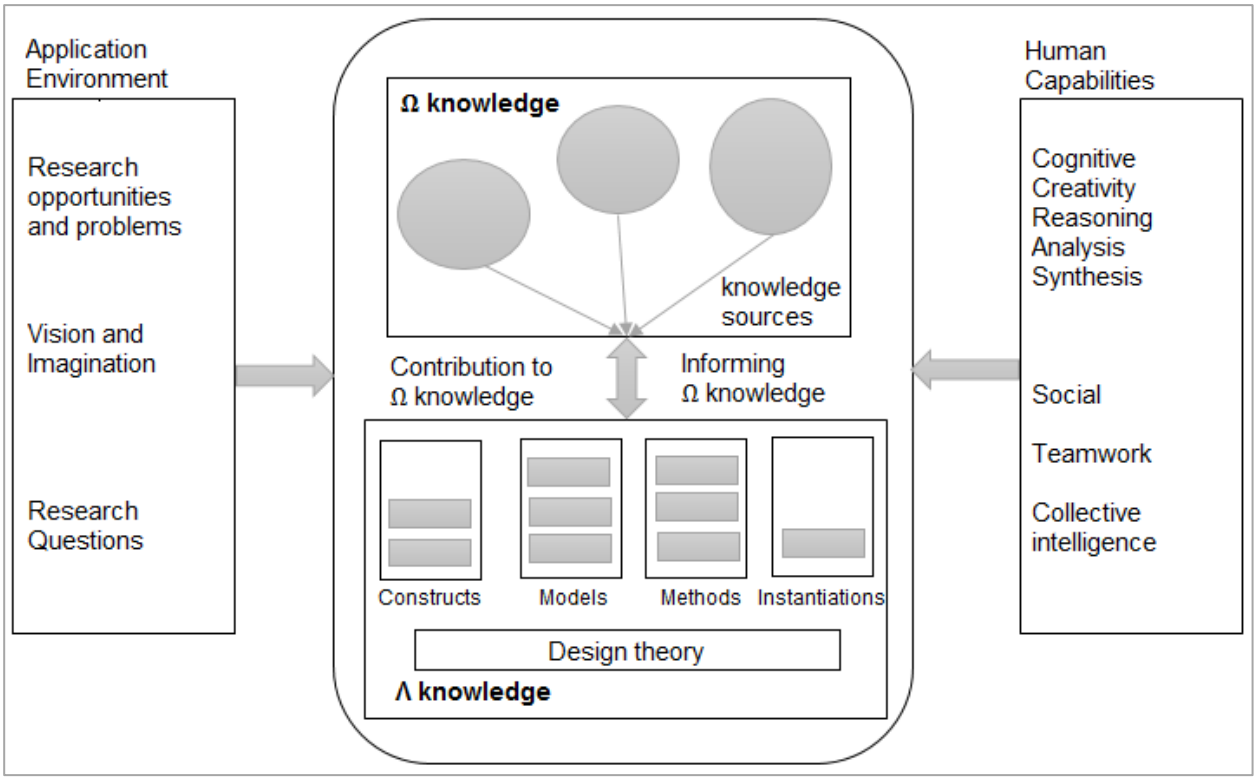


**Figure 2-5: DSR knowledge roles adapted from Gregor and Hevner (2013:344).**

A DSR project has the capability of making various types and scaled research contributions. These contributions depend on the problem maturity and solution maturity based on the starting points of the project. The knowledge innovation matrix (KIM) explored in the coming section, assists the researcher to make sense and pinpoint the DSR project contribution, opportunities for research and external impact outcomes.

#### 2.5.1.2 The knowledge innovation matrix (KIM)

Gregor and Hevner (2014:&:219) described the knowledge innovation matrix (KIM) as an integrative focal point for strategic development in industry, government, and the scholarly world by proposing unmistakable esteem recommendations.

Further, Gregor and Hevner (2013:343) described two existing degrees of knowledge contribution ranging from incremental artefact construction to partial theory building. Both contributions are significant and publishable. Additionally, KIM relies on two primary means for classifying innovations which are application domain maturity and knowledge maturity (Gregor & Hevner, 2014:&:219). The matrix that results has four quadrants namely: invention, improvement, exaptation, and exploitation. Figure 2.6 displays a summative description and location of knowledge within the KIM matrix.

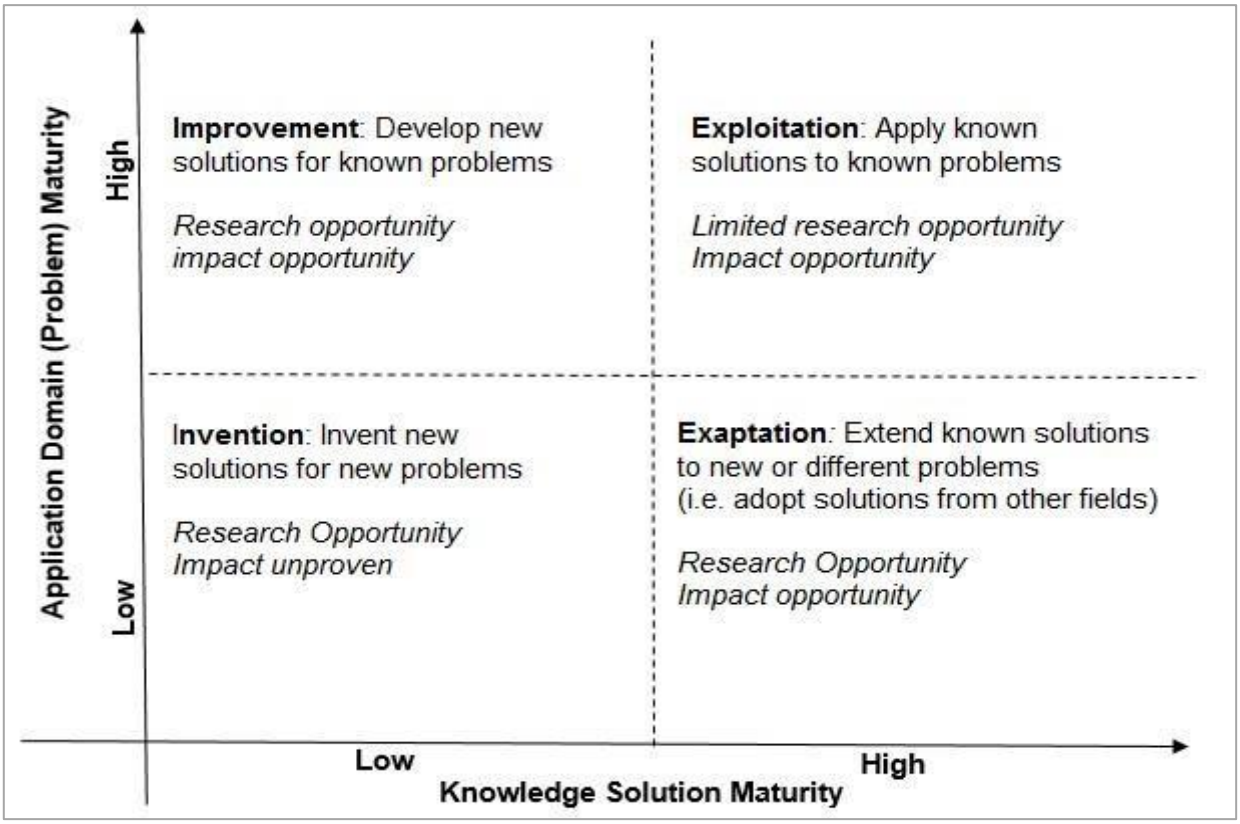


**Figure 2-6: Knowledge Innovation Matrix (KIM) adapted from Gregor and Hevner (2014:221)**

Each quadrant presents a summarised discussion of the contextually starting points of the research based on the problem and solution foundations. A detail explanation of KIM's four processes is presented below.

- Gregor and Hevner (2014:221) described the invention process as an exploring lookout on a multidimensional problem area which requires researchers to employ creativity, insight, cognitive skills of curiosity, imagination and knowledge of various realms in order to invent feasible solutions. By the same token this process develops new solutions for new problems. The knowledge contribution is based on the recognisability of the novel artefacts or the inventions state Gregor and Hevner (2014:222). Moreover, Gregor and Hevner (2014:222) state that the real-world impact of innovation in the invention process are most often unproven and made of unverified theory.

- Gregor and Hevner (2014:222) stated that the objective of the improvement process is to design valuable solutions for effective and efficient use in various sectors including: technologies, productions, processes, services, or ideas. In essence, improvement

processes create new solutions for existing problems. Further, Gregor and Hevner (2014:222) argued that solutions are drawn from the problem environment in order to design innovative artefacts as feasible solutions to pertinent preoccupations. Difficulty encountered in this process is to clearly illustrate that the improved solution is genuinely advanced compared to the existing knowledge (Gregor & Hevner, 2014:222). Moreover, Gregor and Hevner (2014:222) added that improvement innovation research is mainly evaluated on its capability to clearly demonstrate and communicate the newly designed artefact. Therefore, the elucidation will show how and why the newly developed solution differs from the existing one and emphasis should be placed on the motivation for portraying improvement which should be based on appropriate theories from the domain knowledge base (Gregor & Hevner, 2014:222).

- Von Hippel and Von Krogh (2013:9) defined the exaptation process as a "need-solution pairs" in a situation where needs and solutions are discovered concurrently. Additionally, Gregor and Hevner (2014:223) stated that the exaptation process extends or refines existing knowledge so that it becomes extendable to a number of new application domains. The exaptation innovation project is most often encountered where new technology advances regularly presents a need of new applications and consequently a need of prior ideas to be tested or refined (Gregor & Hevner, 2014:223). Also, Gregor and Hevner (2014:223) expressed that innovators, in an exaptation project, need to showcase that the extension of existing design knowledge on a new field should appear interesting and non-trivial in a manner of claiming a knowledge contribution.

- Gregor and Hevner (2014:224) stated that exploitation occurs when existing knowledge for the problem area is well understood and when existing artefacts are used to address the opportunity or question. Linden and Fenn (2003) compared the exploitation process to the popular Gartner Hype Cycle (GHC) which is the "plateau of productivity" where real-world benefits of new technology and mainstream adoption are accepted and can be demonstrated. Exploitation process opportunities for knowledge contributions are less obvious, and rarely ask research methods to resolve identified problems (Gregor & Hevner, 2014:224). In other words, the exploitation process can be understood as a mechanism where users adopt a relevant existing theory where basic logic and purpose behind the innovation remains unchanged, but customised and modified to some degree to fit the current context.

By applying existing knowledge of mobile development to the design of a mobile application for the trading of used books at a university using a design science research approach, this study may be positioned within the exploitation quadrant.

The use of KIM is an integrative aid to improve the understanding and the management of various innovations to support a selected number of propositions for more research and investigation. However, Gregor and Hevner (2014:228) declared that KIM allows an individual to be engaged, in a more holistic view, with collaborative and industry-academic ventures to evaluate the conceivable results of projects and to arrange a portfolio of projects. DSR methodology within IS research is presented in the following section with an objective of assisting in the formulation of the process for the study.

### 2.5.2 DSR processes and DSR products

March and Smith (1995) identified two processes and four products of design science. The two processes are design and evaluate. Further, Hevner *et al.* (2004:4) attested that the main purpose of the two processes is the construction of an artefact that is intended to resolve problems and the evaluation thereof. A nominal process for administrating design science research is turned out by the DSR process model (Peffers *et al.*, 2007:88). The four products of design science include: models, constructs, methods, and instantiations. Hevner *et al.* (2004:4) stated that "design is both a process and a product", where the creation of the product, which will further represent the actual artefact, involved a series of activities known as processes. Again, Hevner *et al.* (2004:4) assert that artefacts are purposefully designed to fulfil unresolved preoccupations. The performance of the artefact will be evaluated based on the utility and usability provided in solving the problem. The four products of design science previously elucidated are presented in Table 2.3.

**Table 2-3: Four products of design science adapted from Hevner *et al.* (2004).**

| DSR products | Description |
|---|---|
| Constructs | Provide the language in which problems and solutions are defined and communicated. |
| Models | Aid in understanding the real world and enable exploration of the effects of design decisions and changes in the real world. |

| | |
|---|---|
| Methods | Provide guidance on how to solve problems |
| Instantiations | Demonstrate feasibility, provide empirical evidence that an artefact is suited to its intended purpose, and enable researchers to learn about the real world and how an artefact affects it. |

Knowledge is constructed from both the knowledge base and the real-world application environment (Hevner *et al.*, 2004:4). Figure 2.7 provides a framework for understanding, executing, and evaluating design science research in information technology. The cycle of design and evaluation is shown in the centre of Figure 2.7. The constituents of the knowledge base are the DSR products and the research methodology.

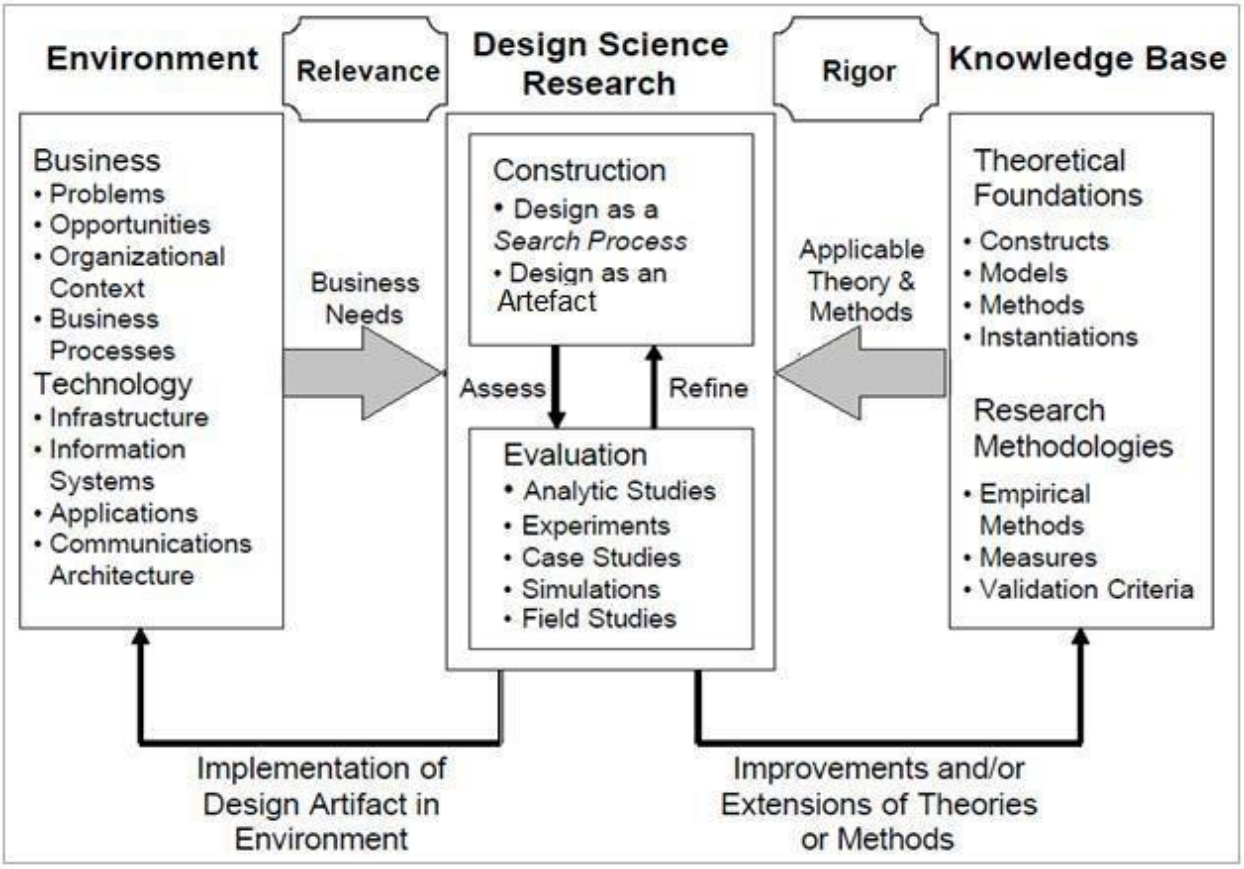


**Figure 2-7: Design science research framework (Hevner *et al.*, 2004:5)**

Simon (1996) attested that the environment expands the problem space in which are located the phenomena of interest, the problems, opportunities, organisational context, and business processes that define business needs. Within that environment the implementation of the artefact represent the test of relevance for design science research (Hevner *et al.*, 2004:5). Moreover,

Hevner *et al.* (2004:5) expressed that materials from and through which artefacts are developed and assessed are provided by the knowledge base.

### 2.5.3 Design science research approaches

Several approaches are available to orientate researchers in performing a DSR study. The DSR approach recommended by Peffers *et al.* (2007) contains six activities including: recognition and motivation of a significant research problem, illustration of the solution objectives, design and development of DSR artefacts, elucidation of the artefacts' capability to solve one or multiple problems, assessment of the designed artefacts and lastly communication of the research. Peffers *et al.* (2007) also asserted that "this process is structured in a nominally sequential order; however, there is no expectation that researchers would always proceed in sequential order from activity 1 through activity 6. In reality, they may actually start at almost any step and move outward". Figure 2.8 illustrates the DSR process model of Peffers *et al.* (2007:11).

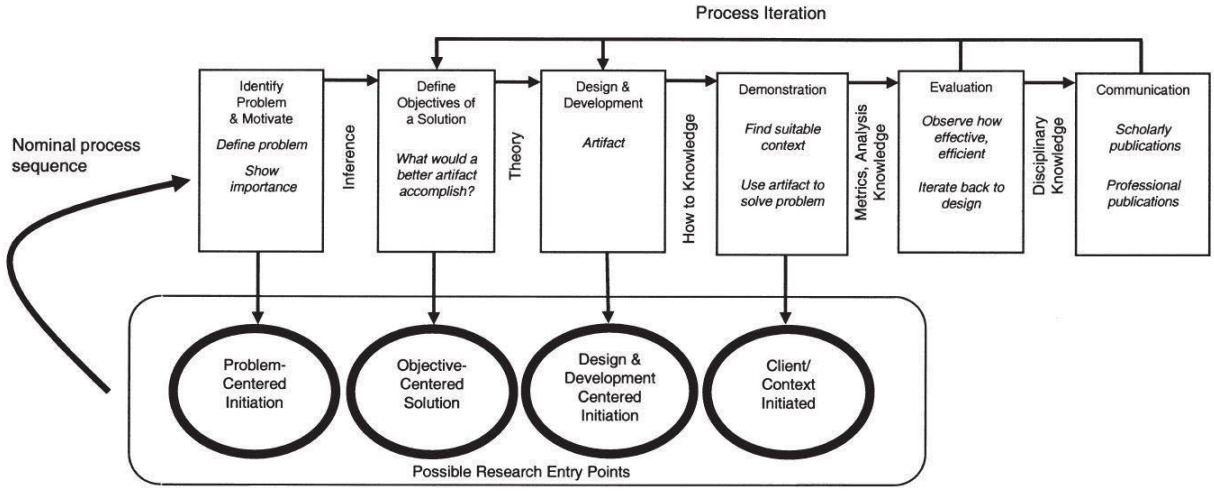


**Figure 2-8: Design science research process model (Peffers *et al.*, 2007:11)**

Table 2.4 describes the six activities of the Peffers *et al.* (2007:11) DSR process model.

**Table 2-4: DSR activities summarised from Peffers *et al.* (2007:25)**

| Activity | Description |
|---|---|

| | |
|---|---|
| **Activity 1: Problem identification and motivation** | • Define the specific research problem.<br>• Justify the value of a solution, because it:<br>  ○ Motivates the researcher and the audience of the research to pursue the solution and to accept the results.<br>  ○ Helps to understand the reasoning associated with the researcher's understanding of the problem.<br>• Resources required: knowledge of the state of the problem; and importance of its solution. |
| **Activity 2: Define the objectives for a solution** | • Deduce the objectives of a solution from the problem definition.<br>• Deduce the knowledge of what is possible and feasible.<br>• The objectives can be:<br>  ○ quantitative or qualitative<br>• The objectives should be inferred rationally from the problem specification.<br>• Resources required: knowledge of the state of problems; knowledge of current solutions, if any, and their efficacy |
| **Activity 3: Design and development** | • Create the artefact. Conceptually, a design research artefact can be any designed object in which a research contribution is embedded in the design.<br>• Determine the artefact's desired functionality.<br>• Determine the artefact's architecture.<br>• Resources required: knowledge of theory that can be used to address the problem situation. |
| **Activity 4: Demonstration** | • Demonstrate the use of the artefact to solve one or more instances of the problem.<br>• Could involve its use in:<br>  ○ Experimentation, simulation, case study,<br>  ○ Proof, or other appropriate activities.<br>• Resources required: effective knowledge of how to use the artefact to solve the problem. |
| **Activity 5: Evaluation** | • Observe and measure how well the artefact supports a solution to the problem.<br>• Compare the objectives of a solution to actual observed results from use of the artefact in the demonstration.<br>• Iterative in nature.<br>• Resources required: knowledge of relevant metrics and techniques. |
| **Activity 6: Communication** | • Communicate:<br>  ○ The problem and its importance, the artefact, its utility and novelty, and the rigor of its design.<br>• Resources required: knowledge of the disciplinary culture |

Vaishnavi and Kuechler (2004) introduced a DSR framework that can be seen as a basis for the DSR process model by Peffers *et al.* (2007:11). The approach by Vaishnavi and Kuechler (2004) to DSR comprises five phases which are: awareness of the problem, suggestions, development, evaluation and conclusion. The five phases proposed by Vaishnavi and Kuechler (2004) shape the main external cycle of a DSR study. The development phase may be divided into inward cycles of repetitive phases. The first and primary external cycle displays the general goal for creating an artefact and the second and internal cycle shows various steps of designing the artefact. These phases are illustrated in Figure 2.9.

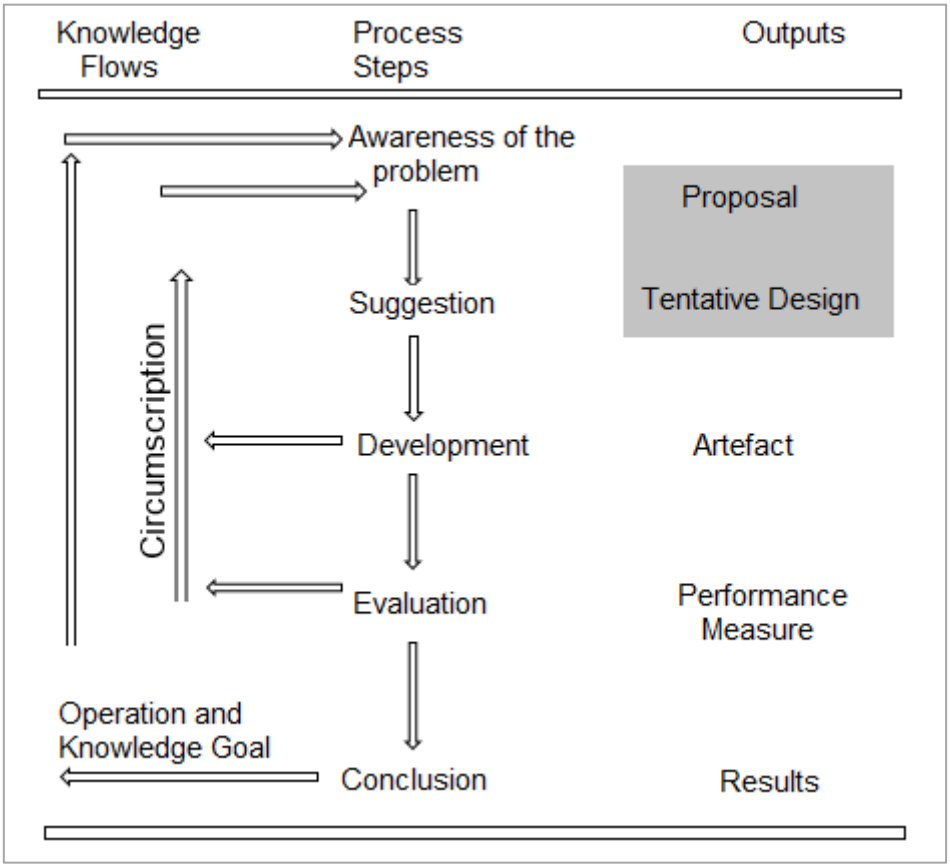


**Figure 2-9: DSR phases developed by Vaishnavi and Kuechler (2004)**

Table 2.5 presents a summarised explanation of DRS framework according to Vaishnavi and Kuechler (2004).

**Table 2-5: DSR phases summarised from Vaishnavi and Kuechler (2004)**

| Phase | Description |
|---|---|

| | |
|---|---|
| **Awareness of Problem** | • How to effectively model operations support system for complex, hierarchical, procedure driven environments with control modelling as the specific research problem.<br>• Output: proposal, formal or informal, for a new research effort. |
| **Suggestion** | • This phase follows a proposal and is connected to it.<br>• Output: tentative design. |
| **Development** | • A set of meta-level rules for implementing domain knowledge and control knowledge separately, but within a single structure, the "smart object".<br>• Another set of meta-rules that described how the domain and control knowledge, once "modelled" as smart objects, would be interpreted (a virtual machine for executing the smart objects).<br>• Output: implemented artefact. |
| **Evaluation** | • During this phase, minor redesign of the artefact (the smart object conceptual model) occurred on several occasions and the artefact is evaluated according to criteria.<br>• Output: deviations from expectations, both quantitative and qualitative noted and tentatively explained. |
| **Conclusion** | • Final phase of a specific research effort.<br>• Output: artefact that is 'good enough'. |

### 2.5.4 Design science research guidelines

Hevner *et al.* (2004:20) stated that DSR is the know-how knowledge for developing artefacts that fulfil an appropriate number of functional requirements. The key rule about DSR is the fact that knowledge is produced by making sense of the design problem and that the solution is obtained in the development and application of the artefact (Hevner *et al.*, 2004:20). The guidelines for conducting DSR illustrated here are subject to the researcher's abilities and judgement to demonstrate how, where and when to portray each guideline in research (Hevner *et al.*, 2004:20). It is fundamental that each guideline is addressed in some manner, in order to complete a DSR project. Among other things, Hevner *et al.* (2004) proposed seven guidelines for Design Science in IS research. These guidelines are presented in Table 2.6.

**Table 2-6: Seven guidelines for Design Science in IS research (Hevner *et al.*, 2004)**

| **Guidelines** |
|---|
| 1. Design as an artefact: an identifiable and viable design artefact should be developed in the form of a construct, model method or instantiation. |

| |
|---|
| 2. Problem relevance: an important and relevant problem should be addressed by the design. |
| 3. Design evaluation: the design artefact must be rigorously evaluated based on the artefact utility, quality and efficacy. |
| 4. Research contributions: the contribution should be easy to perceive and capable of being tested by experiments or observations. Novelty, generality, and significance of the designed artefact are major contributors to a research contribution. The design of the artefacts, new foundations and new methodologies are included in a research contribution. |
| 5. Research rigour: the application of the research methods should prove to be rigorously portrayed. |
| 6. Design as a search process: research should be approached with the understanding of other, concurrent approaches and should also conduct the process as a cyclical problem solving process, where solutions are assessed against each other and against their efficacy for providing a solution to the entire problem. |
| 7. Communication of the research: the rigour requirements of the academic audience and the relevant requirements of the professional audience need to be addressed when dispensing the outcome of the research. |

These guidelines constitute a benchmark to effectively evaluate a DSR project. The guidelines also supply researchers with a foundation for conducting a self-reflection at the end of a DSR study. Table 2.7 presents Hevner and Chatterjee (2010:20)'s questions that form a checklist for DSR projects.

**Table 2-7: DSR checklist summarised from Hevner and Chatterjee (2010:20).**

| **Questions** |
|---|
| 1. What is the research question (design requirements)? |
| 2. What is the artefact? How is the artefact represented? |
| 3. What design processes (search heuristics) will be used to build the artefact? |
| 4. How are the artefact and the design processes grounded by the knowledge base? |
| 5. What, if any, theories support the artefact's design and the design process? |

| |
|---|
| 6. What evaluations are performed during the internal design cycles? |
| 7. What design improvements are identified during each design cycle? |
| 8. How is the artefact introduced into the application environment and how is it field-tested? |
| 9. What metrics are used to demonstrate the artefact's utility and improvement over previous artefacts? |
| 10. What new knowledge is added to the knowledge base and in what form (e.g. peer-reviewed literature, meta-artefacts, new theory and new method)? |
| 11. Has the research question been satisfactorily addressed? |

The following section explores data collection techniques which may be applied in guiding the problem identification and the evaluation in this study.

### 2.6 Data collection techniques

Two essential approaches for conducting research is acknowledged by Kothari (2004:22) which are quantitative and qualitative approaches. Chang and Hsu (2006:67) described the two approaches as follow:

- Quantitative research relies on the judgement of values, numbers, and quantity;
- Qualitative research is adopted where the investigated phenomena is generally concerned with opinions, behaviour and subjective assessment of attitudes.

The achievement of research objectives can be accomplished through a complementary process of both qualitative and quantitative research approaches; however, the complementary action should not combine the two processes into a single research study (Choy, 2014:100). Moreover, Choy (2014:101) pinpointed a number of strengths and weaknesses of research methodology based on qualitative and quantitative research approaches. Figure 2.10 presents a model of strengths and weaknesses of qualitative and quantitative research methodologies adapted from Choy (2014:101).

It is crucial to gather accurate and reliable data, when conducting studies, about the phenomenon under scrutiny (Lethbridge, Sim, & Singer, 2005:2). Researchers are presented with various techniques for collecting data some of which are:

- Interviews: a purposeful discussion between two or more people (Saunders, Lewis, & Thornhill, 2009:146).
- Questionnaires: a self-administered data collection technique in which each person is asked to respond to the same set of questions in a predetermined order (Lethbridge *et al.*, 2005:2).
- Observations: a systematic observation, recording, description, analysis, and interpretation of people's behaviour (Oates, 2006:116).
- Documents: include written documents inclusive of notices, minutes of meetings, diaries, administrative and public records and reports to shareholders (Saunders *et al.*, 2009:146). Further, Saunders *et al.* (2009:146) stated that documents include non-written formats such as voice and video recordings, pictures, films and television programmes.
- Focus groups: a type of interview that brings together five to seven people in one place to provide feedback concerning a service, product, or concept (Lazar, Feng, & Hochheiser, 2010a:192). Lazar *et al.* (2010a:192) declared that a trained moderator leads a conversation within the group that is designed to gather helpful information.

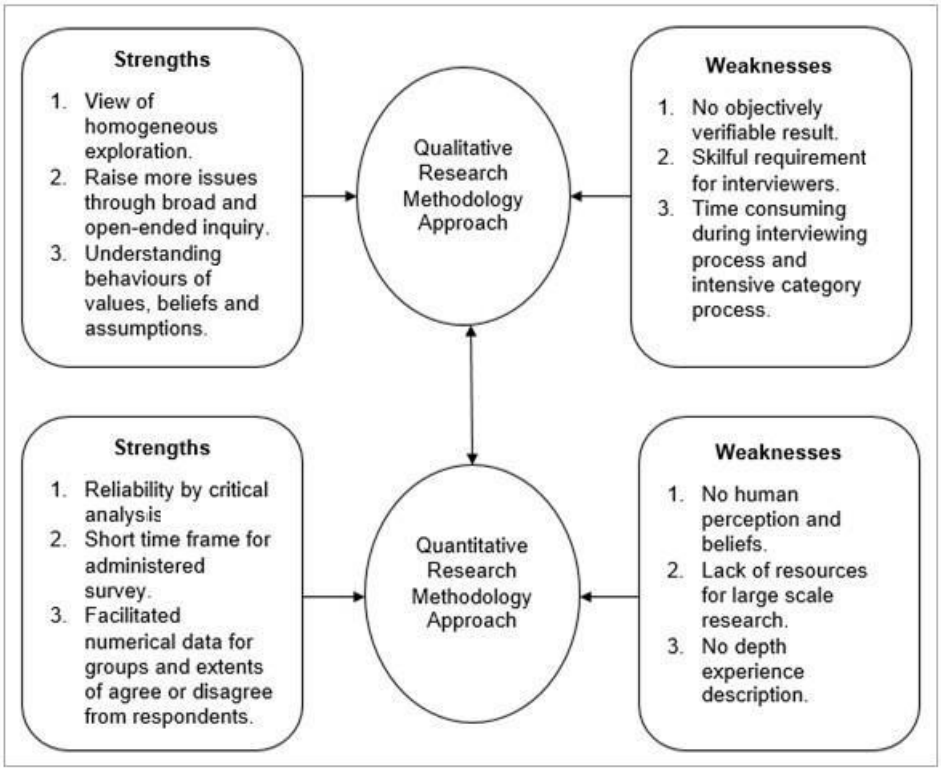


**Figure 2-10: The model of strengths and weaknesses of qualitative and quantitative research methodologies (Choy, 2014:101).**

The data collected through the application of these techniques may be grouped into quantitative data and qualitative data. Seaman (1999:572) expresses that “qualitative data is richer than quantitative data”. Data gathered using qualitative methods contain more information than data collected using quantitative methods (Seaman, 1999:572).

It is often best to use multiple data collection methods to learn about various aspects of a phenomenon. The combination of multiple data collection techniques are known as mix-method techniques and referred to as triangulation (Saunders *et al.*, 2009:146). The choice of data collection methods should be performed based on the research goal or the research question (Lethbridge *et al.*, 2005:5).

The goal of this study is to design a mobile application for the trading of used books at a university by using a design science research approach. Qualitative research methods are recommended for obtaining rich information. Qualitative data in the form of interview and focus group data will be valuable for rich evaluation of the artefact.

### 2.6.1 Interviews and focus groups

Kahn and Cannell (1957) describe an interview as a firm conversation between two or more people. Lazar *et al.* (2010a:192) asserted that a focus group or focus group interview is a qualitative method for data gathering through a conversation in a group setting. Furthermore, Patton (2002) stated that a focus group consists of generating high-quality data in a social context.

Kothari (2004:114) affirmed that presentation of oral-verbal stimuli and reply in terms of oral-verbal responses is a characteristic of an interview. Data collected using interviews are valid and reliable for research means (Saunders *et al.*, 2009:146). Various types of interviews exist including: structured interviews, semi-structured interviews, and unstructured or in-depth interviews. The types of interviews are explained by Saunders *et al.* (2009:146) as follows:

- Structured interviews: the goal of this approach is to ensure that the same questions in the same order are used for each interview. These questionnaires are standardised and predetermined.
- Semi-structured interviews: this approach combines a pre-determined set of open questions with the opportunity for the interviewer to explore particular themes or responses further.
- Unstructured interviews: questions are not prearranged, informal, explore a general area in depth and area of interest.

Semi-structured interviews were employed in this study in order to identify the requirement analysis. Further, the researcher used a focus group with a semi-structured interview to evaluate the usability of the designed artefact.

### 2.6.2 Interview guidelines

Every effort should be undertaken to develop a friendly atmosphere of trust and confidence in order to make feel respondents at ease while talking to and conversing with the interviewer. Planning and preparation are crucial recommendations for conducting an interview. This allows the placement of aims and a plan to account for practical issues. Kothari (2004:116) recommends multiple guidelines to perform an interview. These guidelines are summarised in Table 2.8 as follow.

**Table 2-8: Guidelines for conducting interviews quoted from Kothari (2004:116)**

| **Guidelines for conducting interviews** |
|---|
| 1. The interviewer must ask questions properly and intelligently and must record the responses accurately and completely. |
| 2. The interviewer must answer legitimate question(s), if any, asked by the respondent and must clear any doubt that the latter has. |
| 3. The interviewers approach must be friendly, courteous, conversational and unbiased. |
| 4. The interviewer should not show surprise or disapproval of a respondent's answer but he must keep the direction of interview in his own hands, discouraging irrelevant conversation and must make all possible effort to keep the respondent on track. |

Professionalism has been identified to be the golden rule when performing interviews (Rogers, Sharp, & Preece, 2011:391). Further, Rogers *et al.* (2011:391) provide advice on how to professionally conduct an interview (Table 2.9).

**Table 2-9: Advice to professionally conduct an interview (Rogers *et al.*, 2011:391).**

| **Recommendations** |
|---|
| 1. Dress similar to interviewees if possible or dress neatly and avoid standing out. |

| |
|---|
| 2. Prepare an informed consent form for signing. |
| 3. If recordings are used, test it prior and make sure how to use it properly. |
| 4. Record answers exactly. |

After collecting data, it needs to be processed and analysed in respect with the outline laid down for the purpose at the time of developing the research plan (Kothari, 2004:139). Concerning this study the collected data is analysed using qualitative data analysis.

### 2.6.3 Qualitative data analysis

Many things need to be taken into consideration when deciding to adopt a qualitative approach for data analysis. Strauss and Corbin (1990) argued that qualitative data analysis is mostly practiced in a situation where little is known about the investigated phenomenon in order to better understand it. Hoepfl (1997) asserted that qualitative data analysis can be employed to obtain new ideas on unknown things, or to gain in-depth data that can possibly be difficult to convey quantitatively. Bogdan and Biklen (1982b:152) described the qualitative data analysis process as follows:

*"…working with data, organizing it, and breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others."*

The placement of crude information into coherent, significant units of data requires some innovativeness when performing qualitative data analysis (Hoepfl, 1997). Qualitative data analysis comprises three different phases, namely, the identification stage, the re-evaluation state, and lastly the interpretation stage.

Qualitative data analysis starts with the identification stage where significant topics arise out of the crude information (Chang & Hsu, 2006:67). This process is known as "open coding" (Strauss & Corbin, 1990). Hoepfl (1997) described open coding as a process of identifying distinct concepts and categories and the naming of conceptual themes by the researcher. The observed facts will be clustered into these themes. Hoepfl (1997) stated that the objective of identifying a theme is to "create descriptive, multi-dimensional categories which form a preliminary framework for analysis". Hoepfl (1997) and Choy (2014:100) conveyed that researchers conceive an 'audit trail' by pointing out data chunks relevant to their speakers and the circumstances.

After the identification of themes, the second stage of qualitative data analysis is the re-examination stage. Hoepfl (1997) asserted that the re-examination stage combines and compares identified themes. Moreover, the identified themes are connected and controlled by the re-examination process (Hoepfl, 1997). This complex process is known as “axial coding” as discussed by Strauss and Corbin (1990).

The last stage, or translation stage, of qualitative data analysis includes the transformation of the theoretical model into a story line. Strauss and Corbin (1990:57) expressed that the translation stage should “closely approximate the reality it represents”. Hoepfl (1997) clarified that although these stages are linear, they may occur at the same time or more than once. Additionally, Hoepfl (1997) expresses that data gathering may occur during any stage should gaps be discovered within the data.

This study used interviews for data collection in the form of individual interviews as well as a focus group, and the collected data was subjected to qualitative data analysis. The aim of the qualitative data analysis of the individual interviews was to elucidate a requirements analysis for the proposed artefact. The purpose of the qualitative data analysis of the focus group interview was to receive feedback on the evaluation of the artefact prototype. The data collected in the individual and group interviews were subject to open coding for data analysis.

## 2.7 An overview of the objectives according to the DSR process followed in this study

Offermann, Levina, Schönherr, and Bub (2009:2) attested that a research process “is the application of scientific method to the complex task of discovering answers (solutions) to questions (problems)”. The design science research methodology process model recommended by Peffers *et al.* (2007:82) was integrated to provide a scientific structure for this study. To follow a DSR structure, the originally stated objectives of the study were refined and divided into the appropriate activities of the DSR process model. Table 2.10 presents a summary of the refined objectives of the study according to the activities of the DSR process model.

**Table 2-10: Overview of objectives according to the activities in the DSR process model (Peffers *et al.*, 2007:82-92)**

| DSR process | Description |
|---|---|

| | |
|---|---|
| **Problem identification and motivation** | **Theoretical objectives**<br>• To identify the research problem.<br>• To motivate the process for conducting the research.<br>• To determine the required fields of research to inform a solution for the research problem. |
| **Objectives of a solution** | **Theoretical objectives**<br>• To understand the concept of design science research.<br>• To understand the concept of mobile applications and its design principles.<br>• To understand the concept of human-computer interaction and its design principles.<br>• To form a conceptual link between mobile application principles and HCI principles.<br>**Empirical objectives**<br>• To conduct interviews with expert participants as part of a requirements analysis for the artefact<br>• To analyse the feedback obtained from the requirements analysis using interpretive content analysis. |
| **Design and development** | **Theoretical objectives**<br>• To form a conceptual link between mobile application principles, HCI principles and the analysed feedback obtained from the requirements analysis.<br>**Empirical objectives**<br>• To design and develop a mobile application for the trading of used books given the consolidated guidelines derived from mobile application principles, HCI principles and the requirements analysis. |
| **Demonstration** | **Theoretical objectives**<br>• To present the artefact by means of screenshots with explanations of how the literature and requirements analysis informed the design process.<br>**Empirical objectives**<br>• To demonstrate the artefact to target audience using different mobile devices. |
| **Evaluation** | **Empirical objectives**<br>• To conduct a focus group with participants from the target audience as part of the evaluation of the artefact.<br>• To analyse the feedback obtained from the evaluation using interpretive content analysis.<br>**Theoretical objectives**<br>• To report on the feedback received from the evaluation of the artefact. |

| | |
|---|---|
| **Communication** | **Theoretical objectives**<br>• To communicate the design science research approach followed for designing a mobile application for the trading of used books at a university.<br>• To communicate limitations within the context of the study by reflecting on restrictions of the research.<br>• To communicate future research within the context of the study by reflecting on recommendations for further improvement of the artefact. |

## 2.8 Conclusion

The goal of this chapter was to provide a detailed understanding on an applicable research methodology for conducting the research. This objective was met by discussing the following: research philosophy, research paradigms, positioning the study in an appropriate paradigm, design science research as a suitable approach, data collection techniques and methods of data analysis for the purpose of this research. The DSR paradigm was chosen for conducting research in this study as the main objective is the creation of an artefact. The research approach of this study explains the processes for designing and evaluating the artefact. These processes are supported by the activities in the DSR process model of Peffers *et al.* (2007).

Figure 2.11 provides a visual representation of the research structure of the study, and how the current chapter is situated in the research. The research methodology has been covered in order to assist the reader in understanding the structure of the study.

The following chapter presents literature on mobile applications in order to create a shared understanding on the concept.

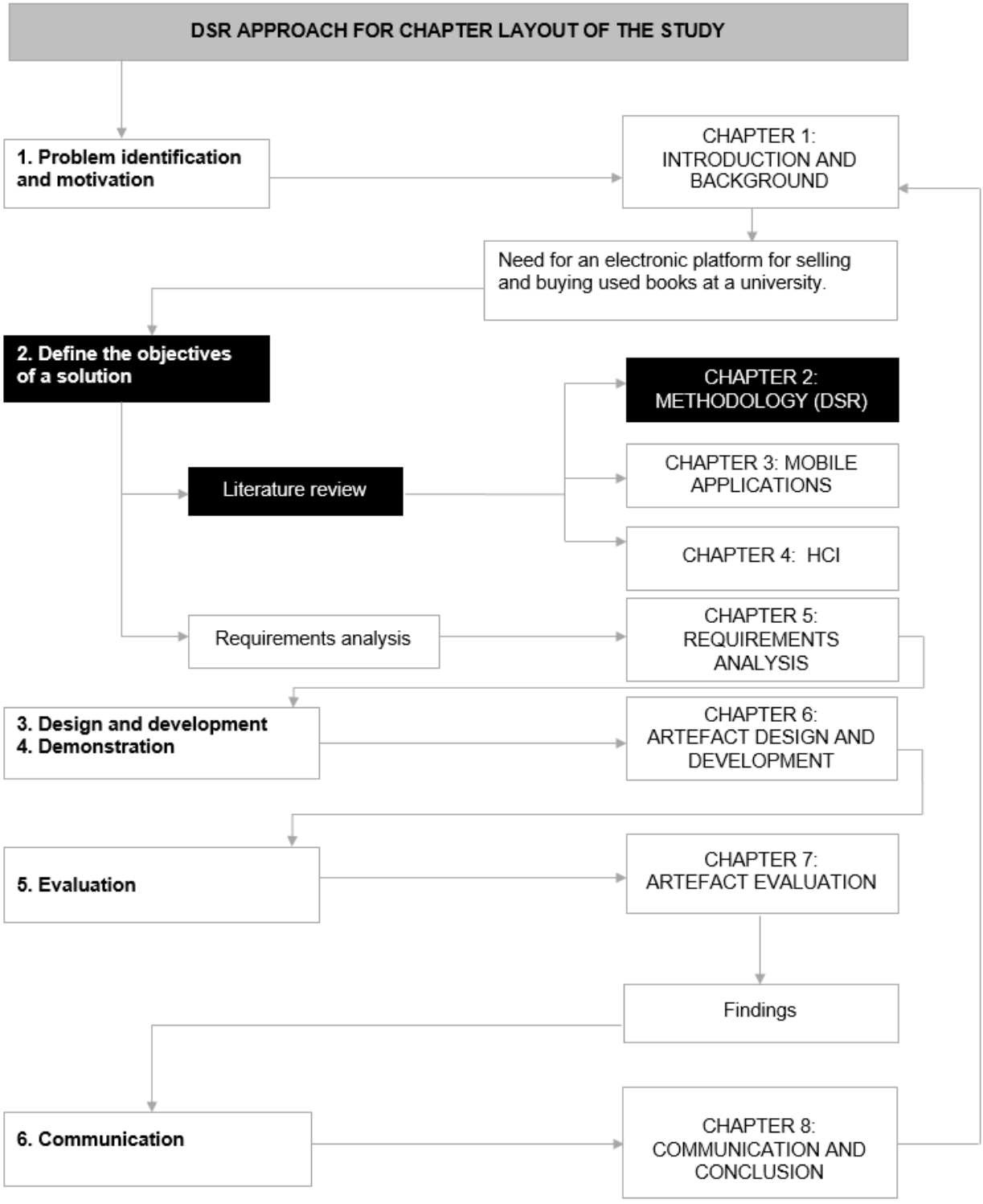


**Figure 2-11: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

# CHAPTER 3: MOBILE APPLICATIONS

## 3.1 Introduction

The goal of this study was to design a mobile application for the trading of used books at a university by following a design science research approach. A mobile application, commonly known as an app, is a kind of application software developed to work on mobile devices, such as tablets and smartphones (Cueto-Manzano *et al.*, 2015:119). Moreover, Holla and Katti (2012:486) stated that mobile applications are designed to provide a rich and fast user experience. Mobile devices and applications give significant benefits to their users, in terms of the following: location awareness, portability, and accessibility (Nayebi, Desharnais, & Abran, 2012:1).

Mobile applications should fulfil special requirements and constraints (Yan & Chen, 2011:6). Therefore, the development of mobile applications will differ from traditional software development in various aspects. This idea is supported by Weyl (2014:11) who states that mobile applications make use of the basic architecture of desktop applications with the functionality of touch-enabled devices. Along with these requirements and constraints, applications produced for mobile devices should be at a high level of quality, for the application to properly operate on different existing mobile platforms or expected future mobile platforms (Rahimian & Ramsin, 2008:352).

Figure 3.1 shows a graphical representation of the high-level view of a mobile application architecture.

This chapter will present the following sections: a general overview of mobile applications (Section 3.2); guidelines for creating mobile applications (Section 3.3); and consolidated mobile application design principles (Section 3.4). Section 3.5 concludes the chapter.

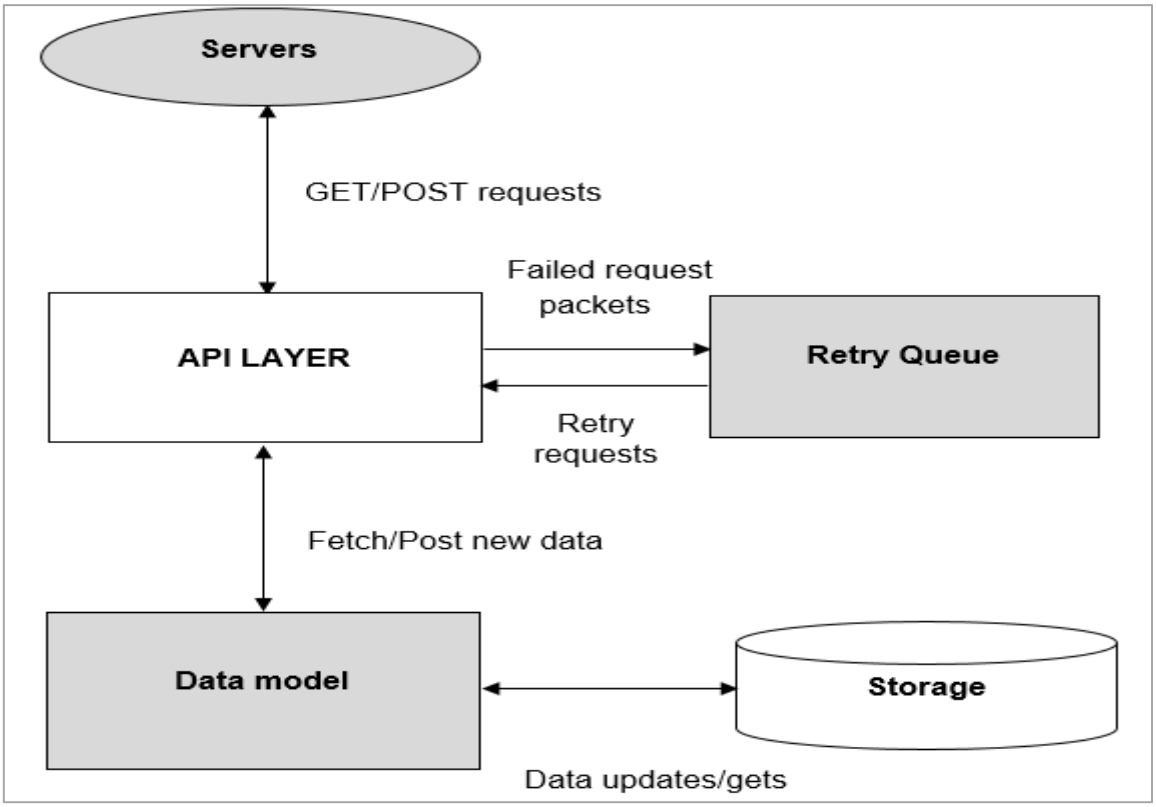


**Figure 3-1: High-level view of mobile application architecture adapted from Yan and Chen (2011:4).**

## 3.2 Overview of mobile applications

Software applications designed for mobile devices are called apps and typically distributed from a platform (Børnich, 2015:23). According to Spataru (2010) numerous perceptions of a mobile applications are existent. Nevertheless, any conceivable perception can lead to better outcomes in the development process, due to a higher focus on issues that are particular to the individual perception (i.e. user perception and developer perception). In Section 3.2.1 the concept of mobile applications is discussed from the user's perspective, and in Section 3.2.2 from the developer's perspective.

### 3.2.1 Mobile applications from the user's perspective

Referring to a report by Ramsay and Nielsen (2000) on wireless application protocol's (WAP) ease of use, the authors partition mobile applications from the user point of view into two groups: " *Highly goal-driven and entertainment-focused*." The meaning of each group is very simple: the highly goal-driven application's goal is to provide fast responses to requests, while entertainment-focused applications will provide users with enjoyable experiences (Spataru, 2010). Børnich (2015:23) stated that it is quite difficult to provide guidelines for the entertainment-focused

category of mobile applications. Further, Spataru (2010) confirmed that no sub-category is provided for the entertainment category due to the high diversity of this type of applications. A mobile game can further expand this category by considering diverse sorts of games they have created before. A taxonomy of mobile applications from a user point of view is presented in Figure 3.2.

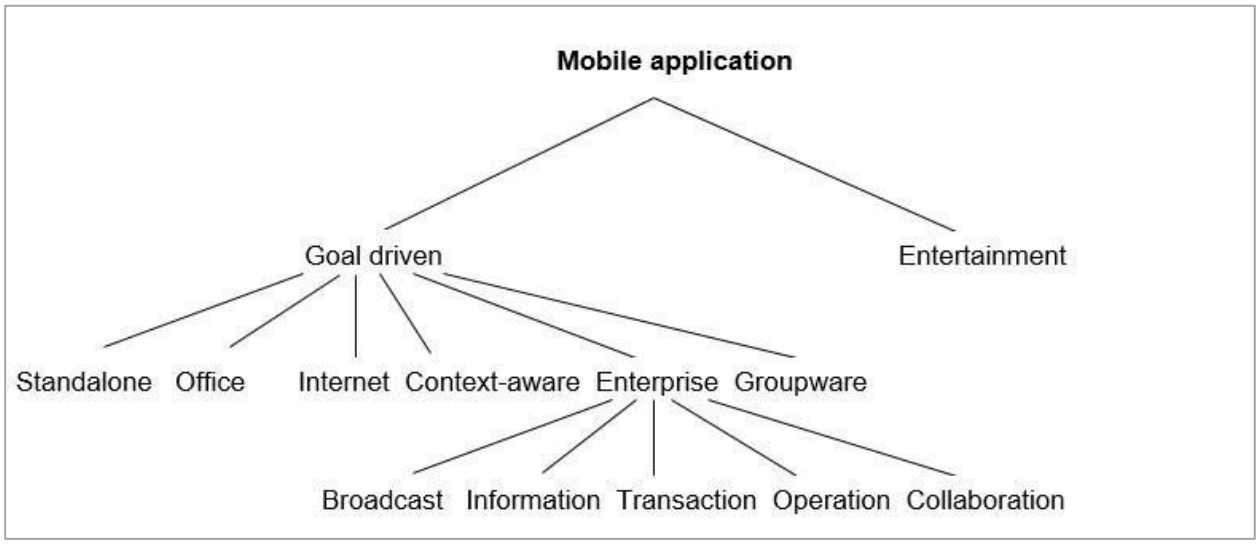


**Figure 3-2: Proposed categories of mobile applications from the user perspective (Unhelkar & Murugesan, 2010).**

Unhelkar and Murugesan (2010) stated that goal driven and entertainment applications require higher expectations in terms of responsiveness, security, and reliability. In terms of this study, the proposed application falls under the goal-driven mobile application category.

### 3.2.2 Mobile applications from the designer's perspective

There are several ways mobile application designers can categorise mobile applications. Based on the assessment of White (2013:8) most designers categorise mobile applications into three categories: native applications, web mobile applications, and hybrid applications. Native applications are typically created for an appropriate mobile platform (iOS or Android) using designed tools and programing languages that supports specific platforms, for example, Xcode and Objective-C with iOS, Eclipse and Java with Android (Korf & Oksman, 2012). Korf and Oksman (2012) stated that a web mobile application designer employs accepted web technologies, typically HTML5, JavaScript and CSS. Further, Korf and Oksman (2012) indicated that the write-once-run-anywhere approach to mobile design allows for a cross-platform mobile application that operates on various devices. Manjunatha, Ranabahu, Sheth, and Thirunarayan (2010) argued that the hybrid mobile application allows HTML5 applications to be embedded

inside a slightly native container, putting together both the best and the worst constituents of native and HTML5 applications. Figure 3.3 shows a graphical representation of the three types of mobile applications namely: native, hybrid and web-based application.

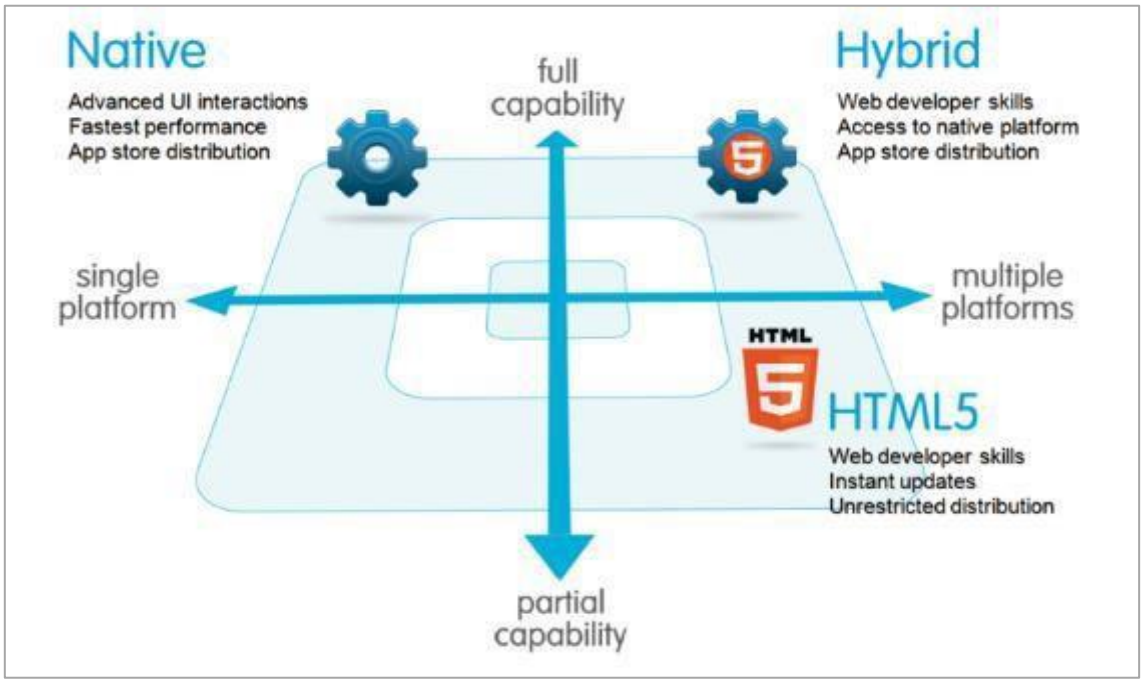


**Figure 3-3: Graphical representation of native, hybrid, and web mobile application based on the capability and type of platform used (Korf & Oksman, 2012)**

Table 3.1 presents an overview of native applications, web applications, and hybrid applications based on the following: mobile application features, device access, gestures, connectivity, and lastly development tools used for mobile applications design.

**Table 3-1: Mobile application features, device access, gestures, connectivity, and development tools (Korf & Oksman, 2012).**

| | NATIVE APPS | WEB APPS | HYBRID APPS |
|---|---|---|---|
| **App Features**<br>Graphics<br>Performance<br>Native look and feel<br>Distribution | Native application program interfaces (APIs)<br>Fast<br>Native<br>Appstore | HTML, Canvas, SVG<br>Slow<br>Emulated<br>Web | HTML, Canvas, SVG<br>Slow<br>Emulated<br>Appstore |

| | | | |
|---|---|---|---|
| **Devices Access**<br>Camera<br>Notification<br>Contacts, calendar<br>Offline storage<br>Geolocation | <br>Yes<br>Yes<br>Yes<br>Secure file storage<br>Yes | <br>No<br>No<br>No<br>Shared SQL<br>Yes | <br>Yes<br>Yes<br>Yes<br>Secure file storage<br>Yes |
| **Gestures**<br>Swipe<br>Pinch, spread | <br>Yes<br>Yes | <br>Yes<br>Yes | <br>Yes<br>Yes |
| **Connectivity** | Online and offline | Mostly online | Online and offline |
| **Development** | Objective-C, Java | HTML5, CSS, JavaScript | HTML5, CSS, JavaScript |

Mobile development is continually changing focus to where there is an upcoming mobile operating system, with specific features only accessible with specific APIs (Korf & Oksman, 2012).

Korf and Oksman (2012) stated that mobile applications are single platform or multiplatform with partial or full capability.

Section 3.2.2.1 will provide further details on native applications, Section 3.2.2.2 will provide further details on non-native applications, and Section 3.2.2.3 will provide details on hybrid applications.

#### 3.2.2.1 Native applications

Native mobile applications are designed to particularly operate on smartphones and tablet computing devices (Langrial *et al.*, 2012:8). In other words, native applications are designed for a group of devices with a specific OS in mind. Currently, one could develop a native application for iOS devices (iPhone, iPad and iPod Touch), for Android devices (a plethora of smartphone and tablet devices developed by different manufacturers, that runs on Google's operating system), for Windows-compatible devices (Microsoft's newly developed OS, Windows operating system, is consistent with some third-party smartphones and tablets, as well as Microsoft's own newly designed surface tablets), for Blackberry, or for one of a few minor players (Korf & Oksman, 2012). Furthermore, Charland and Leroux (2011) state that:

*"Native applications are designed based on a set of specifications provided by the operating system publisher".*

Langrial *et al.* (2012:8) confirmed that the majority of mobile devices use one of the two most dominant native operating systems including: The Android with 48% of the worldwide mobile application users and the Apple with an estimated number of 41% of the worldwide mobile application users. Each of these operating systems ask that native applications be designed using a particular coding language for example, Objective-C for iOS, Java for Android, and typically C++ or C# for Windows (Kristbergsson, 2015:8). Figure 3.4 shows a graphical representation of a native application and its logic.


**Figure 3-4: Graphical representation of a native UI and the logic of a native application (Korf & Oksman, 2012).**

The distribution of a native application is directly performed by the operating systems publishing companies, such as Apple, Google and Microsoft, using the applications stored on the device (Charland & Leroux, 2011).

#### 3.2.2.2 Non-native applications or web based applications

Non-native applications are developed to operate across various devices and operating systems (Georgiev, Jana, & Shmatikov, 2014:4). Additionally, Georgiev *et al.* (2014:4) declare that designers are using platforms that are accessible on all devices, including Hypertext Mark-up Language (HTML) and JavaScript, for developing non-native applications. Moreover, these applications are integral websites that have been designed for tiny screens, although the design

of a non-native application becomes a challenge when designers are trying to develop a web application that supports different devices, with various screen sizes, resolutions, central processing units and graphics processing units (Georgiev *et al.*, 2014:6). Figure 3.5 shows a graphical representation of a web-based mobile application.


**Figure 3-5: Graphical representation of a Web based application UI and its logic (Korf & Oksman, 2012).**

Budiu and Nielsen (2011) stated that web applications turned out to be truly popular when HTML5 was developed and individuals understood that HTML5 provides native-like functionality in the browser. Currently, as an ever increasing number of applications use HTML5, the difference between web applications and regular web pages has turned out to be confusing, declared Wohlfahrt and Tasser (2015). Users receive a URL address, just as they would for a standard website, and navigate to it using the browser on their devices (White, 2013:2). Again, Nielsen and Budiu (2013) confirmed that with web application the operating system and device manufacturers have no influence over content or functionality (Nielsen & Budiu, 2013).

#### 3.2.2.3 Hybrid applications

Hybrid applications combine web-based functionalities and wrap them into a native container (White, 2013:9). In other words, hybrid applications put together the features of native and non-native applications to produce a set of native applications for individually targeted systems. Hybrid

applications are designed using a hybrid application framework such as PhoneGap, that supplies an embedded web browser that runs the application web code and provides bridges that will allow the web code to access local resources on the device and escape the browser (Georgiev *et al.*, 2014:6). Figure 3.6 shows a graphical representation of a hybrid mobile application.


**Figure 3-6: Graphical representation of a hybrid mobile application (Korf & Oksman, 2012).**

Hybrid applications (apps) are distributed via the appropriate application stores and, while some core functionality may only be altered via a new submission, other content may be updated immediately (Børnich, 2015:27). Further, Børnich (2015:27) stated that hybrid apps make it possible to embed HTML5 inside a thin native container, combining the best (and worst) elements of native and HTML5 apps. In fact there are two ways to implement a hybrid application according to Korf and Oksman (2012) which are:

- Local: HTML and JavaScript code is packaged inside the mobile application binary, in a manner similar to the structure of a native application. In this situation the REST APIs is utilised to move data back and forth between the device and the database.
- Server: Alternatively the web application is fully implemented from the server (with optional caching for better performance), simply using the container as a thin shell over the user interface web view (UIWebview).

Hybrid apps balance the strengths and weaknesses for both native and web apps by merging the two technologies into one (Børnich, 2015:28).

### 3.2.3 Mobile application markets

As indicated by Rahimian and Ramsin (2008:352), the number of mobile phones is increasing everywhere throughout the world, and this has created the perpetually expanding interest for specialised software. Holzer and Ondrus (2011:22) confirmed that for many years, the development of mobile applications was entirely supervised and overseen by the mobile network operators (MNO). Holzer and Ondrus (2011:22) expressed that recently, this has changed with the growth of multiple software companies with new platforms and mobile phones such as Android and the iPhone.

Currently, the mobile development market is dominated by a series of vast platform providers of operating systems and development tools including: Google with its Android operating system (OS), RIM with its Blackberry OS, and Apple with its iPhone OS, Microsoft with its Windows CE OS family, and Linux mobile operating system (LiMo) establishment with its LiMo OS (De Reuver & Haaker, 2009).

### 3.2.4 Mobile application distribution process

According to Holzer and Ondrus (2011:25), an application is designed and made available to consumers through an application portal. Holzer and Ondrus (2011:22) defined mobile portals as essential components that play the role of intermediary between designers and buyers in the mobile application distribution process. The mobile application user purchases applications directly from the portal and this operates as the sole provider of the designed application or serves as the "storefront" for developers (Adrian, 2002:11). Further, Adrian (2002:11) stated that the model is an entirely closed system, where purchases initiated by the user are directly invoiced to his or her monthly wireless bill. Figure 3.7 presents the application distribution model which follows a mediated approach as described in Adrian (2002:11) and Holzer and Ondrus (2011:25).

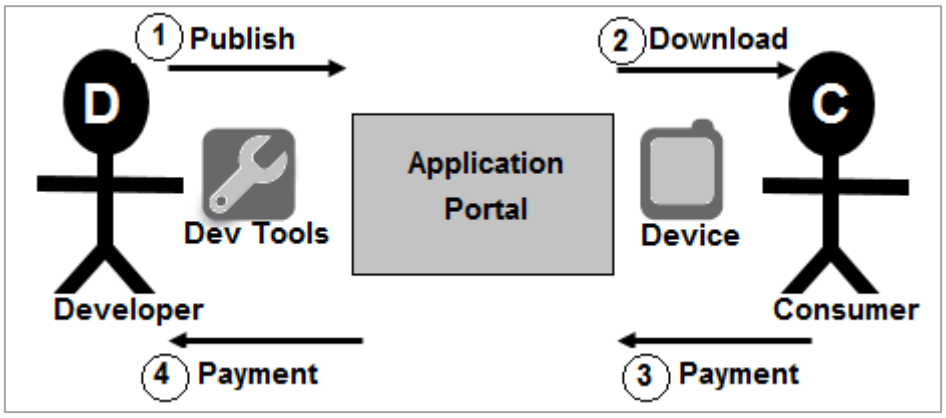


**Figure 3-7: Mobile application distribution process (Adrian, 2002:11; Holzer & Ondrus, 2011).**

Holzer and Ondrus (2011:22) asserted that two mobile portals are used to market mobile applications, namely, a centralised single point of sale strategy and a decentralised multiple point of sale strategy. Figure 3.8 presents the two portal trends proposed by Holzer and Ondrus (2011:22).

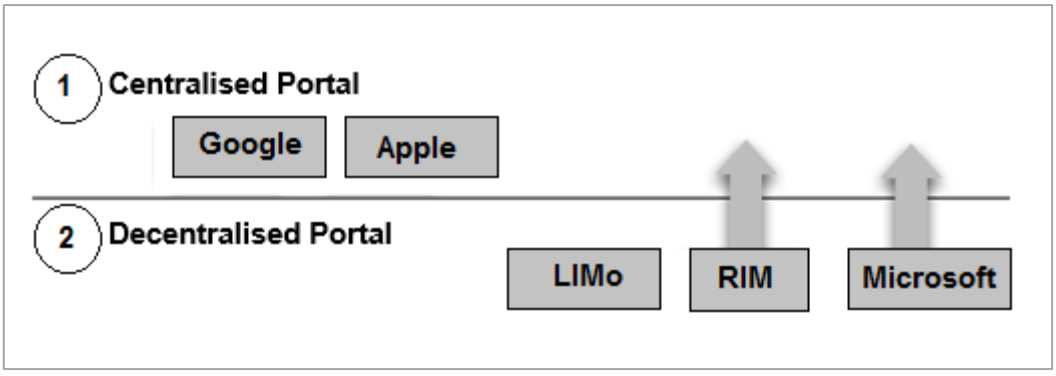


**Figure 3-8: Portal trends adapted from Holzer and Ondrus (2011:22)**

- Decentralised portal: In this model developers freely upload new applications on any third party portal.
- Centralised portal: In this model, most applications are published on one portal which is proposed as the main portal. Therefore, the main portal is given a competitive advantage over others in this approach.

Gereffi, Humphrey, and Sturgeon (2005) classified platforms according to their level of integration. Again, Holzer and Ondrus (2011:22) identified four different types of level of integrations, namely, full integration, portal integration, device integration and no integration. Figure 3.9 presents the four levels of platform integrations.

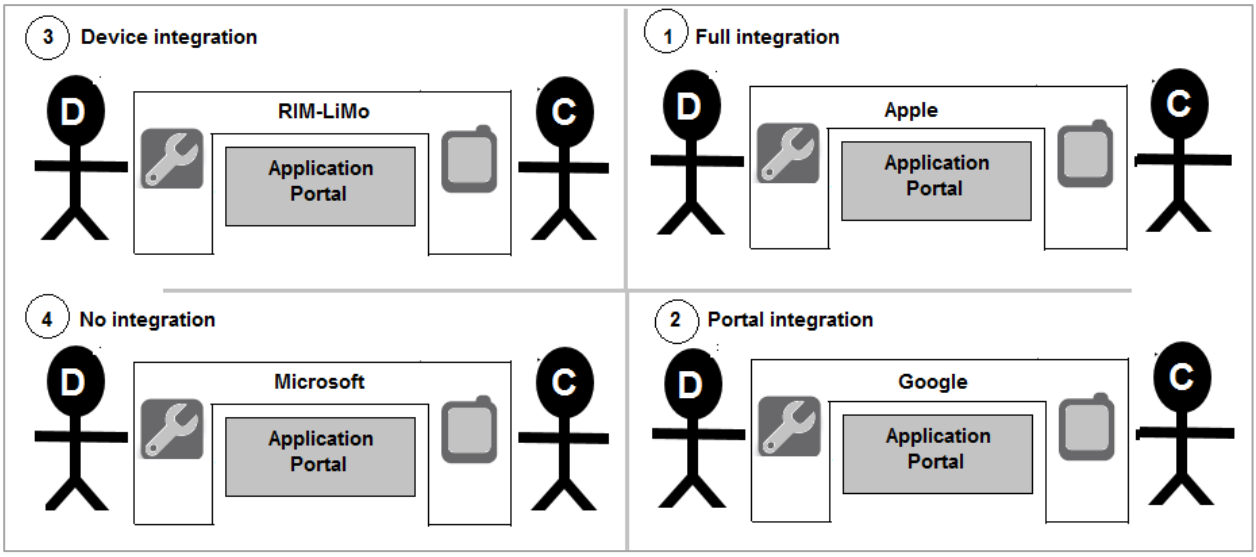


**Figure 3-9: Platform integration adapted from Holzer and Ondrus (2011:22)**

Table 3.2 presents a summarised explanation of the four different types of platform integrations quoted from Holzer and Ondrus (2011:22).

**Table 3-2: Platform integration quoted from Holzer and Ondrus (2011:22)**

| Platform integration |
|---|
| **Full integration**: platforms with a full integration have a strict control over every step of the distribution model from device manufacturing to application publishing. Apple produces the device on which its OS runs, namely, its iPhone, and it owns the unique authorized portal for mobile applications, namely the AppStore. |
| **Portal integration:** platforms with portal integration focus on application development and application sale by integrating a portal. Google provides such an integration with its Android Market |
| **Device integration:** in the device integration model, platforms also manufacture devices but are not in the application portal business. RIM and LiMo are such platforms. |
| **No integration:** platforms with no integration focus only on their core business. |

According to Parker and Van Alstyne (2005), the mobile application distribution model imitates a conventional two-sided market. In such a market, similar impacts are observed on both sides of the market. In a case of an increase or a decrease on one end the same effect will be induced on the other end (Adrian, 2002:12). A better two-sided market will provide a higher volume of transactions and can thus be attractive for the middleman to charge a fee per transaction (Parker & Van Alstyne, 2005).

In context of this research however, the mobile application artefact is detailed to the needs of a specific university, and it is suggested that the application be made available internally via, for example, the learning management system of the institution.

### 3.2.5 Mobile application design and development tools

Design and development terms are virtually interchangeable as “software companies” alternate the way they describe their services (Purelybranded, 2017). Furthermore, Purelybranded (2017) stated that the truth is these terms reference two fundamentally different aspects of the software building process requiring two unique skill sets. According to Purelybranded (2017), designers create the application layout and then hand the design files over to a programmer who completes the development stage. Concerning this study, the researcher will complete both the design and development of the artefact. These two terms will be used interchangeably. The design and development process will be explored in Chapter 6.

Software development kits (SDK) are crucial to each development platform and also allow third-party developers to create applications running on the platform (Capiluppi, Lago, & Morisio, 2003). Furthermore, Capiluppi *et al.* (2003) stated that generally these kits incorporate libraries, debuggers, and handset emulators. In order to ease the development process an integrated development environment (IDE) is provided. Current platforms have chosen different approaches when offering their SDK to designers. Raymond (1999) stated that some have favoured to limit access as much as possible, while others have decided to reveal the entire source code of their SDK and OS. As presented in Capiluppi and Michlmayr (2007:37) two technologies are distinguished, namely, closed technology (Section 3.2.5.1) following a cathedral model and open technology (Section 3.2.5.2) adopting a bazaar model.

#### 3.2.5.1 Closed technology

Raymond and Enterprises (2012) asserted that in a cathedral model (closed technology) control over all strategic decisions about the platform are done by the platform providers and therefore developers should be hired from these platform providers. In other words, closed technology providers will not leverage on freelancer developer communities to support the application design process. Lankford and Hepworth (2010) expressed that three platforms (i.e., Apple, Microsoft and RIM), representing roughly half of the total smartphone users, have chosen the proprietary software path.

#### 3.2.5.2 Open technology

In contrast, in an open technology (bazaar model), developers are granted access to parts or the entire SDK and operating system (OS) source code of the platform; therefore no central architect is responsible for the platform (Gizaw, Bygstad, & Nielsen, 2016). It has been confirmed that the use of open technology encourages the gathering of communities of developers (Wareham, Busquets, & Austin, 2009). As a result, the cost of developing and maintaining mobile applications are tremendously reduced. Currently, Linux and Google have opted to provide open platforms.

#### 3.2.5.3 A trend towards open technology

Linux Mobile (LiMo) has been the only provider in the open-technology field among the major mobile platforms providers, until Google adopted the open-source ideology when launching Android OS (Paletti, 2016). Later, Nokia also opted for the open-source ideology after acquiring and making Symbian OS open-source (Clark, Frank, & Kulkarni, 2016). The moving of major mobile platform providers toward open technology had a significant impact and the market shifted from a majority of closed systems to a minority dominated by mobile devices running open-source systems. Figure 3.10 presents the technology trend of major mobile platforms provider towards openness.

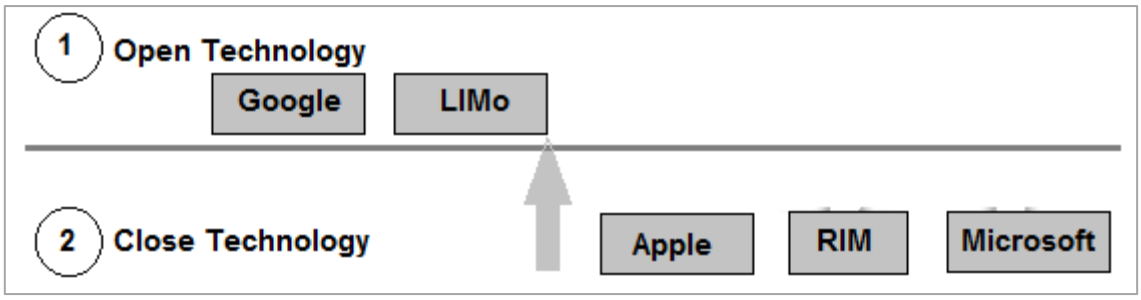


**Figure 3-10: Technological trends of major mobile platforms provider towards openness (Holzer & Ondrus, 2011:25).**

### 3.2.6 Advantages, disadvantages and challenges of mobile applications

The sections below present advantages, disadvantages and challenges of mobile application development and usability.

#### 3.2.6.1 Advantages of mobile applications

Bruck, Motiwalla, and Foerster (2012:341) state that mobile applications provide users with a number of valuable opportunities including personal control, ownership of the learning process

and the ability to make changes in their environment, which in turn makes the mobile application robust.

Even as early as the 1990's, the advantages of mobile applications were focused on its mobility and ease of use: the ability for users to connect to the Internet anywhere and at any time; and bringing mobile communications to remote areas without any pre-existing infrastructure at a low cost (Johnson & Maltz, 1996:4).

Additionally, Reddy (2002:41) presents a number of mobile application advantages which are:

- Reduction in network load: Communication protocols are used to achieve an interaction in a distributed system.
- Protocol encapsulation: Protocols allow components of a distributed system to exchange and co-ordinate all activities.
- Fault tolerance: Mobile applications react autonomously and dynamically to changes occurring in the mobile application environment, which in turn make mobile applications robust and fault tolerant.

#### 3.2.6.2 Disadvantages and challenges of mobile applications

Security is the main drawback when coming to mobile applications and most experts confirm that this risk is far more difficult to deal with (Reddy, 2002:42). Further, Reddy (2002:42) assert that a malicious host can tamper with the functioning of the mobile application causing damage. According to Reddy (2002:41), in spite of multiple improvements in the field of cryptography many security issues still exist and these need attention in mobile application development and usability.

Additionally, Wasserman (2010:4) stated that common issues in mobile applications include integration with device hardware, as well as traditional issues of security, performance, reliability, and storage limitations. However, mobile applications present some additional requirements that are less commonly found with traditional software applications. These issues are presented in Table 3.3.

**Table 3-3: Issues with mobile applications based on Wasserman's (2010:4) assessment.**

| **Disadvantages of mobile applications** |
|---|

| |
|---|
| **Potential interaction with other applications**: Mobile devices may have numerous applications from varied sources with the possibility of interactions among them. |
| **Native and hybrid applications**: Mobile devices often include applications that invoke services over the telephone network or the internet via a web browser and affect data and displays on the device. |
| **Security**: Most mobile platforms are open, allowing the installation of new "malware" applications that can affect the overall operation of the device, including the surreptitious transmission of local data by such an application. |
| **Complexity of testing**: While native applications can be tested in a traditional manner or via a PC-based emulator, mobile web applications are particularly challenging to test. Not only do they have many of the same issues found in testing web applications, but they have the added issues associated with transmission through gateways and the telephone network. |
| **Power consumption**: Many aspects of an application affect its use of the device's power and thus the battery life of the device. Dedicated devices can be optimised for maximum battery life, but mobile applications may inadvertently make extensive use of battery-draining resources. |

Rahimian and Ramsin (2008:351) also stated that there are various difficulties that mobile application designers have to cope with. These challenges are presented in Table 3.4.

**Table 3-4: Issues in mobile application development (Rahimian & Ramsin, 2008:351)**

| Challenges encountered by mobile application designers |
|---|
| Wireless communication issues (considerations such as availability and disconnection, bandwidth variability, heterogeneous networks, and security risks). |
| Mobility issues (concerns such as address migration, and management of location-dependent information). |
| Portability issues. |
| Various standards, protocols and network technologies. |
| Limited capabilities of terminal devices (factors pertaining to low power, risks to data integrity, small sized user interfaces, and low storage capacities). |
| Special privacy and customizability needs. |
| Strict time-to-market requirements. |

Most of these issues are the result of insufficiencies in current technology; however, the majority of them are intrinsic to mobility (Rahimian & Ramsin, 2008:352). Therefore, Rahimian and Ramsin

(2008:352) stated that designing a mobile application is much more complex than that frequently seen in software development projects, thus forcing developers to take into consideration the application of empirical software development methodologies.

### 3.2.7 Mobile development methodologies

Different methodologies exist for mobile development. Section 3.2.7.1 provides an overview of available approaches to mobile development. Section 3.2.7.2 further explores the mobile-D approach.

#### 3.2.7.1 Approaches to mobile development

Despite the fact that agile methodology offers an acceptable solution for mobile application development, distinctive methodologies exist for the development of mobile applications (Gruhn & Cheddie, 2005).

One approach to mobile development is called the Mobile-D methodology which is also known as an agile approach to mobile application development. Rahimian and Ramsin (2008:353) declared that this approach is employed for the iterative-incremental development of methodologies in view of a predefined set of necessities and the learning gained from existing methodologies and process patterns. Yan and Chen (2011:4) confirm that mobile-D methodology depends on the development practices acquired from XP (eXtreme Programming) and gives life-cycle scope as endorsed by the RUP (rational unified process).

Another approach, asserted by Gruhn and Cheddie (2005), is model-driven development (MDD) which includes utilising models not only to archive code but also as a basis for application development. The purpose of MDD is to acquire a framework that allows developers with no programming experience to design their own mobile application. MDD gives mobile application developers the possibility of creating a platform-independent application, which will be automatically be converted into platform-specific code (Balagtas-Fernandez & Hussmann, 2008)

Another alternative approach is presented by Rahimian and Ramsin (2008:354) called hybrid method engineering. This method produces reasonable techniques for different development scenarios, motivated by the conviction that no single process fits all circumstances.

Many more approaches exist for the design of a mobile application. Some methodologies are presented in Abrahamsson, Hanhineva, Hulkko, Ihme, Jäälinoja, Korkala, Koskela, Kyllönen, and Salo (2004:177) . Table 3.5 provides an overview of available methodologies that can be applied to mobile development.

**Table 3-5: Methodologies applied for mobile development.**

| Methodology | Description |
|---|---|
| Extreme programming (XP) | According to Kirmani (2017:1203), XP is a collection of well-known software engineering practices. Some of the main characteristics of XP are rapid feedback, close customer participation, constant communication and pair programming. |
| Scrum | Scrum has been developed for managing the software development process in a volatile environment and also encourage researchers to embrace changes (Kirmani, 2017:1202). Further, Almasri (2016:3) attest that Scrum will assist developers to concentrate on established goals and minimise the work done on less important tasks. |
| Crystal | The Crystal methodology is one of the most lightweight, adaptable approaches to software development (Kirmani, 2017:1203). Almasri (2016:3) confirmed that this method has many practices based on complexity like size and type of team. |
| Dynamic software development method (DSDM) | It is fully agile software development method. The fundamental idea is that instead of fixing the amount of functionality in a product and then adjusting time and resources to reach the functionality, it is preferred to fix the time and resources (Almasri, 2016:4). |
| Rapid application development (RAD) | In this methodology a rapid prototype is built up and given to user for evaluation and feedback (Almasri, 2016:2). |
| Spiral model | In this methodology the work is completed similar to the waterfall process model through a sequence of activities with some backtracking between activities (Almasri, 2016:2). |
| Adaptive software development (ASD) | Attempts to bring about a new way of seeing the software development in an organisation, promoting an adaptive paradigm (Kirmani, 2017:1203). Further, Kirmani (2017:1203) asserts that ASD encourages incremental and iterative development with constant prototyping. |

With reference to this study, mobile-D is adopted as a suitable option for the design of the application and is further discussed in the next section.

### 3.2.7.2 Mobile-D development methodology

Mobile-D is considered to be a powerful and proficient approach to accommodate rapidly changing demands of the market and to cope with modern software development trends (Kaleel & Harishankar, 2013:5).

Spataru (2010:14) explains that Mobile-D comprises five phases, namely, explore, initialise, productionise, stabilise, and system test & fix. Each of these phases has a number of associated stages, tasks and practices (Spataru, 2010:14). Figure 3.11 presents the five phases of mobile-D methodology.

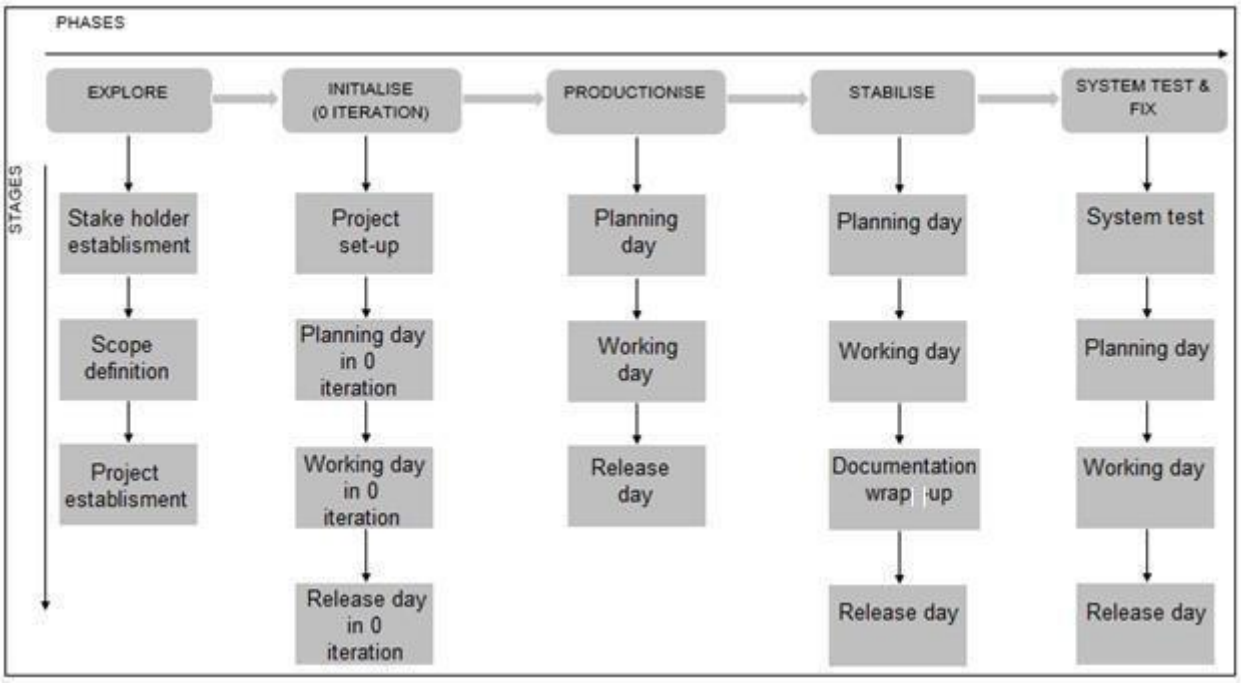


**Figure 3-11: Mobile-D phases and stages (Spataru, 2010:14).**

The five phases of Mobile-D are further explained in Table 3.6.

**Table 3-6: Mobile-D phases and stages explanation (Spataru, 2010:14).**

| **Mobile-D phases and stages** |
|---|

| |
|---|
| **Explore:** The development team must generate a plan and establish project characteristics. This is done in three stages: stakeholder establishment, scope definition and project establishment. Mobility issues (concerns such as address migration, and management of location-dependent information). |
| **Initialise**: Developers and all active stakeholders understand the product in development and prepare the key resources necessary for production activities, such as physical, technological, and communications resources. This phase is divided into three stages: project set-up, initial planning and trial day. |
| **Productionise**: This phase mainly comprises implementation activities. At the end of this phase, most of the implementation should be complete. This phase is divided into planning days, working days, and release days. |
| **Stabilise and System Test & Fix:** The final two phases are used for product finalisation and testing, respectively. They comprise stages similar to the productionise phase, with some modifications to accommodate documentation building and system testing. |

Abrahamsson *et al.* (2004:175) stated that the Mobile-D approach has been tested and further developed in different case studies within the ENERGI (Industry-Driven Experimental Software Engineering Initiative) laboratory at the Technical Research Centre of Finland. Further, these cases were concerned with new mobile phone extensions of database systems (Abrahamsson *et al.*, 2004:174).

Mobile-D provides a good fit for the development of mobile applications (Abrahamson *et al.*, 2003). The following positive observations have been made when applying the Mobile-D approach (Abrahamsson *et al.*, 2004:175):

- increased progress visibility,
- early identification,
- solving of technical problems,
- shared responsibility,
- efficient information sharing, and
- high process practice coherence.

According to Abrahamsson *et al.* (2004:174), web-based solutions require an app to stay on-line more or less permanently which may cause considerable costs and usability restrictions. Mobile-

D can help to improve this situation through a faster development process and easier adaptability to new features of underlying platforms (Taentzer & Vaupel, 2016:24).

### 3.2.8 Adopted platform for designing the mobile app for the trading of used books at a specific university

The first challenge in designing an app is to select the right technology for the target device platforms and desired functionality (Børnich, 2015:27). Developing effective learning solutions for mobile delivery involves multiple disciplines and a wide range of technologies. This may sound simple in theory, but is a complex process due to a range of factors such as the highly fragmented mobile technology landscape, rapidly evolving standards, limitations imposed by the mobile device itself (screen size, input methods, display capabilities, etc.) and also constraints of the mobile network such as high latency and low bandwidth.

Cross-compiling separates the designed environment from the targeted environment, effectively decoupling a source from its target. In the mobile development context it works as follows: the framework provides a platform-independent API (application programming interface) using a mainstream programming language (like JavaScript, Ruby or Java) (Børnich, 2015:27). Developers use the API to build the mobile application, including the UI, data persistence and business logic, and the software artefact generated from this process can be deployed and executed natively on the device (Böhmer, Hecht, Schöning, Krüger, & Bauer, 2011).

Since the required application will be used by different people with different mobile devices (sizes and OS), a suitable choice is to design a hybrid / cross-platform mobile application. Developing a cross-platform mobile apps can be achieved in several ways. This research focuses mainly on open source frameworks although commercial tools also exist.

With reference to this study, a hybrid mobile application was built using the capabilities of HTML 5 and CSS 3, including embedded SQL databases, local storage, animations, canvas, web sockets and video playback and to make it appear and behave as a native app. This technique brings the best of both worlds into a single integrated solution: the flexibility of web apps with speed and feature richness of native apps.

In order to determine requirements for the design of the hybrid mobile application artefact, a literature review of design principles for mobile applications are discussed next.

### 3.3 Guidelines for creating mobile application

The most essential thing to have in mind when developing a mobile application is to ensure it is both useful and intuitive (Babich, 2016). Moreover, Babich (2016) state that good user interface (UI) design addresses these design problems:

- Mobile apps should be user-centric in order to be useful. Users install the app because they need to solve a pressing problem. Thus, the app has a sharply defined "sense of purpose." Think about what it is your users will be trying to accomplish and focus on their key goals/remove all obstacles from their way.
- Designers should bring clarity into the UI for the designed interface to be effective and users should be able to identify the goal of the designed interface and how to use it.

Babich (2016) provides nine design principles, given in Table 3.7, that are key for designing acceptable mobile applications.

**Table 3-7: Nine guiding principles for designing a mobile application (Babich, 2016).**

| Guiding principles | Description |
|---|---|
| 1. Cut out the clutter | User attention is a precious resource and should be allocated accordingly. Cluttering the interface overloads users with too much information: every added button, image, and line of text make the screen more complicated. |
| 2. Make navigation self-evident | Good navigation should feel like an invisible hand that guides the users along their journey. The principles of good mobile navigation are:<br>• Mobile navigation must be coherent.<br>• Mobile navigation must be consistent for the app.<br>• Mobile navigation should communicate the current location. |
| 3. Create a seamless experience | Mobile app developers should not think of a mobile design in isolation. Creating a seamless experience across mobile applications, desktop application and tablet applications is very important for users. |
| 4. Design finger-friendly tap-targets | Smaller touch targets are harder for users to hit than larger ones. When designing mobile interfaces, it is best to make targets big enough to easily tap. |
| 5. Text content should be legible | When compared with desktops, smartphones have relatively small screens, which means that one of the challenges of mobile design is to fit a lot of information on a small UI. A rule of thumb for mobiles: text should be at least 11 points so it's legible at a typical viewing distance without zooming. |

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|---|---|
| 6. Make interface elements clearly visible | Choose primary, secondary, and accent colours for the application that support usability. Ensure sufficient colour contrast between elements so that users with low vision can see and use the app. Make sure there is ample contrast between the font colour and the background so texts are legible. The world wide web consortium (W3C) recommends the following contrast ratios for body text and image text:<br>• Small text should have a contrast ratio of at least 4.5:1 against its background.<br>• Large text (at 14 pt bold/18 pt regular and up) should have a contrast ratio of at least 3:1 against its background. |
| 7. Design controls based on hand position | Hoober and Berkman (2011:231) uncovered that 49% of people rely on one thumb to get things done on their phones. Hand positions and grip should influence the placement of controls on a mobile design:<br>• It is important to place top-level menu, frequently-used controls and common actions in the center of the screen because they are comfortably reached with one-thumb interactions.<br>• Place negative actions (such as delete or erase) in the hard to reach zone, because you do not want users to accidentally tap them. |
| 8. Minimize need for typing | Typing on a mobile is a slow and error-prone process. It is therefore best to always try to minimize the amount of typing required to use a mobile app:<br>• Keep forms as short and simple as possible by removing any unnecessary fields.<br>• Use auto-complete and personalized data where appropriate so that users only have to enter the bare minimum of information. |
| 9. Test the design | Even the most painstakingly-considered user experience (UX) will ultimately contain some unseen flaw when put into the real world. Designers should treat your app as a continuously evolving entity, using data from analytics and user feedback to constantly improve the experience. |

As stated by Leung (2007) mobility is huge and growing, the convergence of cloud computing, ubiquitous broadband, and affordable mobile devices have begun to transform every aspect of societies. Currently, mobile phones overtake desktop computers as user's primary means for accessing the internet (Babich, 2016). Babich (2016) stated that although mobile devices are often lumped together as computing devices, smartphones and desktop computers remain different in numerous ways: small screen versus big screen, intermittent versus reliable connectivity, low versus high bandwidth, battery powered versus plugged in, and so on.

Given the numerous contrasts between mobile and desktop computing devices, it should occur as no shock that the development of a mobile application is more distinct to the development of a desktop application (Stark, 2012). Stark (2012) proposed a list of ten design principles for mobile applications, given in Table 3.8.

**Table 3-8: Ten guiding principles for the design of a mobile application (Stark, 2012).**

| Guiding principles | Description |
|---|---|
| 1. Mobile mind set | Because of the differences between mobile and desktop, it is imperative to get yourself into a mobile mind set before getting started. |
| 2. Mobile contexts | To begin to put ourselves in the shoes of mobile app users, one needs to consider three major mobile contexts: bored, busy and lost. |
| 3. Global Guidelines | Different apps call for different approaches, designs and techniques such as: responsiveness, polish, thumbs, targets, content and controls, avoid scrolling. |
| 4. Navigation Models | There are plenty of novel navigation models for mobile apps but if one chooses to use one of the common navigation models, be sure to pick the one that makes the most sense for the app.<br>• None: Single screen utility apps (e.g. Weather app on iPhone)<br>• Tab bar: Three to six distinct content areas (e.g. Twitter for iPhone)<br>• Drill down: List and detail content hierarchy (e.g. Settings app on iPhone) |
| 5. User input | Typing stinks even on the best devices, so the developer should do what needs to be done to make it easier for mobile app users. |
| 6. Gestures | One of the most iconic aspects of modern touch interfaces is that they support gesture-based user interaction. |
| 7. Orientation | Portrait is by far the most popular orientation so optimise for this case first. If the app invites lots of typing, mobile app developers should implement landscape orientation so users can access |

| | |
|---|---|
| | the larger keyboard. When orientation changes unexpectedly, it is, well… disorienting. If the developer thinks the designed app will be used for long periods of time consider adding an orientation lock right in the app. |
| 8. Communications | Provide feedback (provide instant feedback for every interaction), modal alerts (use them when something is seriously wrong. Even then, try to mitigate the intensity by keeping the language reassuring and friendly), confirmations (when the app will have to ask a user to confirm an action, it is acceptable to display a modal confirmation dialog). |
| 9. Launching | When a user goes back into the app after having used it previously, the user should resume operations right where the user left off. This will give the illusion of speed and contribute to an overall feel of responsiveness. |
| 10. First impressions | The icon has to compete for attention in a sea of other icons. Use a strong silhouette and keep text to a minimum. A polished icon suggests a polished app, so it is worth devoting serious time and money to doing it right. |

Ramsay and Nielsen (2000) provided seven guiding principles for the development of a mobile application. These proposed guidelines for creating a mobile application are given in Table 3.9.

**Table 3-9: Seven guiding principles for the development of mobile application according to Ramsay and Nielsen (2000).**

| Guiding principles | Description |
|---|---|
| 1. Mobility | Provide information while on the move. |
| 2. Usefulness | Serving some purpose. |
| 3. Relevance | Include only relevant information. |
| 4. Ease of use | The degree to which a software can be used specifically. |
| 5. Fluency of navigation | Most important information should be easiest to locate. |
| 6. User centered | Adapt to the users' way of interaction and way of thinking. |
| 7. Personalisation | Adapt to the users' needs and capability. |

According to Wasserman (2010:4), while a considerable number of mobile applications make it appear that developing software for them are easily understood, there is still a large number of intricate matters where a significant amount of work is required. Spataru (2010) stated that it is quite difficult to provide guidelines for mobile application design due to the great diversity of this type of application.

### 3.4 Consolidated mobile application design principles

As stated by Xiao-qing (2010) mobile application design desires a slightly different mind-set to that of desktop application development. Furthermore, Xiao-qing (2010) asserted that mobile application development requires a slightly different skillset, and certainly different design principles. In other words, a mobile application should be lightweight, quick, nimble, focused and stripped down. Again a mobile application should not be bloated with unnecessary features as mobile devices are simply too small and complex, their duration of use too short and their environment too distracting to try to do too much. Table 3.10 presents a consolidated list of principles adopted from all principles listed in Section 3.3..

**Table 3-10: Consolidated guiding principles for designing a mobile application (Ramsay & Nielsen, 2000; Stark, 2012; Babich, 2016).**

| | Mobile application design principles | |
|---|---|---|
| M1 | Cut out the clutter | User attention is a precious resource, and should be allocated accordingly. Cluttering the interface overloads the user with too much information: every added button, image, and line of text make the screen more complicated (Babich, 2016). |
| M2 | Make navigation self-evident | Good navigation should feel like an invisible hand that guides the user along their journey (Babich, 2016). |
| M3 | Create a seamless experience | Developer should not think of a mobile design in isolation. Creating a seamless experience across mobile, desktop and tablet is very important for the users (Babich, 2016). |
| M4 | Design finger-friendly tap-targets | Smaller touch targets are harder for users to hit than larger ones. When you are designing mobile interfaces, it is best to make your targets big enough so that they are easy for users to tap (Babich, 2016). |
| M5 | Text content should be legible | When compared with desktops, smartphones have relatively small screens, which means that one of the challenges of mobile design is to fit a lot of information on a small UI. A rule of thumb for mobile: text should be at least 11 points so it is legible at a typical viewing distance without zooming (Babich, 2016). |

| | | |
|---|---|---|
| M6 | Make interface elements clearly visible | Choose primary, secondary, and accent colours for the app that support usability. Ensure sufficient colour contrast between elements so that users with low vision can see and use the app (Babich, 2016). |
| M7 | Design controls based on hand position | Hand positions and grip should influence the placement of controls on a mobile design (Babich, 2016):<br>• It is important to place top-level menu, frequently-used controls and common actions to the center of the screen, because they are comfortably reached with one-thumb interactions.<br>• Place negative actions (such as delete or erase) in the hard to reach zone, because designers do not want users to accidentally tap them. |
| M8 | Minimize need for typing | Typing on a mobile is a slow and error-prone process. It is therefore best to always try to minimize the amount of typing required to use a mobile app (Babich, 2016; Stark, 2012). |
| M9 | Test your design | Even the most painstakingly-considered UX will ultimately contain some unseen flaws when put into the real world. One should ask real users to proceed regular tasks only after that it can be seen how well the design really performs. Treat the designed app as a continuously evolving entity, using data from analytics and user feedback to constantly improve the experience (Babich, 2016). |
| M10 | Mobile mind set | Because of the differences between mobile and desktop, it is imperative to get yourself into a mobile mind set before getting started (Stark, 2012). |
| M11 | Mobile contexts | Designers should put themselves in the shoes of the users, one need to consider three major mobile contexts: Bored, Busy and Lost (Stark, 2012). |
| M12 | Global guidelines | Different apps call for different approaches, designs and techniques such as: responsiveness, polish, thumbs, targets, content and controls, avoid scrolling (Stark, 2012). |
| M13 | | There are plenty of novel navigation models for mobile apps but if one chooses to use one of them, be sure to pick the one that |

| | | |
|---|---|---|
| | Navigation models | makes the most sense for the designed app (Ramsay & Nielsen, 2000; Stark, 2012).<br>• None: Single screen utility apps (e.g. Weather app on iPhone)<br>• Tab bar: Three to six distinct content areas (e.g. Twitter for iPhone)<br>• Drill down: List and detail content hierarchy (e.g. Settings app on iPhone) |
| M14 | Gestures | One of the most iconic aspects of modern touch interfaces is that they support gesture-based user interaction (Stark, 2012; Ramsay & Nielsen, 2000). |
| M15 | Orientation | Portrait is by far the most popular orientation so optimise for this case first. If the designed app invites lots of typing, designers should implement landscape orientation so users can access the larger keyboard. When orientation changes unexpectedly, it is, well disorienting. If the app is intended to be used for long periods of time consider adding an orientation lock right in the app (Stark, 2012). |
| M16 | Communications | Provide feedback (Provide instant feedback for every interaction), Modal alerts (use them when something is seriously wrong. Even then, try to mitigate the intensity by keeping language reassuring and friendly), Confirmations (When you have to ask a user to confirm an action, it is acceptable to display a modal confirmation dialog) (Stark, 2012; Ramsay & Nielsen, 2000). |
| M17 | Launching | When a user goes back into the app after having used it previously, the app should resume operations right where the user left off. This will give the illusion of speed and contribute to an overall feel of responsiveness (Stark, 2012). |
| M18 | Usefulness | Serving some purpose (Ramsay & Nielsen, 2000). |
| M19 | Relevance | Include only relevant information (Ramsay & Nielsen, 2000). |
| M20 | Ease of use | The degree to which a software can be used specifically (Ramsay & Nielsen, 2000). |

| | | |
|---|---|---|
| M21 | Personalisation | Adapt to the users' needs and capability (Ramsay & Nielsen, 2000). |
| M22 | First impressions | Your icon has to compete for attention in a sea of other icons. Use a strong silhouette and keep text to a minimum. A polished icon suggests a polished app, so it's worth devoting serious time and money to doing it right (Stark, 2012). |

This concludes the discussion of mobile applications. In the next chapter, a closer look at human-computer interaction is considered to further enrich the guidelines for creating a mobile application that fulfils the need of students at a university in terms of acquiring second hand books.

## 3.5 Conclusion

Mobile applications are invaluable and has the potential to change the way we perceive and engage with traditional learning tools and paradigms. It can make learning widely available to people anywhere at any time. The aforementioned guidelines in the development process of a mobile application will be used in the design of the mobile application for the trading of used books at a university using a DSR approach. In order to achieve this, an in-depth look at human-computer interaction is discussed in the following chapter for the identification of key factors and principles that are needed for the design of a multiplatform mobile application.

Figure 3.12 provides an adaptation of the design science research process to represent the research structure of this study.

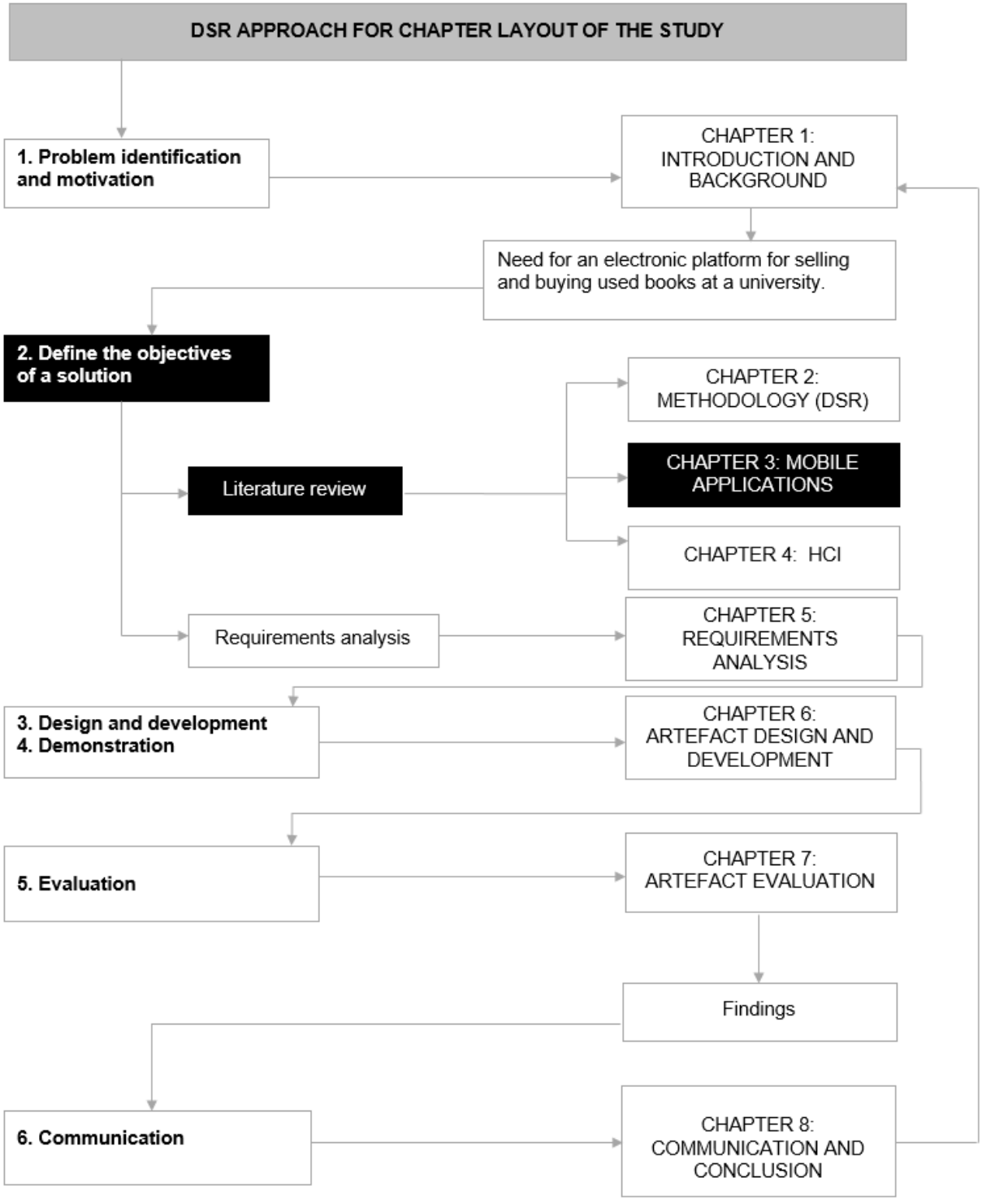


**Figure 3-12: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

# CHAPTER 4: HUMAN-COMPUTER INTERACTION

## 4.1 Introduction

The goal of this study is to design a mobile application for the trading of used books at a university following a design science research approach. It is recommended to perform an analysis of human-computer interaction (HCI) principles within the context of mobile applications to inform the design process.

According to Sharp, Rogers, and Preece (2007:78), HCI is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use. Additionally, HCI can be understood as a set of procedures and activities through which people interact with a computer (Baecker & Buxton, 1987:40). Issa and Isaias (2015:6) argue that the goals of HCI are to generate usable and safe systems, as well as functional systems. Moreover, HCI goals can be expressed in a concise form as: effectiveness, safety, efficiency, utility, and support (Issa & Isaias, 2015:6). In other words, HCI research is conducted to facilitate a scientific apprehension of the interaction between humans and computers (Dix, Finlay, & Abowd, 2004:3).

We do not only refer to a unique desktop computer with a single user, when considering human-computer interaction. Therefore, Dix *et al*. (2004:4) define each term of human-computer interaction as follows:

- Human – a user completing a task by employing technology. A human can either be seen as a single user, or a group of users working together to complete tasks in sequence within an organisation.
- Computer – any type of technology going from a typical desktop computer to a process system, a vast network of computers, or a system that is inserted inside other devices
- Interaction – any technique of conveyance that occurs between a human and the computer. Two types of interaction are provided:
    - Direct interaction: it is communication between the human and the computer with feedback and monitoring throughout the entire process.
    - Indirect interaction: it is communication between the human and the computer involving different methods of communication, such as intelligent sensors that serve to monitor the entire process.

Despite the fact that we define each of the terms independently, the most critical aspect for HCI is that the human is interacting with a computer and the end goal is to complete some particular tasks (Dix *et al.*, 2004:4). HCI has become an umbrella term for a number of disciplines including

theories of education, psychology, collaboration as well as efficiency and ergonomics as shown in Figure 4.1.

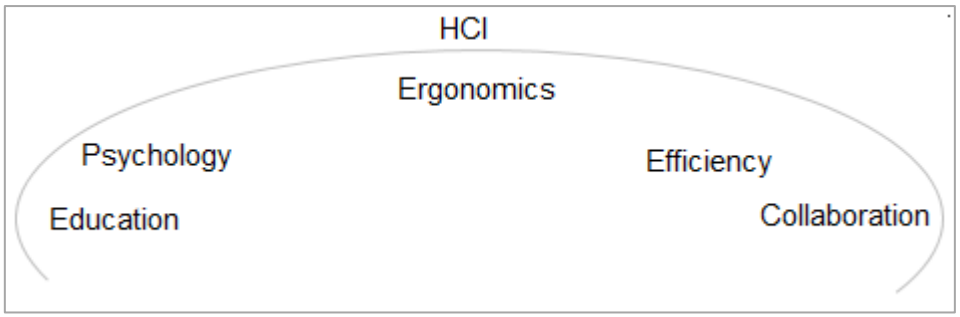


**Figure 4-1: HCI Components (Hinze-Hoare, 2007:2)**

This chapter will be divided as follows: Section 4.2 will cover HCI in general. Section 4.3 will be discussing human-computer interaction principles. Section 4.4 discusses selected HCI principles for this study. Section 4.5 presents enriched guidelines for the design of a mobile application. Section 4.6 concludes the chapter.

## 4.2 An overview of HCI

Technology has improved to such an extent that it is no longer a matter of what technology is capable to accomplish, but what users need to achieve, as technology can currently provide nearly unrestrained processing capabilities (Smith-Atakan, 2006:4). For an effectiveness and acceptable use of a computer by its intended users, the interaction needs to be well designed (Preece *et al.,* 1994:5). The term 'well-designed' does not imply that a computer interface needs to be designed in such a way as to accommodate every prospective user, but rather to be designed to cater for the capabilities and needs of the users for which it was intended (Preece, Rogers, Sharp, Benyon, Holland, & Carey, 1994:5). Human-computer interaction (HCI) serves to unite both theory and practice as it intends to ameliorate the understanding of both the designs that users need and the design processes intricate in their development (Smith-Atakan, 2006:2). Below are presented crucial aspects in the field of HCI (Smith-Atakan, 2006:184):

- It gives an outline of an interactive system from the user point of view.
- It helps in the strategic investigation of the accessibility and usability of current interactive systems.
- It promotes the development and creation of interactive systems that are valuable, accessible and usable.
- It helps in the assessment of various design options.
- It substantiates the achievability of developing interactive systems that are less demanding to utilise.

For a successful development of a computer interface, developers need to be aware of the capabilities and limitations of humans and account for these in the design of a human-computer interface. Preece *et al*. (1994:8) present two major challenges that HCI designers are faced with, which are:

- How to stay aware of the rapid changes that happen inside the field of technology.
- How to guarantee that their designs display great HCI principles while using the functionality of the new technology to its maximum capacity.

By the same token, Dix *et al.* (2004:4) disclose that there are four main concerns in HCI, namely, the humans, the computers, the tasks that are performed and the support a computer provides a user in achieving a task. For a human to successfully accomplish a task a computer needs to satisfy three 'use' words (Dix *et al*., 2004:5):

- Useful – the user should be able to accomplish the intended task through the use of the computer (e.g. receiving an email).
- Usable – the user should be able to complete the task easily and in a natural manner (e.g. pressing a 't' key should produce the letter 't' and not 'a').
- Used – the computer should be attractive, fun, engaging, etc., and as a result make individuals to enjoy using it.

Smith-Atakan (2006:4) declares that an interactive system is a technological system that portrays interaction between user and the interactive system. Interactive systems have forged their way into everyday activities and examples of these systems include automatic teller machines, cars, vending machines and cell phones. Four major components for interactions are identified by the interaction framework which are depicted in Figure 4.2. The four components for interaction are: the user (U), the system (S), the input (I) and the output (O), which each have their own respective languages. The input and output components combined constitute the interface (Abowd & Beale, 1991:75). The interface can be observed as the layer that allows the system and the user to interact with each other and convey the flow of information from one end to the other end (Löwgren, 2001:31; Huang, Blevis, Mankoff, Nathan, & Tomlinson, 2009).

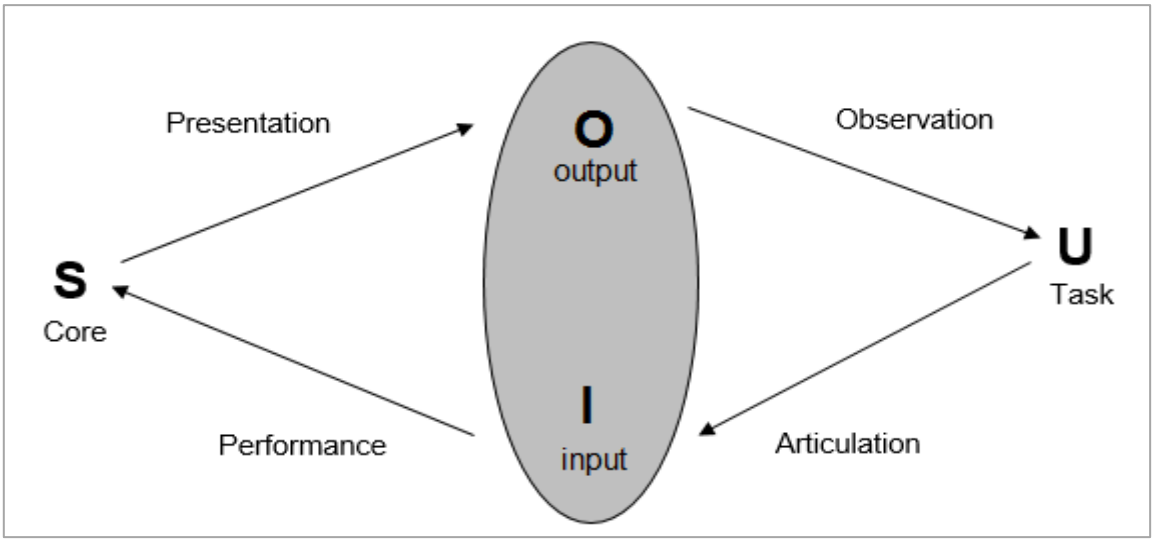


**Figure 4-2: General interaction framework (Abowd & Beale, 1991:75)**

It is vital for HCI practitioners to put careful consideration into the design of software systems and the possible interactions that can take place in order to provide a positive experience for the user while reducing negative experiences (Sharps, Rogers, & Preece, 2011:2). Software designers should have an understanding of interactive computer systems on the one hand and the human user on the other. In order to successfully produce an interactive system that is useful, usable, and used it is important to design it for the intended human user (Zhang, Carey, Te'eni, & Tremaine, 2004:575).

### 4.3 HCI principles

Wickens, Gordon, Liu, and Lee (1998:184) stated that before designing an interactive system, the task that the display is intended to support must be defined (e.g. navigating, controlling, decision making, learning, entertaining, etc.). To continue, Wickens *et al.* (1998:184) asserted that a user or operator must be able to process whatever information that a system generates and displays; therefore, the information must be displayed according to principles in a manner that will support perception, situation awareness, and understanding. HCI practitioners and designers employ design rules to pattern them in creating an effective user experience (UX) of interactive systems (Dix *et al.*, 2004:259).

HCI principles are abstract and general design rules, meaning that they can be applied to a wide variety of design situations. These design principles are mostly derived from research in the fields of psychology, sociology, cognitive science and computer science and tend to be context free (Dix *et al.*, 2004:259; Zhang *et al.*, 2004:576).

In general, the objective of an interactive system is to help a user in his/her intention to fulfil a specific aim within a given domain (Dix *et al.*, 2004:125). In other words, an interactive system is described as a user-oriented system in which the focal point is based on significant communication of media through recurrent and communal processes between individual and technology. Once more, successful interactive designs have basic, clearly described goals, strong objectives, and intuitive screen.

Over and above that, Norman (2013:72) developed seven fundamental principles of design which are listed and briefly discussed in Table 4.1.

**Table 4-1: Seven fundamental principles of design (Norman, 2013:72)**

| HCI principles | Definitions |
|---|---|
| 1. Discoverability | The user must be able to determine the current state of the system as well as what the currently available actions are. |
| 2. Feedback | The user must continually receive information about the results of actions and be able to easily determine the new state of the system after the actions were executed. |
| 3. Affordances | Affordance is the relationship between the properties of an object and the capabilities of the agent interacting with the object. |
| 4. Signifiers | Signifiers must be used effectively to ensure discoverability and that feedback is understandable to the user. |
| 5. Mappings | Good mappings between controls, their actions and the results must exist. Mappings are enhanced through spatial layout and temporal contiguity. |
| 6. Conceptual model | The system must provide all the information to the user to allow the user to create a good conceptual model of the system, which leads to understanding and feeling in control. A good conceptual model enhances discoverability and evaluation of results. |
| 7. Constraints | Providing physical, logical, semantic and cultural constraints guides the user to available actions and eases the user's interpretation when using the system. |

Middleton, Bloomrosen, Dente, Hashmat, Koppel, Overhage, Payne, Rosenbloom, Weaver, and Zhang (2013) declared that to enrich the usability of an application it is vital to procure a well-designed interface. Shneiderman's "Eight golden rules of interface design" are a guide to better interaction design (Middleton *et al.*, 2013). Shneiderman (1992:60) proposed this set of principles that are derived heuristically from experience and is applicable in most interactive systems after being properly refined, extended, and interpreted. Shneiderman's eight golden rules are listed below in Table 4.2.

**Table 4-2: Eight golden rules for interface design (Shneiderman, 1992:60).**

| Eight golden rules of interface design |
|---|
| 1. Strive for consistency in action sequences, layout, terminology, command use and so on. |
| 2. Enable frequent users to use shortcuts, such as abbreviations, special key sequences and macros, to perform regular, familiar actions more quickly. |
| 3. Offer informative feedback for every user action, at a level appropriate to the magnitude of the action. |
| 4. Design dialogs to yield closure so that the user knows when they have completed a task. |
| 5. Offer error prevention and simple error handling so that, ideally, users are prevented from making mistakes and, if they do, they are offered clear and informative instructions to enable them to recover. |
| 6. Permit easy reversals of actions in order to relieve anxiety and encourage exploration, since the user knows that he or she can always return to the previous state. |
| 7. Support internal locus of control so that the user is in control of the system, which responds to his/her actions. |
| 8. Reduce short term memory load by keeping displays simple, consolidating multiple page displays and providing time to learn action sequences. |

Moreover, Johnson (2007:8) developed a number of fundamental principles of design which are listed and briefly discussed in Table 4.3.

**Table 4-3: Design principles for user interface (Johnson, 2007:8)**

| HCI design principles |
|---|
| 1. Focus on the users and their tasks, not on the technology. |
| 2. Consider function first, presentation later. |
| 3. Conform to the users' view of the task. |
| 4. Design for the common case. |
| 5. Do not complicate the user's task. |
| 6. Facilitate learning |
| 7. Deliver information, not just data. |
| 8. Design for responsiveness. |
| 9. Try it out on users; then fix it. |

Developers should keep the interface as simple as possible and task-focused (Stone, Jarrett, Woodroffe, & Minocha, 2005:179). Below Stone *et al.* (2005:97) present, in Table 4.4, design principles that could help developers to achieve this goal.

**Table 4-4: Stone *et al.* (2005:97) design principles for user interface.**

| HCI design principles |
|---|
| 1. Visibility – The first step in order to achieve the goal should be clear. |
| 2. Affordance – The control should suggest how the user should use it. |
| 3. Feedback – What happened or is happening should be clear. |
| 4. Simplicity – As simple as possible and task-focused. |
| 5. Structure – Sensible organisation of content. |
| 6. Consistency – Similarity for predictability. |
| 7. Tolerance – Prevent errors and aid in recovery. |
| 8. Accessibility – Usable by all intended users in spite of handicap, or environmental conditions. |

Although HCI principles allow more complex work to be placed within the bounds of a common framework, it concentrates on the interaction from the user's point of view. Limitations and benefits of HCI principles will be discussed in the following section.

### 4.3.1 Review and analysis of HCI principles

According to Hinze-Hoare (2007:7) it has been proven that HCI is in a state of fragmentation. This leads to the issue of selecting consistent and coherent sets of principles by which HCI performance of an interface will be measured. Hinze-Hoare (2007:1) performed an in-depth review and analysis of human-computer interaction principles that include those mentioned in Table 4.1, Table 4.2, Table 4.3, Table 4.4 and others. In doing so, Hinze-Hoare (2007:7) attempts to standardise a scope of recommended principles and to identify the principles that constitute the most remarkable set. The standardisation process started with a survey grounded on the citation frequency of authors of HCI principles. Hinze-Hoare (2007:7) accepted that the most frequently author cited would offer the most respected and significant HCI principles. Moreover, Hinze-Hoare employed the citation frequency of authors as a way of weighting the authority of HCI principles. Again, the authors were weighted as a percentage of all the citations listed in the ranking. Thereafter, HCI principles were grouped according to each author and placed within a matrix and subsequently factored.

As a result of this, an entire set of HCI principles was drawn from the principles given by each significant author (Hinze-Hoare, 2007:8). Each HCI principle obtained had at least one author

proposing it at the end of the analysis. Finally, Hinze-Hoare (2007:8) multiplied the weighting factor obtained from the citation frequency of a significant author by the number of times a certain HCI principle was proposed by the author in order to derive a ranking of HCI principles that needed to be established. Once the fundamental principles of every significant author were examined, categorised and weighted, the top eight HCI rules were found to be those given in Table 4.5.

**Table 4-5: Weighted HCI rules according to their frequency of use.**

| Weighted HCI rules according to their frequency of use | | |
|---|---|---|
| 1. | Recoverability | 96 |
| 2. | Familiarity | 57 |
| 3. | Consistency | 57 |
| 4. | Task migratability | 40 |
| 5. | Synthesisability | 34 |
| 6. | Predictability | 32 |
| 7. | Perceptual ergonomics | 31 |

This concludes the overview of the common human-computer interaction principles.

### 4.3.2 Benefits and limitations of HCI principles

According to Te'eni-Harari, Lampert, and Lehman-Wilzig (2007:195) HCI principles do not only have advantages; they also have disadvantages and limitations one should consider carefully when using HCI principles. A basic goal of HCI principles is to improve the interactions between users and computers by making computers more usable and receptive to the user's needs (Grudin, 1992:4). A few of the many potential benefits that can be achieved through utilisation of HCI principles are shown below (Grudin, 1992:4):

- To create an effective display design.
- To reduce errors.
- To reduce required training time.
- To increase efficiency.
- To increase user satisfaction.

Concerning disadvantages, certain principles may not be applicable to different displays or situations (Brown, 1998:2). Furthermore, Brown (1998:2) argued that some HCI principles may seem to be conflicting and there is no simple solution to say that one principle is more important

than another. The principles may be tailored to a specific design or situation and striking a functional balance among the principles is critical for an effective design (Brown, 1998:2).

Given the overall review of human-computer interaction principles, the researcher determined the principles that were applicable for this study.

### 4.4 Selected HCI principles for this study

In spite of the fact that all human-computer interaction principles can be used as design guidelines, not every one of them will be relevant to mobile application design. Subsequently, a number of HCI principles that can be applied in the design of a mobile application have been identified. These HCI principles are presented, with an example for shared understanding, in the remainder of this section.

Offer informative feedback for every user action, at a level appropriate to the magnitude of the action (Shneiderman, 1992:60). An example of informative feedback can be seen when a file becomes “highlighted” as the user clicks on a file. Figure 4.3 shows the ‘word’ file becomes highlighted as the user clicks on it, which provides feedback in the form of the user seeing that an option has been chosen. The feedback is presented visually in accordance to the magnitude of the action.

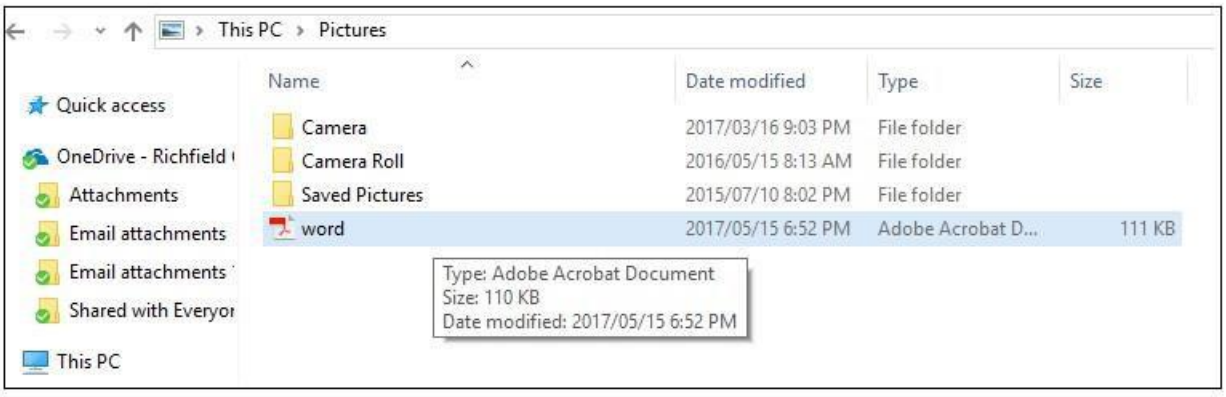


**Figure 4-3: Informative feedback for a user action.**

*Prevent errors* (Shneiderman & Plaisant, 2005:74): An example of this principle is found when a user tries to delete a file which is open. To prevent errors of this type, the system does not allow the deletion of an open file. Figure 4.4 shows a user gently alerted with an informative message preventing him from deleting an open file.

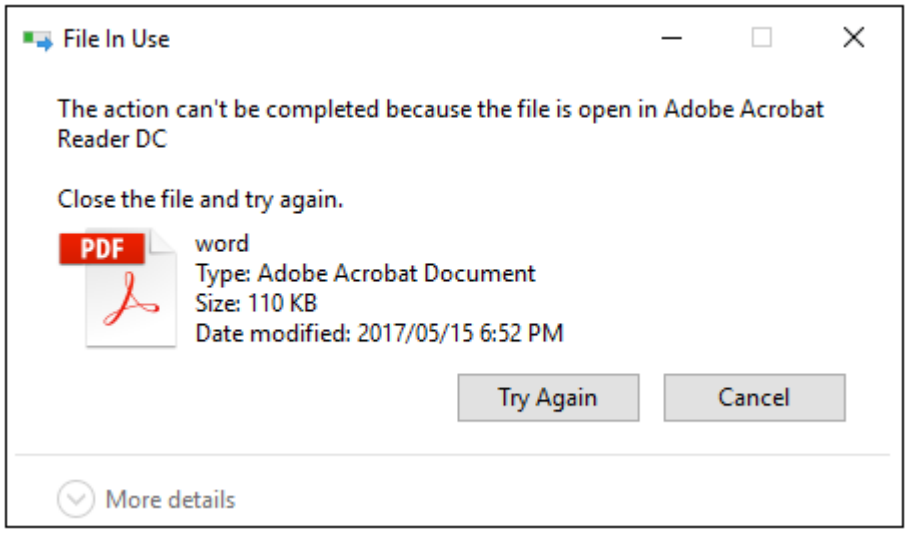


**Figure 4-4: An error prevention method used by the system when a user tries to delete a file which is open.**

*Permit reversal of actions* (Shneiderman, 1992:60). An example of this principle can be found when a user accidently navigates to a new webpage while busy with a different one. Figure 4.5 shows a user being provided with an option to go back to the previous webpage they opened.

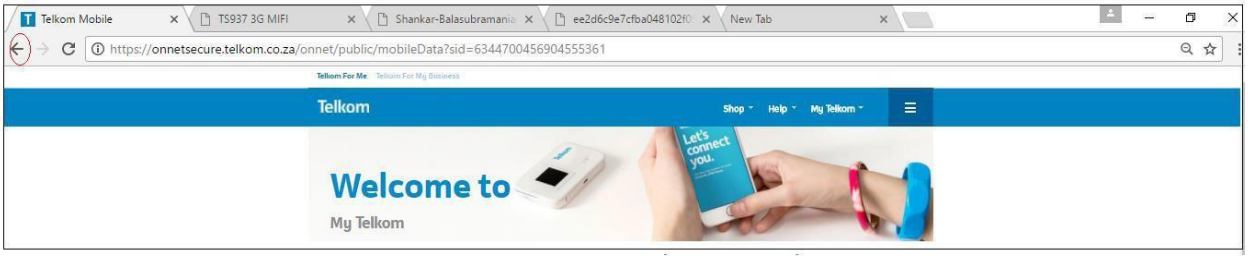


**Figure 4-5: The 'back' button in a web browser (www.telkom.co.za).**

*Discoverability* (Norman, 2013:72): The user must be able to determine the current state of the system as well as what the currently available actions are. A better example of discoverability is when a Bluetooth option is activated, as shown in Figure 4.6, the device can connect to other devices for a transfer of files, reception of files, and other tasks.

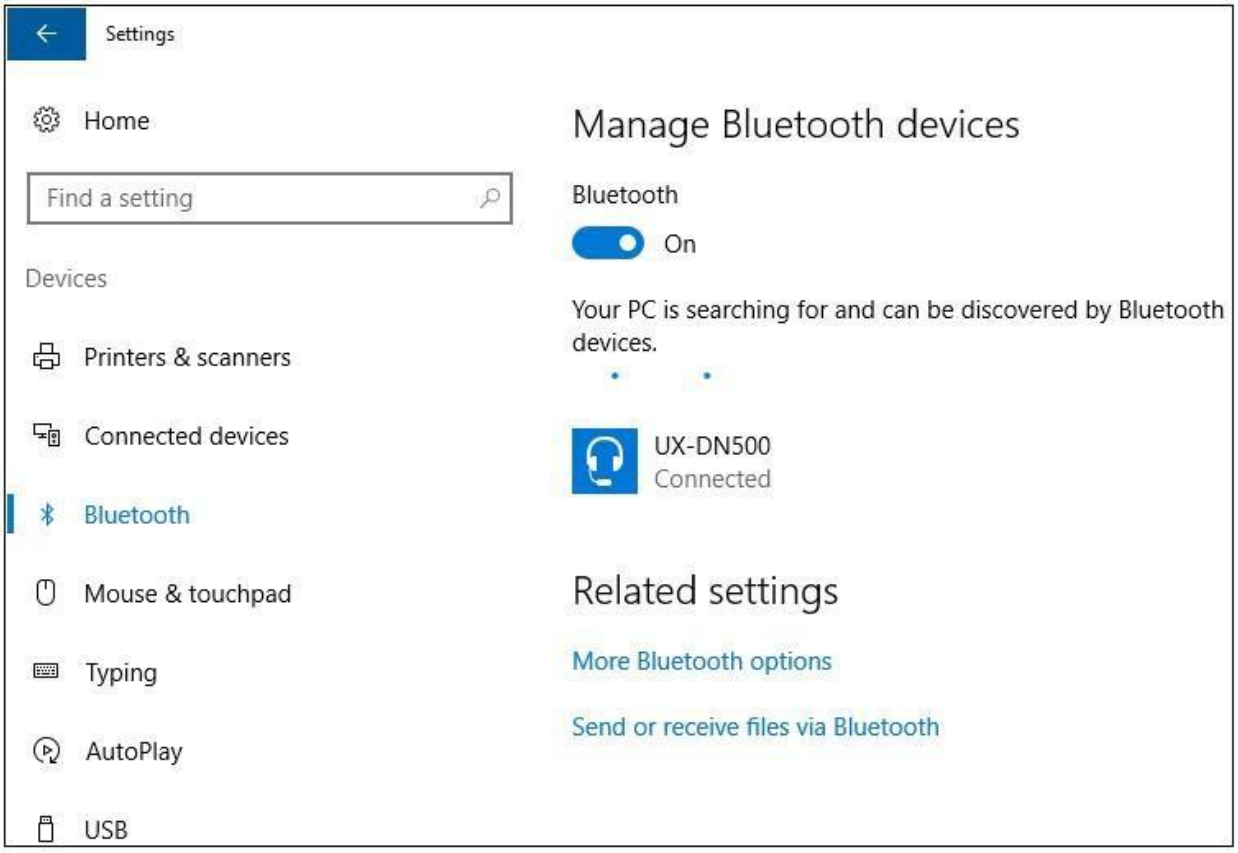


**Figure 4-6: The discoverability principle.**

*Strive for consistency* in action sequences, layout, terminology, command use and so on (Shneiderman, 1992:60). An example of consistency is presented in Figure 4.7 and Figure 4. 8 from the ABSA banking website where both layouts are consistent in design but the contents differ in options for personal and business banking.

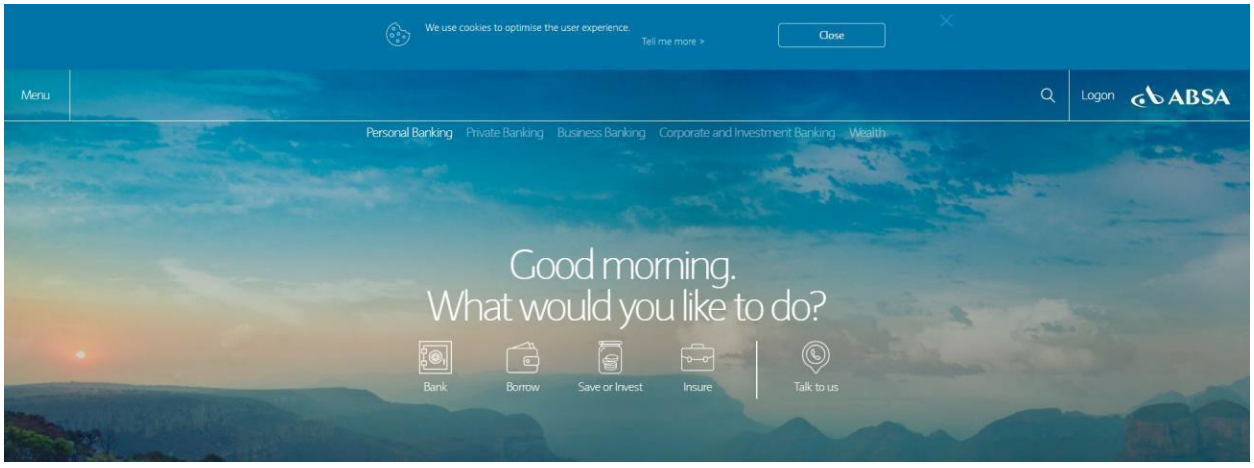


**Figure 4-7: The consistency principle (https://www.absa.co.za/personal/).**

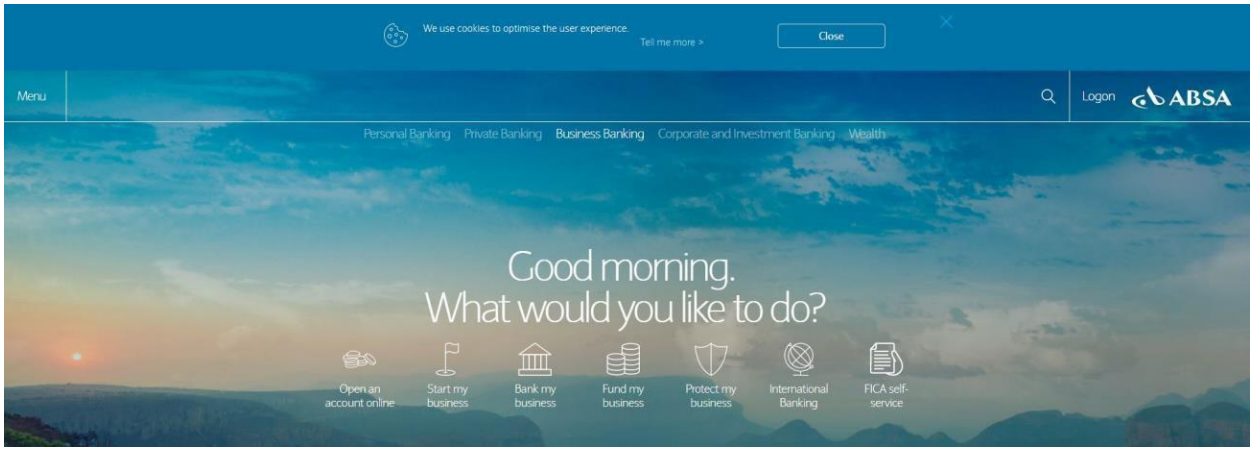


**Figure 4-8: The consistency principle (https://www.absa.co.za/business/)**

*Design dialogs to yield closure so that the users know when they have completed a task* (Shneiderman, 1992:60) . A good example of a dialog is as the user is copying a file, a pop-up message appears showing the progress of the copy, the duration of time remaining for it to be completed, and the dialog closing when the copy is finished (Figure 4.9).

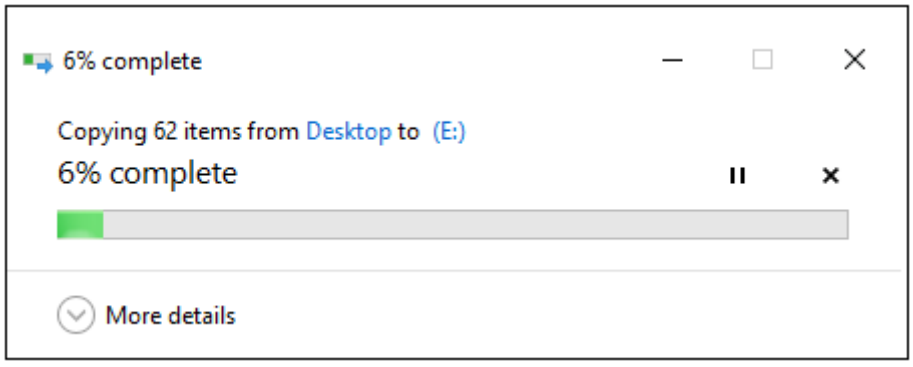


**Figure 4-9: Design dialog to yield closure so that the users know when they have completed a task.**

Affordances (Norman, 2013:11): Affordance is the relationship between the properties of an object and the capabilities of the agent interacting with the object. Suitable affordances must exist to make the desired actions possible. For example, the buttons of the Calculator application that is presented similar to a real-world calculator, shown in Figure 4.10, affords clicking.

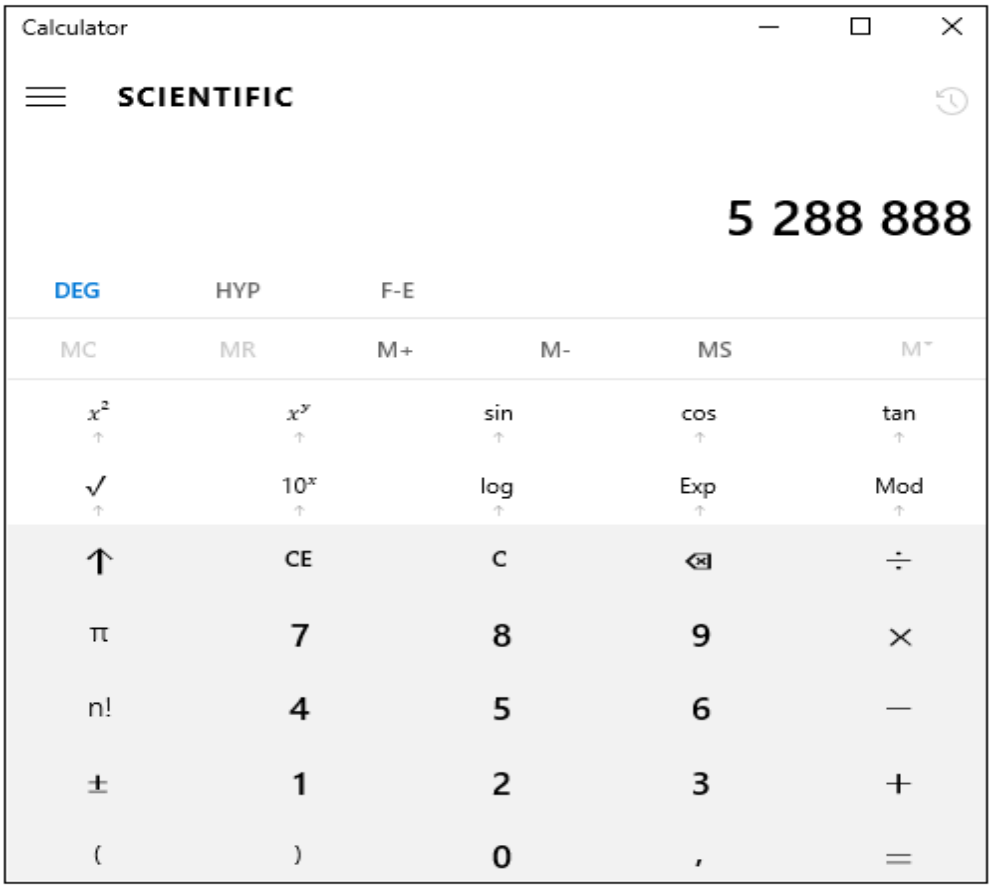


**Figure 4-10: Principle of affordance.**

*Mappings* (Norman, 2013:11): Good mappings between controls, their actions and the results must exist. Mappings are enhanced through spatial layout and temporal contiguity. For example, the rewind, stop and fast forward buttons of media players are usually next to each other, with the rewind button first, followed by the stop button and lastly the fast forward button, as shown in Figure 4.9.

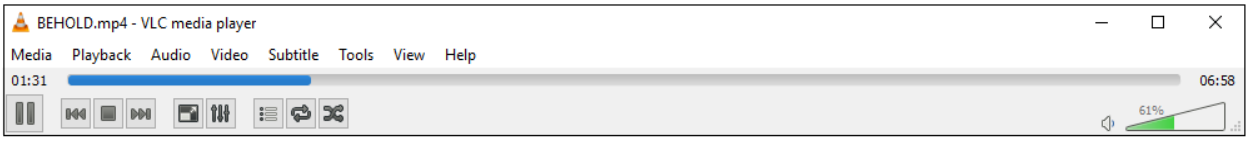


**Figure 4-11: Mapping between controls.**

The aforementioned principles can be applied to mobile application design as they have been applied in environments that mimic the development of interactive design. By combining the identified principles for mobile applications with principles of HCI, an environment can be created within the proposed mobile application that is conducive to a positive user experience.

## 4.5 Enriched guidelines for designing a mobile application

The chosen HCI principles mentioned in the previous section have been used to enrich the original proposed guidelines for creating mobile applications as discussed in Chapter 3. Table 4.6 provides an overview of the enriched guidelines that contain principles for mobile application design with HCI principles.

**Table 4-6: Enriched guidelines for designing a mobile application.**

| Mobile application design principles | | |
|---|---|---|
| M1 | Cut out the clutter | User attention is a precious resource, and should be allocated accordingly. Cluttering the interface overloads the user with too much information: every added button, image, and line of text make the screen more complicated (Babich, 2016). |
| M2 | Make navigation self-evident | Good navigation should feel like an invisible hand that guides the user along their journey (Babich, 2016). |
| M3 | Create a seamless experience | Developer should not think of a mobile design in isolation. Creating a seamless experience across mobile, desktop and tablet is very important for the users (Babich, 2016). |
| M4 | Design finger-friendly tap-targets | Smaller touch targets are harder for users to hit than larger ones. When you are designing mobile interfaces, it is best to make your targets big enough so that they are easy for users to tap (Babich, 2016). |
| M5 | Text content should be legible | When compared with desktops, smartphones have relatively small screens, which means that one of the challenges of mobile design is to fit a lot of information on a small UI. A rule of thumb for mobile: text should be at least 11 points so it's legible at a typical viewing distance without zooming (Babich, 2016). |
| M6 | Make interface elements clearly visible | Choose primary, secondary, and accent colours for the app that support usability. Ensure sufficient colour contrast between elements so that users with low vision can see and use the app (Babich, 2016). |
| M7 | Design controls based on hand position | Hand positions and grip should influence the placement of controls on a mobile design (Babich, 2016):<br>• It's important to place top-level menu, frequently-used controls and common actions to the center of the screen, because they are comfortably reached with one-thumb interactions.<br>• Place negative actions (such as delete or erase) in the hard to reach zone, because designers do not want users to accidentally tap them. |

| | | |
|---|---|---|
| M8 | Minimize Need For Typing | Typing on a mobile is a slow and error-prone process. It is therefore best to always try to minimize the amount of typing required to use a mobile app (Babich, 2016; Stark, 2012). |
| M9 | Test Your Design | Even the most painstakingly-considered UX will ultimately contain some unseen flaw when put into the real world. One should ask real users to proceed regular tasks only after that it can be seen how well the design really performs. Treat the designed app as a continuously evolving entity, using data from analytics and user feedback to constantly improve the experience (Babich, 2016). |
| M10 | Mobile mind set | Due to the differences between mobile and desktop, it is imperative to get yourself into a mobile mind set before getting started (Stark, 2012). |
| M11 | Mobile contexts | Designers should put themselves in the shoes of the users, one need to consider three major mobile contexts: Bored, Busy and Lost (Stark, 2012). |
| M12 | Global guidelines | Different apps call for different approaches, designs and techniques such as: Responsiveness, polish, thumbs, targets, content and Controls, avoid scrolling (Stark, 2012). |
| M13 | Navigation models | There are plenty of novel navigation models for mobile apps but if one chooses to use one of common navigation models, be sure to pick the one that makes the most sense for the designed app (Ramsay & Nielsen, 2000; Stark, 2012).<br>• None: Single screen utility apps (e.g. Weather app on iPhone)<br>• Tab bar: Three to six distinct content areas (e.g. Twitter for iPhone)<br>• Drill down: List and detail content hierarchy (e.g. Settings app on iPhone) |
| M14 | Gestures | One of the most iconic aspects of modern touch interfaces is that they support gesture-based user interaction (Stark, 2012; Ramsay & Nielsen, 2000). |
| M15 | Orientation | Portrait is by far the most popular orientation so optimise for this case first. If the designed app invites lots of typing, designers should implement landscape orientation so users can access the larger keyboard. When orientation changes unexpectedly, it is well disorienting. If the app is intended to be used for long periods of time consider adding an orientation lock right in the app (Stark, 2012). |
| M16 | Communications | Provide feedback (Provide instant feedback for every interaction), Modal alerts (use them when something is seriously wrong. Even then, try to mitigate the intensity by keeping language reassuring and friendly), Confirmations (When you have to ask a user to confirm an action, it is acceptable to display a modal confirmation dialog) (Stark, 2012; Ramsay & Nielsen, 2000). |

| | | |
|---|---|---|
| M17 | Launching | When a user goes back into the app after having used it previously, the app should resume operations right where the user left off. This will give the illusion of speed and contribute to an overall feel of responsiveness (Stark, 2012). |
| M18 | Usefulness | Serving some purpose (Ramsay & Nielsen, 2000). |
| M19 | Relevance | Include only relevant information (Ramsay & Nielsen, 2000). |
| M20 | Ease of use | The degree to which a software can be used specifically (Ramsay & Nielsen, 2000). |
| M21 | Personalisation | Adapt to the users' needs and capability (Ramsay & Nielsen, 2000). |
| M22 | First impressions | Your icon has to compete for attention in a sea of other icons. Use a strong silhouette and keep text to a minimum. A polished icon suggests a polished app, so it's worth devoting serious time and money to doing it right (Stark, 2012). |
| **HCI design principles** | | |
| H1 | Strive for consistency | Sequences of actions should be required in similar situations (Shneiderman *et al*., 2009:80). |
| H2 | Offer informative feedback | For every operator action, there should be some system feedback (Shneiderman *et al*., 2009:80). |
| H3 | Permit easy reversal of action | This feature relieves anxiety; it thus encourages exploration of unfamiliar options (Shneiderman *et al.,* 2009:82). |
| H4 | Offer simple error handling | If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error (Shneiderman *et al*., 2009:81). |
| H5 | Mappings | According to Norman (2013:11) good between controls, their actions and the results must exist. Mappings are enhanced through spatial layout and temporal contiguity According (Norman, 2013:11). |
| H6 | Affordance | According to Norman (2013:11) affordance is the relationship between the properties of an object and the capabilities of the agent interacting with the object. In terms of systems, it relates to the possibilities of how users can interact with a system (Norman, 2013:18). |
| H7 | Discoverability | The user must be able to determine the current state of the system as well as what the currently available actions are (Norman, 2013:70). |
| H8 | Usefulness | The user needs to be able to accomplish what is required through the use of the computer (e.g. sending an email) (Dix et al., 2004:5). In other word serving some purpose |
| H9 | Dialog | Design dialogs to yield closure so that the user knows when they have completed a task (Shneiderman, 1992:60). |

## 4.6 Conclusion

This chapter provided an overview of the field of human-computer Interaction. Subsequently, HCI principles were discussed, followed by a review of HCI principles applicable to mobile development where nine HCI principles were identified that can be appropriate in the development of a mobile application. The selected principles are used to enrich the proposed guidelines for the development of a mobile application for the trading of used books at a specific university.

Figure 4.12 provides an adaptation of the design science research process to represent the research structure of this study. Continuing from the literature review, Chapter 5 will now present the process followed to conduct the requirements analysis for the artefact.

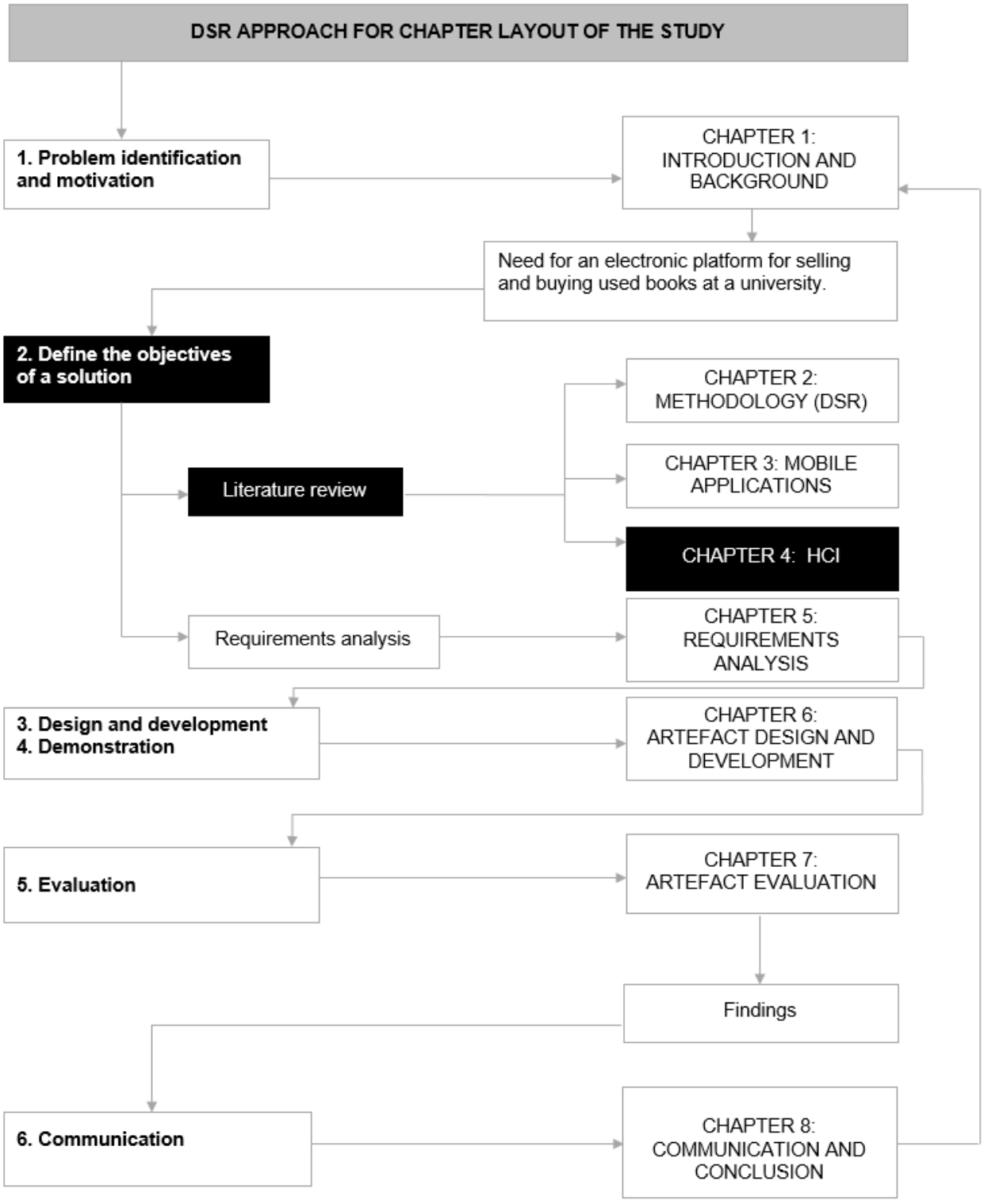


**Figure 4-12: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

# CHAPTER 5: REQUIREMENTS ANALYSIS

## 5.1 Introduction

The goal of this research was to design a mobile application for the trading of used books at a university following a design science research approach. In this chapter, a requirements analysis is conducted by collecting data using interviews, analysing the data, and then drawing conclusions from it. Furthermore, this chapter provides an understanding of the requirements of the artefact that needs to be designed.

The discussion of this chapter is divided into the following sections: Overview of the requirements analysis (Section 5.2); interview questions (Section 5.3); interview process (Section 5.4); data analysis (Section 5.5); and finally, the conclusion (Section 5.6).

## 5.2 Overview of requirements analysis

According to Moore (2004:100) the achievement or failing of systems or software projects depends on the requirements analysis. Moreover, Moore (2004:100) state that requirements should be documented, measurable, traceable, and associated to selected business needs or opportunities, and illustrate a level of detail adequate for system development. Conceptually, requirements analysis incorporates three sorts of activities, namely, (Moore, 2004:100):

- Requirements gathering: Determine what users' requirements are by engaging in communication with them (e.g. interview, questionnaire, etc...)
- Analysing requirements: Determining whether the gathered requirements are incomplete, unclear, contradictory, or ambiguous, and then resolve these discrepancies.
- Recording requirements: Various forms might be used to document requirements such as, use cases, user stories, natural-language documents, or process specifications.

Newly design applications convert the environment and connections between individuals, therefore it is crucial to pinpoint all the stakeholders, take into consideration all their needs and assure they incorporate the impacts of the new application (Moore, 2004:100). Methods used to support the stages of the requirement analysis are presented in the next sections.

### 5.2.1 Method

There are various methods that exist for requirement analysis and data collection. Some of the common techniques include: interviews, questionnaires, survey, observations and documents (Oates, 2006:116; Saunders *et al*., 2009:146). In this study, interviews are used for data collection and content analysis is used for data analysis. An interview is an engaging conversation between two or more people (Kahn & Cannell, 1957). Again, Bogdan and Biklen (1982a:152) stated that content analysis is the process of organising data, breaking it into manageable units, synthesising it, searching for patterns, discovering what is important and what is to be learned about this data.

### 5.2.2 Participants

Since the aim of this study was to design a mobile application for the trading of used books at a university the participants chosen had to meet two criteria. Firstly, for a requirements analysis of the mobile application to be accurate, one needed to consult experts in the field of mobile applications and human-computer interaction. Secondly, it would also be beneficial if the participants involved in the requirements analysis were active members of the environment the artefact is intended for.

For this reason, staff members of the specific university that are experts in essential fields were consulted. Four staff members with the required background knowledge were identified and subsequently interviewed.

Interview respondents are listed in Table 5.1 and named D under Atlas Doc Reference. The Atlas document reference is the reference used by the textual analytical software, Atlas.ti. The document name is the name of the file containing the transcript of the interview for a specific participant. Other data such as the participants' experience, qualification and field of specialisation were collected. This information might give insight into individuals' answers and views and might serve as basis for further comparative studies.

**Table 5-1: Participants list**

| Atlas Doc Reference | Document Name | Area of expertise | Years active in area of expertise | Highest Qualification |
|---|---|---|---|---|
| D:1 | Ann2 | Software development | 15 years | MSc in Computer Science |
| D:2 | Ann3 | Software Design | 5 years | BA Hons |

| | | | | |
|---|---|---|---|---|
| D:3 | Ann4 | DSR<br>HCI | 7 years | MSc in Computer Science |
| D:4 | Ann1 | Mobile Technology | 6 years | DSc |

### 5.3 Interview questions

The questions were designed to help the researcher gain a better understanding of user requirements and build features that meet these requirements. The questions were structured according to the HCI and mobile application principles identified in the literature that was presented in Chapter 4. All questions posed to participants are given in Table 5.2 alongside which key principles they are derived from.

**Table 5-2: Interview questions adapted from literature.**

| | Question found in literature | Mobile principles Code | HCI principle code | Question formulated for the purpose of this study |
|---|---|---|---|---|
| 1 | Do you believe that platform versioning and upgrading is a major concern for developers? (Joorabchi, Mesbah, & Kruchten, 2013:3) | M9 | H1 | Which platform should be used to create a mobile application for the trading of used books at the North-West University? |
| 2 | What type of reporting and analytics on user data, devices need to be collected? (Ong, 2014) | M5, M1, M12, M13, M16, M18, M19 | H2, H6, H8 | Which information should be included in an application for the trading of used books at the North-West University (NWU)? |
| | What task or activity do you use the system for? (Blackwell & Green, 2000:3) | | | |
| | What UX information do you need to have before you start designing? (Neustaedter & Sengers, 2012:7) | | | |
| 3 | How many screens will be involved? (Ong, 2014) | | | Which manner of displaying information on a mobile application screen is most effective? Should tabs, |
| | Are tabs a pattern good for mobile design? How do they affect an | | | |

| | | | | |
|---|---|---|---|---|
| | app's usability? (Joorabchi *et al.*, 2013:3) | M2, M3, M20, M6, M7, M12, M10, M14, M15, M16 | H4, H5, H8, H9 | pagination or infinite scroll be used? Why? |
| | How do you decide when to use infinite scroll or pagination? (Joorabchi *et al.*, 2013:3) | | | |
| 4 | What is the best practice when it comes to designing icons for a mobile product? (Ong, 2014) | M22, M10, M11 | H1, H5 | What is the best practice when it comes to designing icons for a mobile product? |
| | | | | Which colours would be most appropriate to use in the design of a mobile application for the trading of used books at the North-West University? |
| 5 | How do you deal with input fields on mobile designs? Why are they important, how do they affect the end-result? (Ong, 2014) | M16, M9, M11, 15 | H7, H1, H2 | Do you have any suggestions on how user data input should be managed? Should there be restrictions on user input? |
| | When designing for mobile we always try to squish everything down in an attempt to provide as much information as possible. How can you resist the urge to clean up the UI, while still displaying important information? (Joorabchi *et al.*, 2013:3) | | | |
| | When you need to make changes to previous work, how easy is it to make the change? (Blackwell & Green, 2000:4) | | | How important is it for the user to be able to correct mistakes? Why? |
| | Will the user notice that the correct action is available? (Kurosu, 2014:210) | | | |

| | | | | |
|---|---|---|---|---|
| 6 | Will the app push or pull data from the phone like geo-location, calendar, weather data etc.? (Ong, 2014) | M6, M13, M15, M20 | H1, H3, H6, H5 | Which device features should be incorporated into the application and why? For example, geo-location, calendar, weather data, voice recorder etc. |
| 7 | What kind of things are more difficult to see or find (Blackwell & Green, 2000:5)? | M7, M12 | H1 | Are there any options for this type of application that should be more visible than others? |
| 8 | Explain how you would approach the security of this application (Ong, 2014)? | M17, M19, M21 | H7, H8, H9 | In which manner should user access be limited for a mobile application for the trading of used books at the NWU? |
| 9 | Are researchers 'cheating' when they test on themselves? (Neustaedter & Sengers, 2012:7) | M9, M10, M11 | H1, H8 | Who should test the mobile application for the trading of used books at the NWU for usability? |
| 10 | What are major things that could make or break a system, and genuine, as opposed to discretionary, needs? (Neustaedter & Sengers, 2012:5) | M1, M2, M8 | H5, H8 | In your experience, what are major factors in mobile application design that could contribute to the success or failure of the artefact? |
| 11 | What is the best way to improve User Experience (UX) without changing the interface? (Ong, 2014) | M22, M10, M11 | H1, H5 | What is the best way to improve User Experience (UX) without changing the interface? |
| 12 | Have you used other similar systems? If so, please name them. (Blackwell & Green, 2000:3) | M3, M9 | H8 | Have you interacted with similar mobile applications? If so, please name them. |

Table 5.3 then presents a list of questions asked to participants that took part in the requirements analysis. Questions were open ended to allow participants to provide a rich overview in their responses.

**Table 5-3: Interview questions derived from questions found in literature.**

| | Interview questions |
|---|---|
| 1 | Which platform should be used to create a mobile application for the trading of used books at the chosen university? |
| 2 | Which information should be included in an application for the trading of used books at a university? |
| 3 | Which manner of displaying information on a mobile application screen is most effective? Should tabs, pagination or infinite scroll be used? Why? |
| 4 | What is the best practice when it comes to designing icons for a mobile product? |
| 5 | Which colours would be most appropriate to use in the design of a mobile application for the trading of used books at the specific university? |
| 6 | Do you have any suggestions on how user data input should be managed? Should there be restrictions on user input? |
| 7 | How important is it for the user to be able to correct mistakes? Why? |
| 8 | Which device features should be incorporated into the application and why? For example, geo-location, calendar, weather data, voice recorder etc. |
| 9 | Are there any options for this type of application that should be more visible than others? |
| 10 | In which manner should user access be limited for a mobile application for the trading of used books at the chosen? |
| 11 | Who should test the mobile application for the trading of used books at a university for usability? |
| 12 | In your experience, what are major factors in mobile application design that could contribute to the success or failure of the artefact? |
| 13 | What is the best way to improve user experience (UX) without changing the interface? |
| 14 | Have you interacted with similar mobile applications? If so, please name them. |

## 5.4 Interview process

One-on-one interviews were conducted at a specific university. During each individual session, participants were asked a series of questions (Table 5.3). The interviews with the four participants were audio-recorded and the interviews were then transcribed for use in the analysis process. Each session lasted between 15 minutes to 25 minutes. The researcher was given an opportunity

to engage in conversation with the participants and be provided with detailed explanations on unclear responses.

Kaplan and Maxwell (2005: 40) explained that when using open ended interviews, one can use the opportunity to request elaborations on responses which might yield more applicable responses. As such, these differences between the written and verbal responses can be expected. However, effort was made by the researcher to make the questions understandable and comprehensive. This had the effect that the responses were satisfactory. The interview schedule is presented in Appendix E.

### 5.5 Data analysis

Myers (1997: 241) presents three modes of textual analysis, including: hermeneutics, semiotics, and narrative and metaphor.

- Hermeneutics is concerned with the meaning gained from interpretation of text. When a piece of text is divided into multiple parts, then, as Myers (1997: 241) explained the hermeneutic circle refers to gaining more understanding of the entire text by analysing some of its parts, then applying the understanding to the whole text and then analysing more of its parts and applying that understanding to the whole text. This circle continues until the text is fully analysed.
- Semiotics refers to discovering pattern in text or a situation. Myers (1997: 241) explained that the researcher then analyses the frequencies of the patterns and makes deductions based on this.
- Narrative and metaphor has its origins in literary studies and have recently become more widespread in other disciplines (Myers, 1997b:241). The narrative mode of analysis involves gaining understanding through a story being related; and a metaphor is gaining understanding through comparison of another object.

In this study, content analysis was performed. The entire body of text that was analysed was all of the transcribed interviews. A part of the transcribed interviews could be a single interview, a question, or even an idea expressed in part of the response to the question. Through analysis of parts of the entire body of text, more understanding was gained of the whole text. This mode of analysis is therefore hermeneutics.

An eight step process for performing content analysis is promoted (Zhang & Wildemuth, 2009:3). Table 5.4 below shows how each of these steps have been applied in this study.

**Table 5-4: 8 step to performing content analysis (Zhang & Wildemuth, 2009:3)**

| Step name | Application in this research |
|---|---|
| Prepare the data. | This was performed by transcribing of interviews and removing personal and identifying data. (Section 5.5.1) |
| Define the unit of analysis. | Content analysis is being performed and the research seeks out the experiences and challenges of HCI and mobile professionals. These challenges and experiences were documented and each of these documents represents a unit of analysis. (Section 5.5.2) |
| Develop categories and a coding scheme. | Research areas and aspects for investigation were identified in literature. These were used to develop the interpretive questions. The main categorisation of data is done after coding. (Section 5.5.3) |
| Test your coding scheme on a sample of text. | A number of interviews were coded as the initial sample. Some excerpts from these are presented with the discussion of how they were tested. (Section 5.5.4) |
| Code all the text. | The rest of the interviews were coded and described and as new codes were created, they were noted as being new along with the corresponding interview in which the code was first created. These notes were used in the next step of coding where consistency was verified. (Section 5.5.5) |
| Assess the coding consistency. | Using the notes created when new codes were created, previously coded interviews were reassessed for consistency with these new codes. Related codes were grouped together to ensure consistency in reporting as discussed (Section 5.5.6). |
| Draw conclusions from the coded data. | After using Atlas.ti to create code categories, the codes grouped together where appropriate to allow for more focused analysis which is presented (Section 5.5.7) |
| Report your methods and findings. | From the conclusions drawn in the previous step, the insight gained is used as requirements analysis for the design of the artefact in Chapter 6. |

Table 5.4 will be referred to throughout the analysis report to guide the reader. Steps 1 to 7 of Table 5.4 are discussed in the coming sections.

### 5.5.1 Prepare the data

Interviews conducted were transcribed and returned in written format. The responses were edited to ensure that no identifiable information, e.g. name of participant, was included. The transcriptions were not corrected in terms of grammar, punctuation, and spelling. Any idiom used during the interview process were kept in the written format to showcase the level of contentment that the participants may have felt. Also idioms were kept in an attempt to make the environment of the interview transparent to the reader.

### 5.5.2 Define the unit of analysis

When conducting content analysis, a unit of analysis may be seen as the 'what' or 'who' that shall be able to be analysed e.g. a word or sentence. The researcher will analyse each answer with respect to the other answers provided by the participants. A single question and the response was initially defined as the unit of analysis. This was then compared to different expressions of a concept between participants. This process of analysing a single question and then returning to an entire response to obtain a better understanding is known as the hermeneutic cycle.

### 5.5.3 Develop categories and a coding scheme

Questions were found in the literature review and human computer-interaction principles were applied alongside mobile application design principles to categorise them for interviews. In a manner, these principles served as categorisation of the questions. However, as content analysis was performed, categories could only be allocated after the content analysis was finalised.

### 5.5.4 Test your coding scheme on a sample of text

As content analysis in being used, the text is coded in according to the selected unit of analysis. The chosen unit of analysis is response per participant per question. In order to test the coding method, one interview was coded. The researcher tested the coding scheme on the responses of three participants to a particular question. Table 5.5 demonstrates the coding of Anon2, Anon3 and Anon4 responses to a question on suitable platform to be used for the design of the mobile application.

**Table 5-5: Code Excerpt 1: Report for Query: 1 Codes: Demonstrates Anon 2, Anon 3 and Anon 4 responses to the researcher question on mobile application platform.**

| |
|---|
| **Resulting quotations (3)** |
| **D 1: Anon 2 - 1:1 So, it depends. Tell me a bit more, first of all, of what you want to… (338:1130)** |
| **1 Codes:** Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform |
| **D 2: Anon 3 - 2:1 Okay well I think in this day and age you would need to cover your bas… (197:1568)** |

**1 Codes:** Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform

**D 3: Anon 4 - 3:1 There are many platforms that exist. The obvious choice would be Andro… (198:534)**

**1 Codes:** Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform

**Platform to be used.**

The researcher was able to categorise three responses from Anon2, Anon3 and Anon4 that offered insight into the selection of a suitable platform for the design of a specific university mobile application. By analysing the responses of each participant and then applying the analysis to the interpretation of the entire collection of data, the researcher was able to achieve a holistic understanding.

### 5.5.5 Code all the text

In the fifth phase of content analysis, codes were created in a directed manner as they were discovered within the text. The researcher used Atlas.ti to code the interview. Once all the text was coded, codes discovered at the end of the analysis were reused on the text analysed at the beginning of the analysis in order to ensure consistency. Table 5.6 shows the code counts of the most frequent codes discovered in interviews.

**Table 5-6: Summary of most frequent codes discovered in interviews.**

| | Anon 2 | Anon 3 | Anon 4 | Anon 1 | Totals |
|---|---|---|---|---|---|
| Android platform for the design | 0 | 0 | 0 | 1 | 1 |
| Barcode scanning, Camera and Calendar | 1 | 1 | 1 | 0 | 3 |
| Consistent, Small colour palette,<br>Strong colour palette, KISS, Trial or Error, 32X32 or 64X64, | 1 | 1 | 1 | 0 | 3 |
| Distribution of the app, Scale of adoption | 1 | 0 | 0 | 0 | 1 |
| Full control of the listing until transaction is completed | 1 | 0 | 0 | 0 | 1 |
| Have a look on OLX features | 1 | 0 | 0 | 0 | 1 |

| | | | | | |
|---|---|---|---|---|---|
| Information about the book(Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book (Cell phone number, email), categorise books per subject, Trading location | 2 | 1 | 1 | 1 | 5 |
| Integrate the system with the learning management system(LMS) and log on with [redacted] details | 1 | 0 | 2 | 0 | 3 |
| Interface(simple to use, effective, pleasant user interface), search function, font choice | 1 | 1 | 1 | 1 | 4 |
| Lecturers and Students | 0 | 0 | 0 | 1 | 1 |
| Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform | 2 | 1 | 1 | 0 | 4 |
| Negative contrast (Grey, White and Black), Corporate colour ( A SPECIFIC UNIVERSITY) | 2 | 0 | 1 | 2 | 5 |
| New fresh colour, Vibrant colour (Orange, Purple and blue) | 0 | 1 | 0 | 0 | 1 |
| No device features | 0 | 0 | 0 | 1 | 1 |
| Quality of the book and price of the book | 1 | 1 | 0 | 0 | 2 |
| Security and log in screen | 0 | 0 | 0 | 2 | 2 |
| Select item and notify the owner with an anonym message | 0 | 1 | 0 | 0 | 1 |
| Subject matter expert and students | 0 | 1 | 0 | 0 | 1 |
| Tabs, Infinite scroll | 0 | 0 | 1 | 0 | 1 |
| Target audience or User group | 2 | 0 | 1 | 0 | 3 |
| Thumbnail on a smaller screen | 1 | 0 | 0 | 0 | 1 |
| User friendly, Scroll screen, Logical flow, One page show all search criteria, Pagination | 1 | 1 | 0 | 1 | 3 |
| **Totals** | **18** | **10** | **10** | **10** | **48** |

Due to the unstructured nature of the interviews, the participants were free to address multiple topics per response. An example of this is demonstrated in Table 5.7: Code Excerpt 2 where Anon1 addressed the effective manner of displaying information on a mobile application screen, colours and Android platform in one response.

**Table 5-7: Code Excerpt 2: Report for Query: User friendly, Scroll screen, Logical flow, one page show all search criteria, Pagination. Addressing multiple topics**

**D 4: Anon1 - 4:3 Of course the layout must be as user friendly as possible. Don't overu… (2013:2893)**

**Created by Isaac on 2017/09/02**

Of course the layout must be as user friendly as possible. Don't overuse colours and spaces and line breaks and so on. Make it as simple as possible. You can use scroll screens, more than one screen, it doesn't matter and make sure that you can change the screen as well from portrait to landscape. That could also be a possibility. Alright, then a bit of advice. Android is so sophisticated now days it will take care of that by itself. I'm not sure if you must design for phone screens and tablets. My advice would be stay with the phone itself. For the moment. If later on you see there's a need for tablets then you can redo your user interface again or redesign it if you want to. But my advice would be for the first round, the first version, stay with cell phones.

**1 Codes:**

○ User friendly, Scroll screen, Logical flow, One page show all search criteria, Pagination

**0 Memos**

**0 Hyperlinks**

### 5.5.6 Assess the coding consistency

Once the entire body of text had been coded, the researcher reviewed all codes in order to ensure that no codes represented the same concept. In this revision, the researcher isolated two codes that could be merged into one. These codes are given in Table 5.8. The merged codes retained the code name of the code with the most instances.

**Table 5-8: Codes merged due to high degree of similarity.**

| | Anon 2 | Anon 3 | Anon 4 | Anon 1 | Totals |
|---|---|---|---|---|---|
| Information about the book(Title, Author, ISBN, price of the book), Database of available books, Information about the owner of the book (Cell phone number, email), categorise books per subject, Trading location | 2 | 1 | 1 | 1 | 5 |
| Quality of the book and price of the book | 1 | 1 | 0 | 0 | 2 |

In the coding process, many codes related to similar topics. In order to prevent these from becoming inconsistencies, codes were grouped together into Code Groups. Code Groups are codes that are organised according to their similar topics. Table 5.9: Code Excerpt 3 shows an example of a Code Group named Platform.

**Table 5-9: Code Excerpt 3: Report for Query Code Group: Platform.**

**Resulting quotations (5)**

**D 1: Anon 2 - 1:1 So, it depends. Tell me a bit more, first of all, of what you want to… (338:1130)**

So, it depends. Tell me a bit more, first of all, of what you want to do because there are various different platforms. I would say, for me personally, I don't think an application is necessarily going to be the best answer for you because of the fact that you would need to it on multiple devices, if you want to do it as an actual mobile application. I would say responsive web design platform is better because you'll get a much wider catch-all there. You also won't require anyone to install anything. If you are going to go IOS as well, you would have to use Apple tools specifically, because there isn't really anything that will allow you to cross develop for them. But, you need to give me a bit more about what exactly you want to do. I understand, kind of, what you are hoping to do.

**D 1: Anon 2 - 1:12 I think so. I think for your specific application that would be better… (1653:2122)**

I think so. I think for your specific application that would be better. And then I would probably, my preference would be .net for the backend and then just normal HTML5 for the front. There are intermediary things that you can use to wrap HTML5 as an application as well. So, Cocoon.JS is a pretty good one for that because that will just take your website and basically just make it look like an application on someone's phone. It will package it like an app for you.

**D 2: Anon 3 - 2:1 Okay well I think in this day and age you would need to cover your bas… (197:1568)**

Okay well I think in this day and age you would need to cover your bases. So, I would say make it available for mobile devices on Android, I think IOS you should make it available on Apple devices as well because you miss out on a huge chunk of the market if you don't. A lot of students are investing in good/better phones nowadays. I think another way to do it, maybe when you start out, when you doing your tests and things, your usability tests so that's when

you talk to students and see what they think. You should make it available on web, just you know not locked behind any Google Play Store or the App Store just make it available on web via link and let them test it that way. I think that might be a good way to start. But I think in the end you'd have to cover all bases so have it on the Google Play Store. Have it on the App Store. Just to make sure you reach as many students as possible. So I don't think there's any "best" platform. I think try for all platforms. It needs to be responsive of design and that's inclusive design. For everyone. With all devices

**D 3: Anon 4 - 3:1 There are many platforms that exist. The obvious choice would be Andro… (198:534)**

There are many platforms that exist. The obvious choice would be Android. Most people would say that, but, I think because some students would not necessarily have smartphones but they do have access to computers in the labs at campus. You might create a hybrid application that is accessible from your phone as well as from a computer.

**D 4: Anon1 - 4:2 There are two major operating systems. One is android and one is IOS … (254:633)**

There are two major operating systems. One is android and one is IOS (spells our IOS). One is for the majority of phones the other one is for Apples. Apples operating system and according to studies in South Africa most people use Android phones. For that I think you should use Android for you mobile application or to create your mobile application.

These code groups form the themes in the data analysis. The quotations listed at the top of each code group indicate how many quotes from the entire body of text fall under the specific family. Figure 5.1 shows all six code groups in Atlas.ti.

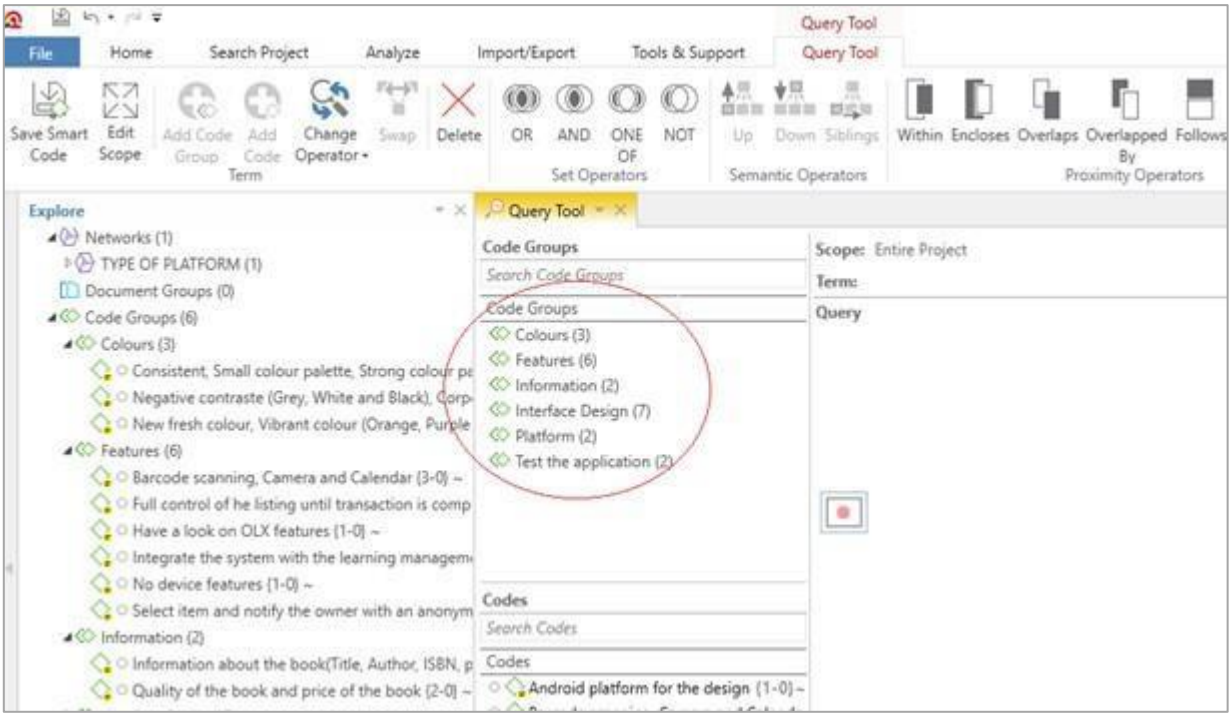


**Figure 5-1: Illustration of the six code groups in Atlas.ti**

The code groups are useful when analysing data with the view of developing themes. Each theme is discussed in the following section.

### 5.5.7 Draw conclusions from the coded data

By making use of code groups as discussed in the previous section, the researcher was able to distinguish six themes that were present in the data. These themes are discussed in the sub-sections of this section.

The discussion of each theme will begin with a short summary of the theme. The codes that support this theme and form part of its code group are then presented in table format along with the number of their occurrences in each primary document. One of the most frequently occurring codes is discussed and finally, conclusions are drawn from the analysis of the data.

#### 5.5.7.1 Theme 1: Colours

According to Babich (2017), it is generally hard to decide on a colour scheme that works well for a newly design application, since there are an infinite number of possible colour combinations that exist. Table 5.10 demonstrates the code occurrence frequencies for each code in the code group colours.

**Table 5-10: Code occurrence frequencies for codes in the colours code group.**

| Code Groups | Codes | Anon 2 | Anon 3 | Anon 4 | Anon 1 | Totals |
|---|---|---|---|---|---|---|
| Colours | Negative contrast (Grey, White and Black), Corporate colour ([redacted] UNIVERSITY) | 2 | 0 | 1 | 2 | 5 |
| | New fresh colour, Vibrant colour (Orange, Purple and blue) | 0 | 1 | 0 | 0 | 1 |
| | Totals | 2 | 1 | 1 | 2 | 6 |

It's appears that code "Negative contrast (Grey, White and Black), Corporate colour (*a specific university*)" occurs five times and "code New fresh colour, Vibrant colour (Orange, Purple and blue)" occurs once. Table 5.11 shows a detailed report query of group code colours with resulting quotations.

**Table 5-11: Code Excerpt 4: Report for Query Code Group: Colours.**

**Report for Query: Colours**

Resulting quotations (6)

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**D 1: Anon 2 - 1:5 If you are sticking specifically to [redacted]at the [redacted]campus, go for the… (10072:10674)**

**1 Codes:**

- **Negative contrast (Grey, White and Black), Corporate colour ([redacted])**

**1 Groups:**

Colours

**5 Quotations:**

D 1: Anon 2 - 1:5 If you are sticking specifically to [redacted]at the [redacted]campus, go for the… (10072:10674) /
D 1: Anon 2 - 1:16 So a uni campus concept? But remember if you look at any of the front… (10693:11508)/
D 3: Anon 4 - 3:4 Well it's an application for the [redacted]so it would be… (1749:2896) /
D 4: Anon1 - 4:7 That is what I normally do. Stay with black and white and grey colours… (4615:5433) /
D 4: Anon1 - 4:11 Again it depends on the user interface. Personally I don't like bright… (3165:4504)

---

**D 1: Anon 2 - 1:16 So a uni campus concept? But remember if you look at any of the front… (10693:11508)**

**1 Codes:**

○ **Negative contrast (Grey, White and Black), Corporate colour ([redacted])**

**1 Groups:**

Colours

**5 Quotations:**

D 1: Anon 2 - 1:5 If you are sticking specifically to [redacted]at the [redacted]campus, go for the… (10072:10674) /
D 1: Anon 2 - 1:16 So a uni campus concept? But remember if you look at any of the front… (10693:11508)/
D 3: Anon 4 - 3:4 Well it's an application for the [redacted]so it would be… (1749:2896) /
D 4: Anon1 - 4:7 That is what I normally do. Stay with black and white and grey colours… (4615:5433) /
D 4: Anon1 - 4:11 Again it depends on the user interface. Personally I don't like bright… (3165:4504)

---

**D 2: Anon 3 - 2:5 Okay for something like this, see it could be perceived by students as… (7000:8080)**

**1 Codes:**

○ **New fresh colour, Vibrant colour (Orange, Purple and blue)**

**1 Groups:**

Colours

**1 Quotations:**

D 2: Anon 3 - 2:5 Okay for something like this, see it could be perceived by students as… (7000:8080)

---

**D 3: Anon 4 - 3:4 Well it's an application for the North West University so it would be… (1749:2896)**

**1 Codes:**

○ **Negative contrast (Grey, White and Black), Corporate colour ([redacted])**

**1 Groups:**

Colours

**5 Quotations:**

D 1: Anon 2 - 1:5 If you are sticking specifically to [redacted]at the [redacted]campus, go for the… (10072:10674) /
D 1: Anon 2 - 1:16 So a uni campus concept? But remember if you look at any of the front… (10693:11508)/
D 3: Anon 4 - 3:4 Well it's an application for the [redacted]so it would be… (1749:2896) /
D 4: Anon1 - 4:7 That is what I normally do. Stay with black and white and grey colours… (4615:5433) /
D 4: Anon1 - 4:11 Again it depends on the user interface. Personally I don't like bright… (3165:4504)

---

**D 4: Anon1 - 4:7 That is what I normally do. Stay with black and white and grey colours… (4615:5433)**

**1 Codes:**

○ **Negative contrast (Grey, White and Black), Corporate colour ([redacted])**

**1 Groups:**

Colours

**5 Quotations:**

D 1: Anon 2 - 1:5 If you are sticking specifically to [redacted]at the [redacted]campus, go for the… (10072:10674) /
D 1: Anon 2 - 1:16 So a uni campus concept? But remember if you look at any of the front… (10693:11508)/
D 3: Anon 4 - 3:4 Well it's an application for the [redacted]so it would be… (1749:2896) /
D 4: Anon1 - 4:7 That is what I normally do. Stay with black and white and grey colours… (4615:5433) /
D 4: Anon1 - 4:11 Again it depends on the user interface. Personally I don't like bright… (3165:4504)

---

**D 4: Anon1 - 4:11 Again it depends on the user interface. Personally I don't like bright… (3165:4504)**

**1 Codes:**

○ **Negative contrast (Grey, White and Black), Corporate colour ([redacted])**

**1 Groups:**

Colours

**5 Quotations:**

D 1: Anon 2 - 1:5 If you are sticking specifically to [redacted]at the [redacted], go for the… (10072:10674) /
D 1: Anon 2 - 1:16 So a uni campus concept? But remember if you look at any of the front… (10693:11508)/
D 3: Anon 4 - 3:4 Well it's an application for the [redacted]so it would be… (1749:2896) /
D 4: Anon1 - 4:7 That is what I normally do. Stay with black and white and grey colours… (4615:5433) /
D 4: Anon1 - 4:11 Again it depends on the user interface. Personally I don't like bright… (3165:4504)

Therefore, the researcher will consider to use the code with more occurrence frequencies which is the code "Negative contrast (Grey, White and Black), Corporate colour ([redacted])" in the design of the application based on the colour choice.

#### 5.5.7.2 Theme 2: Features

There is much to be considered while developing a mobile application. The features group will identify the needed features for the designed application. The features group consists of six codes. Table 5.12 demonstrates the code occurrence frequencies for each code in the code group features.

**Table 5-12: Code occurrence frequencies for codes in the features code group.**

| Code Groups | Codes | Anon 2 | Anon 3 | Anon 4 | Anon 1 | Totals |
|---|---|---|---|---|---|---|
| Features | Barcode scanning, Camera and Calendar | 1 | 1 | 1 | 0 | 3 |
| | Full control of the listing until transaction is completed | 1 | 0 | 0 | 0 | 1 |
| | Have a look on OLX features | 1 | 0 | 0 | 0 | 1 |
| | Integrate the system with the learning management system (LMS) and log on with [redacted] details | 1 | 0 | 2 | 0 | 3 |
| | No device features | 0 | 0 | 0 | 1 | 1 |
| | Select item and notify the owner with an anonym message | 0 | 1 | 0 | 0 | 1 |
| | Totals | 4 | 2 | 3 | 1 | 10 |

It appears that code “Barcode scanning, Camera and Calendar” and code “Integrate the system with the learning management system (LMS) and log on with [redacted] details” occurs three times. Table 5.13 shows a detailed report query of group code features with resulting quotations.

**Table 5-13: Code Excerpt 5: Report for Query Code Group: Features.**

**Report for Query: Features**

Resulting quotations (10)

---

**D 1: Anon 2 - 1:6 I would say it’s going to depend on whether you want to make this some… (11676:12722)**

**1 Codes:**

○ **Integrate the system with the learning management system(LMS) and log on with [redacted] details**

**3 Quotations:**

D 1: Anon 2 - 1:6 I would say it’s going to depend on whether you want to make thissome…(11676:12722)/
D 3: Anon 4 - 3:6 Well you will have to have some form of database that doe’s user authen… (3664:3742) /
D 3: Anon 4 - 3:10 Yes. So you have to register somehow because you have to be able to us(3944:4220)

---

**D 1: Anon 2 - 1:7 In general with applications of this nature, if I’ve placed a listing… (13298:14346)**

**1 Codes:**

○ **Full control of the listing until transaction is completed**

**1 Quotations:**

D 1: Anon 2 - 1:7 In general with applications of this nature, if I've placed a listing… (13298:14346)

---

**D 1: Anon 2 - 1:8 If you can use the barcode scanning that would be ideal. Specifically… (15093:15439)**

**1 Codes:**

- **Barcode scanning, Camera and Calendar**

**3 Quotations:**

D 1: Anon 2 - 1:8 If you can use the barcode scanning that would be ideal. Specifically… (15093:15439) /
D 2: Anon 3 - 2:7 Features I think you would want it to access your camera on your devic… (9710:10492) /
D 3: Anon 4 - 3:7 You can definitely add the camera feature to take a picture of the boo… (4420:4871)

---

**D 1: Anon 2 - 1:14 Yes. But specifically very targeted search. So, if I'm going onto some… (6503:6862)**

**1 Codes:**

- **Have a look on OLX features**

**1 Quotations:**

D 1: Anon 2 - 1:14 Yes. But specifically very targeted search. So, if I'm going onto some… (6503:6862)

---

**D 2: Anon 3 - 2:6 I think in terms of user input what you need to be very careful of is… (8246:9493)**

**1 Codes:**

- **Select item and notify the owner with an anonym message**

**1 Quotations:**

D 2: Anon 3 - 2:6 I think in terms of user input what you need to be very careful of is… (8246:9493)

---

**D 2: Anon 3 - 2:7 Features I think you would want it to access your camera on your devic… (9710:10492)**

**1 Codes:**

- **Barcode scanning, Camera and Calendar**

**3 Quotations:**

D 1: Anon 2 - 1:8 If you can use the barcode scanning that would be ideal. Specifically… (15093:15439) /
D 2: Anon 3 - 2:7 Features I think you would want it to access your camera on your devic… (9710:10492) /
D 3: Anon 4 - 3:7 You can definitely add the camera feature to take a picture of the boo… (4420:4871)

**D 3: Anon 4 - 3:6 Well you will have to have some form of database that does user authen… (3664:3742)**

**1 Codes:**

○ **Integrate the system with the learning management system(LMS) and log on with [redacted]details**

**3 Quotations:**

D 1: Anon 2 - 1:6 I would say it's going to depend on whether you want to make this some… (11676:12722)/
D 3: Anon 4 - 3:6 Well you will have to have some form of database that does user authen… (3664:3742) /
D 3: Anon 4 - 3:10 Yes. So you have to register somehow because you have to be able to us… (3944:4220)

---

**D 3: Anon 4 - 3:7 You can definitely add the camera feature to take a picture of the boo… (4420:4871)**

**1 Codes:**

○ **Barcode scanning, Camera and Calendar**

**3 Quotations:**

D 1: Anon 2 - 1:8 If you can use the barcode scanning that would be ideal. Specifically… (15093:15439) /
D 2: Anon 3 - 2:7 Features I think you would want it to access your camera on your devic… (9710:10492) /
D 3: Anon 4 - 3:7 You can definitely add the camera feature to take a picture of the boo… (4420:4871)

---

**D 3: Anon 4 - 3:10 Yes. So you have to register somehow because you have to be able to us… (3944:4220)**

**1 Codes:**

○ **Integrate the system with the learning management system(LMS) and log on with [redacted]details**

**3 Quotations:**

D 1: Anon 2 - 1:6 I would say it's going to depend on whether you want to make this some… (11676:12722)/
D 3: Anon 4 - 3:6 Well you will have to have some form of database that does user authen… (3664:3742) /
D 3: Anon 4 - 3:10 Yes. So you have to register somehow because you have to be able to us… (3944:4220)

---

**D 4: Anon1 - 4:8 In this application I don't think that is necessary. It will complicat… (7792:8292)**

**1 Codes:**

○ **No device features**

**1 Quotations:**

D 4: Anon1 - 4:8 In this application I don't think that is necessary. It will complicat… (7792:8292)

Therefore, the researcher considered to use the code with more occurrence frequencies which are: code “Barcode scanning, Camera and Calendar” and code “Integrate the system with the learning management system (LMS) and log on with [redacted] details”. These codes will be used in the design of the application in terms of the features selection.

#### 5.5.7.3 Theme 3: Information

This code group will allow the researcher to identify information that needs to be displayed on the application. This group includes two codes: “Information about the book (Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book (Cell phone number, email), categorise books per subject, Trading location” and “Quality of the book and the price of the book”. Table 5.14 demonstrates the code occurrence frequencies for each code in the code group information.

**Table 5-14: Code occurrence frequencies for codes in the information code group.**

| Code Groups | Codes | Anon 2 | Anon 3 | Anon 4 | Anon 1 | Totals |
|---|---|---|---|---|---|---|
| Information | Information about the book (Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book (Cell phone number, email), categorise books per subject, Trading location | 2 | 1 | 1 | 1 | 5 |
| | Quality of the book and price of the book | 1 | 1 | 0 | 0 | 2 |
| | Totals | 3 | 2 | 1 | 1 | 7 |

It appears that the code “Information of the book and information of the owner of the book” occurs five times. Table 5.15 shows a detailed report query of group code features with resulting quotations.

**Table 5-15: Code Excerpt 6: Report for Query Code Group: Information.**

| |
|---|
| **Report for Query: Information** |
| Resulting quotations (7) |

**D 1: Anon 2 - 1:2 Okay, if you are going to do a trade in, you need to decide on whether… (2488:3373)**

**1 Codes:**

○ **Information about the book(Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book(Cell phone number, email), categorise books per subject, Trading location**

**1 Groups:**

Information

**5 Quotations:**

D 1: Anon 2 - 1:2 Okay, if you are going to do a trade in, you need to decide on whether… (2488:3373) /
D 1: Anon 2 - 1:13 I would think that would be better but then you would need to display… (3588:5913) /
D 2: Anon 3 - 2:2 Okay, so no electronic exchanging of money? I think you should allow f… (2231:3871) /
D 3: Anon 4 - 3:2 Well the application is for the trading of used books so obviously you… (694:1230) /
D 4: Anon1 - 4:1 Okay, first of all, all the information about the book itself. For ins… (1254:1708)

---

**D 1: Anon 2 - 1:13 I would think that would be better but then you would need to display… (3588:5913)**

**1 Codes:**

○ **Information about the book(Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book(Cell phone number, email), categorise books per subject, Trading location**

**1 Groups:**

Information

**5 Quotations:**

D 1: Anon 2 - 1:2 Okay, if you are going to do a trade in, you need to decide on whether… (2488:3373) /
D 1: Anon 2 - 1:13 I would think that would be better but then you would need to display… (3588:5913) /
D 2: Anon 3 - 2:2 Okay, so no electronic exchanging of money? I think you should allow f… (2231:3871) /
D 3: Anon 4 - 3:2 Well the application is for the trading of used books so obviously you… (694:1230) /
D 4: Anon1 - 4:1 Okay, first of all, all the information about the book itself. For ins… (1254:1708)

---

**D 1: Anon 2 - 1:17 For that the reason that I am suggesting something like (inaudible 18:… (16181:18308)**

**1 Codes:**

○ **Quality of the book and price of the book**

**1 Groups:**

Information

**2 Quotations:**

D 1: Anon 2 - 1:17 For that the reason that I am suggesting something like (inaudible 18:… (16181:18308)/
D 2: Anon 3 - 2:10 Options. Okay, I think first and foremost it has to be your main selli… (10735:12259)

---

**D 2: Anon 3 - 2:2 Okay, so no electronic exchanging of money? I think you should allow f… (2231:3871)**

**1 Codes:**

○ **Information about the book(Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book(Cell phone number, email), categorise books per subject, Trading location**

**1 Groups:**

Information

**5 Quotations:**

D 1: Anon 2 - 1:2 Okay, if you are going to do a trade in, you need to decide on whether… (2488:3373) /
D 1: Anon 2 - 1:13 I would think that would be better but then you would need to display… (3588:5913) /
D 2: Anon 3 - 2:2 Okay, so no electronic exchanging of money? I think you should allow f… (2231:3871) /
D 3: Anon 4 - 3:2 Well the application is for the trading of used books so obviously you… (694:1230) /
D 4: Anon1 - 4:1 Okay, first of all, all the information about the book itself. For ins… (1254:1708)

---

**D 2: Anon 3 - 2:10 Options. Okay, I think first and foremost it has to be your main selli… (10735:12259)**

**1 Codes:**

○ **Quality of the book and price of the book**

**1 Groups:**

Information

**2 Quotations:**

D 1: Anon 2 - 1:17 For that the reason that I am suggesting something like (inaudible 18:… (16181:18308)/
D 2: Anon 3 - 2:10 Options. Okay, I think first and foremost it has to be your main selli… (10735:12259)

---

**D 3: Anon 4 - 3:2 Well the application is for the trading of used books so obviously you… (694:1230)**

**1 Codes:**

○ **Information about the book(Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book(Cell phone number, email), categorise books per subject, Trading location**

**1 Groups:**

Information

**5 Quotations:**

D 1: Anon 2 - 1:2 Okay, if you are going to do a trade in, you need to decide on whether… (2488:3373) /
D 1: Anon 2 - 1:13 I would think that would be better but then you would need to display… (3588:5913) /
D 2: Anon 3 - 2:2 Okay, so no electronic exchanging of money? I think you should allow f… (2231:3871) /
D 3: Anon 4 - 3:2 Well the application is for the trading of used books so obviously you… (694:1230) /
D 4: Anon1 - 4:1 Okay, first of all, all the information about the book itself. For ins… (1254:1708)

---

**D 4: Anon1 - 4:1 Okay, first of all, all the information about the book itself. For ins… (1254:1708)**

**1 Codes:**

○ **Information about the book(Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book(Cell phone number, email), categorise books per subject, Trading location**

**1 Groups:**

Information

**5 Quotations:**

D 1: Anon 2 - 1:2 Okay, if you are going to do a trade in, you need to decide on whether… (2488:3373) /
D 1: Anon 2 - 1:13 I would think that would be better but then you would need to display… (3588:5913) /
D 2: Anon 3 - 2:2 Okay, so no electronic exchanging of money? I think you should allow f… (2231:3871) /
D 3: Anon 4 - 3:2 Well the application is for the trading of used books so obviously you… (694:1230) /
D 4: Anon1 - 4:1 Okay, first of all, all the information about the book itself. For ins… (1254:1708)

In conclusion, the most occurred code in the Information group is “Information about the book (Title, Author, ISBN, price of the book), Database of available books, Information about owner of the book (Cell phone number, email), categorise books per subject, Trading location”. Therefore, the designed application will contain information stated in the code Information.

#### 5.5.7.4 Theme 4: Interface design and platform selection

These two code groups are similar. Therefore only the interface design code group was analysed. The interface code group contain seven codes which gives an idea of the platform to be used for the design of the application and also explains how the interface should be presented. Table 5.16 presents code occurrence frequencies in the interface design code group.

**Table 5-16: Code occurrence frequencies for codes in the interface design code group.**

| Codes Groups | Codes | Anon 2 | Anon 3 | Anon 4 | Anon1 | Totals |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| **Interface design** | Android platform for the design | 0 | 0 | 0 | 1 | 1 |
| | Interface(simple to use, effective, pleasant user interface), search function, font choice | 1 | 1 | 1 | 1 | 4 |
| | Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform | 2 | 1 | 1 | 0 | 4 |
| | Security and log in screen | 0 | 0 | 0 | 2 | 2 |
| | Tabs, Infinite scroll | 0 | 0 | 1 | 0 | 1 |
| | Thumbnail on a smaller screen | 1 | 0 | 0 | 0 | 1 |
| | User friendly, Scroll screen, Logical flow, One page show all search criteria, Pagination | 1 | 1 | 0 | 1 | 3 |
| | Totals | 5 | 3 | 3 | 5 | 16 |

It appears that the code “Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform” and code “Interface (simple to use, effective, pleasant user interface), search function, font choice” occur four times. Table 5.17 shows a detailed report query of group code interface design with resulting quotations.

**Table 5-17: Code Excerpt 7: Report for Query Code Group: Interface Design.**

**Report for Query: Interface Design**

Resulting quotations (16)

---

**D 1: Anon 2 - 1:1 So, it depends. Tell me a bit more, first of all, of what you want to… (338:1130)**

**1 Codes:**

○ **Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform**

**2 Groups:**

Interface Design / Platform

**4 Quotations:**

D 1: Anon 2 - 1:1 So, it depends. Tell me a bit more, first of all, of what you want to… (338:1130) /
D 1: Anon 2 - 1:12 I think so. I think for your specific application that would be better… (1653:2122) /
D 2: Anon 3 - 2:1 Okay well I think in this day and age you would need to cover your bas… (197:1568) /
D 3: Anon 4 - 3:1 There are many platforms that exist. The obvious choice would be Andro… (198:534)

**D 1: Anon 2 - 1:3 I'm very big on single page applications. So basically if I am scrolli… (6115:6413)**

**1 Codes:**

○ **User friendly, Scroll screen, Logical flow, One page show all search criteria, Pagination**

**1 Groups:**

Interface Design

**3 Quotations:**

D 1: Anon 2 - 1:3 I'm very big on single page applications. So basically if I am scrolli… (6115:6413) /
D 2: Anon 3 - 2:3 I think you will need to have scroll obviously for your list of books.… (4073:5099) /
D 4: Anon1 - 4:3 Of course the layout must be as user friendly as possible. Don't overu… (2013:2893)

---

**D 1: Anon 2 - 1:10 Adoption. It's one of the things that you will need to decide is how y… (19907:21447)**

**1 Codes:**

○ **Interface(simple to use, effective, pleasant user interface), search function, font choice**

**1 Groups:**

Interface Design

**4 Quotations:**

D 1: Anon 2 - 1:10 Adoption. It's one of the things that you will need to decide is how y… (19907:21447) /
D 2: Anon 3 - 2:9 It's a tough one. The thing is people are so used to applications nowa… (13754:15347) /
D 3: Anon 4 - 3:9 For me, it's always important, especially if you have an application t… (5971:6957) /
D 4: Anon1 - 4:6 First of all your user name interface. Your user name interface must b… (11219:11590)

---

**D 1: Anon 2 - 1:12 I think so. I think for your specific application that would be better… (1653:2122)**

**1 Codes:**

○ **Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform**

**2 Groups:**

Interface Design / Platform

**4 Quotations:**

D 1: Anon 2 - 1:1 So, it depends. Tell me a bit more, first of all, of what you want to… (338:1130) /
D 1: Anon 2 - 1:12 I think so. I think for your specific application that would be better… (1653:2122) /
D 2: Anon 3 - 2:1 Okay well I think in this day and age you would need to cover your bas… (197:1568) /

D 3: Anon 4 - 3:1 There are many platforms that exist. The obvious choice would be Andro… (198:534)

---

**D 1: Anon 2 - 1:15 So those are not necessarily icons. Logo put top left. Because that is… (7719:9863)**

**1 Codes:**

○ **Thumbnail on a smaller screen**

**1 Groups:**

Interface Design

**1 Quotations:**

D 1: Anon 2 - 1:15 So those are not necessarily icons. Logo put top left. Because that is… (7719:9863)

---

**D 2: Anon 3 - 2:1 Okay well I think in this day and age you would need to cover your bas… (197:1568)**

**1 Codes:**

○ **Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform**

**2 Groups:**

Interface Design / Platform

**4 Quotations:**

D 1: Anon 2 - 1:1 So, it depends. Tell me a bit more, first of all, of what you want to… (338:1130) /
D 1: Anon 2 - 1:12 I think so. I think for your specific application that would be better… (1653:2122) /
D 2: Anon 3 - 2:1 Okay well I think in this day and age you would need to cover your bas… (197:1568) /
D 3: Anon 4 - 3:1 There are many platforms that exist. The obvious choice would be Andro… (198:534)

---

**D 2: Anon 3 - 2:3 I think you will need to have scroll obviously for your list of books.… (4073:5099)**

**1 Codes:**

○ **User friendly, Scroll screen, Logical flow, One page show all search criteria, Pagination**

**1 Groups:**

Interface Design

**3 Quotations:**

D 1: Anon 2 - 1:3 I'm very big on single page applications. So basically if I am scrolli… (6115:6413) /
D 2: Anon 3 - 2:3 I think you will need to have scroll obviously for your list of books.… (4073:5099) /
D 4: Anon1 - 4:3 Of course the layout must be as user friendly as possible. Don't overu… (2013:2893)

**D 2: Anon 3 - 2:9 It's a tough one. The thing is people are so used to applications nowa… (13754:15347)**

**1 Codes:**

○ **Interface(simple to use, effective, pleasant user interface), search function, font choice**

**1 Groups:**

Interface Design

**4 Quotations:**

D 1: Anon 2 - 1:10 Adoption. It's one of the things that you will need to decide is how y… (19907:21447) /
D 2: Anon 3 - 2:9 It's a tough one. The thing is people are so used to applications nowa… (13754:15347) /
D 3: Anon 4 - 3:9 For me, it's always important, especially if you have an application t… (5971:6957) /
D 4: Anon1 - 4:6 First of all your user name interface. Your user name interface must b… (11219:11590)

---

**D 3: Anon 4 - 3:1 There are many platforms that exist. The obvious choice would be Andro… (198:534)**

**1 Codes:**

○ **Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platform**

**2 Groups:**

Interface Design / Platform

**4 Quotations:**

D 1: Anon 2 - 1:1 So, it depends. Tell me a bit more, first of all, of what you want to… (338:1130) /
D 1: Anon 2 - 1:12 I think so. I think for your specific application that would be better… (1653:2122) /
D 2: Anon 3 - 2:1 Okay well I think in this day and age you would need to cover your bas… (197:1568) /
D 3: Anon 4 - 3:1 There are many platforms that exist. The obvious choice would be Andro… (198:534)

---

**D 3: Anon 4 - 3:3 Infinite scroll is more often used in web design because this is an ap… (1411:1565)**

**1 Codes:**

○ **Tabs, Infinite scroll**

**1 Groups:**

Interface Design

**1 Quotations:**

D 3: Anon 4 - 3:3 Infinite scroll is more often used in web design because this is an ap… (1411:1565)

**D 3: Anon 4 - 3:9 For me, it's always important, especially if you have an application t… (5971:6957)**

**1 Codes:**

○ **Interface(simple to use, effective, pleasant user interface), search function, font choice**

**1 Groups:**

Interface Design

**4 Quotations:**

D 1: Anon 2 - 1:10 Adoption. It's one of the things that you will need to decide is how y… (19907:21447) /
D 2: Anon 3 - 2:9 It's a tough one. The thing is people are so used to applications nowa… (13754:15347) /
D 3: Anon 4 - 3:9 For me, it's always important, especially if you have an application t… (5971:6957) /
D 4: Anon1 - 4:6 First of all your user name interface. Your user name interface must b… (11219:11590)

---

**D 4: Anon1 - 4:2 There are two major operating systems. One is android and one is IOS (… (254:633)**

**1 Codes:**

○ **Android platform for the design**

**2 Groups:**

Interface Design / Platform

**1 Quotations:**

D 4: Anon1 - 4:2 There are two major operating systems. One is android and one is IOS (… (254:633)

---

**D 4: Anon1 - 4:3 Of course the layout must be as user friendly as possible. Don't overu… (2013:2893)**

**1 Codes:**

○ **User friendly, Scroll screen, Logical flow, One page show all search criteria, Pagination**

**1 Groups:**

Interface Design

**3 Quotations:**

D 1: Anon 2 - 1:3 I'm very big on single page applications. So basically if I am scrolli… (6115:6413) /
D 2: Anon 3 - 2:3 I think you will need to have scroll obviously for your list of books.… (4073:5099) /
D 4: Anon1 - 4:3 Of course the layout must be as user friendly as possible. Don't overu… (2013:2893)

**D 4: Anon1 - 4:6 First of all your user name interface. Your user name interface must b… (11219:11590)**

**1 Codes:**

○ **Interface (simple to use, effective, pleasant user interface), search function, font choice**

**1 Groups:**

Interface Design

**4 Quotations:**

D 1: Anon 2 - 1:10 Adoption. It's one of the things that you will need to decide is how y… (19907:21447) /
D 2: Anon 3 - 2:9 It's a tough one. The thing is people are so used to applications nowa… (13754:15347) /
D 3: Anon 4 - 3:9 For me, it's always important, especially if you have an application t… (5971:6957) /
D 4: Anon1 - 4:6 First of all your user name interface. Your user name interface must b… (11219:11590)

---

**D 4: Anon1 - 4:9 Okay, then users must have access. So they will complain later. Now th… (5926:6863)**

**1 Codes:**

○ **Security and log in screen**

**1 Groups:**

Interface Design

**2 Quotations:**

D 4: Anon1 - 4:9 Okay, then users must have access. So they will complain later. Now th… (5926:6863) /
D 4: Anon1 - 4:10 That depends on your application itself. Will you allow your user to u… (5660:5841)

---

**D 4: Anon1 - 4:10 That depends on your application itself. Will you allow your user to u… (5660:5841)**

**1 Codes:**

○ **Security and log in screen**

**1 Groups:**

Interface Design

**2 Quotations:**

D 4: Anon1 - 4:9 Okay, then users must have access. So they will complain later. Now th… (5926:6863) /
D 4: Anon1 - 4:10 That depends on your application itself. Will you allow your user to u… (5660:5841)

In conclusion the two codes that occurred most frequently was used (“Multiple devices, Catch all there, Responsive web, cover all basis, Hybrid application, Available for all platforms” and code “Interface (simple to use, effective, pleasant user interface), search function, font choice”) in the group code for the selection of the platform to be used in the design of the application.

#### 5.5.7.5 Theme 5: Test the application

It is necessary to acknowledge that each application must be tested. In this group code, test the application, insight on who should test the application after the design was obtained. Table 5.18 presents code occurrence frequencies in the test the application codes group.

**Table 5-18: Code occurrence frequencies in the test the application code group.**

| Code Groups | Codes | Anon 2 | Anon 3 | Anon 4 | Anon 1 | Totals |
|---|---|---|---|---|---|---|
| Test the application | Subject matter expert and students | 0 | 1 | 0 | 0 | 1 |
| | Target audience or User group | 2 | 0 | 1 | 0 | 3 |
| | Totals | 2 | 1 | 1 | 0 | 4 |

It appears that the code “Target audience or user group” occurs three times in the code group test the application. Table 5.19 shows a detailed report query of code group test the application.

**Table 5-19: Code Excerpt 8: Report for Query Code Group: Test the application.**

**Report for Query: Test the application**

Resulting quotations (4)

---

**D 1: Anon 2 - 1:9 Specifically the people that are going to be in the target audience (18505:18571)**

**1 Codes:**

- **Target audience or User group**

**1 Groups:**

Test the application

**3 Quotations:**

D 1: Anon 2 - 1:9 Specifically the people that are going to be in the target audience (18505:18571) /
D 1: Anon 2 - 1:18 They should be the people testing it as well. You’d obviously quaranti… (18678:18865) /
D 3: Anon 4 - 3:8 Well, the application should always be tested by the user group. You’r… (5006:5766)

**D 1: Anon 2 - 1:18 They should be the people testing it as well. You'd obviously quaranti… (18678:18865)**

**1 Codes:**

- **Target audience or User group**

**1 Groups:**

Test the application

**3 Quotations:**

D 1: Anon 2 - 1:9 Specifically the people that are going to be in the target audience (18505:18571) /
D 1: Anon 2 - 1:18 They should be the people testing it as well. You'd obviously quaranti… (18678:18865) /
D 3: Anon 4 - 3:8 Well, the application should always be tested by the user group. You'r… (5006:5766)

---

**D 2: Anon 3 - 2:8 Beta testing I think you would need obviously people like myself and J… (12393:13540)**

**1 Codes:**

- **Subject matter expert and students**

**1 Groups:**

Test the application

**1 Quotations:**

D 2: Anon 3 - 2:8 Beta testing I think you would need obviously people like myself and J… (12393:13540)

---

**D 3: Anon 4 - 3:8 Well, the application should always be tested by the user group. You'r… (5006:5766)**

**1 Codes:**

- **Target audience or User group**

**1 Groups:**

Test the application

**3 Quotations:**

D 1: Anon 2 - 1:9 Specifically the people that are going to be in the target audience (18505:18571) /
D 1: Anon 2 - 1:18 They should be the people testing it as well. You'd obviously quaranti… (18678:18865) /
D 3: Anon 4 - 3:8 Well, the application should always be tested by the user group. You'r… (5006:5766)

## 5.6 Conclusion

In this chapter, the process for conducting the requirements analysis was discussed by providing an overview of the participants, interview questions and interview process, and how the data collected was analysed. Due to the nature of the research, where detailed understanding leads to a higher level of understanding and vice versa, the research mode chosen was hermeneutics.

Before beginning with the data analysis, questions were developed from the literature and expert participants at the specific university were interviewed. The interviews were audio recorded, transcribed and then coded through content analysis.

This method of analysis produced themes in the form of code groups from the research data. The code groups were analysed and conclusions were drawn from each of them. Table 5.20 provides an overview of the code groups identified that will be used as requirements analysis for the design of the artefact.

**Table 5-20: Final code groups for requirements analysis.**

| | Code groups |
|---|---|
| 1. | Platform selection and interface design<br>• Use hybrid platform to create a responsive mobile web application<br>• Create a pleasant user interface (useful and friendly) |
| 2. | Colours:<br>• Use negative contrast and corporate colours of the institution where the app will be used |
| 3. | Information:<br>• Include the following information: Title of the book, author of the book, ISBN, price of the book, owner of the book details (cell phone and email address), and the trading location. |
| 4. | Features:<br>• Integrate the application with LMS of the institution<br>• Include barcode, camera and calendar features |
| 5. | Test the application:<br>• Use targeted audience to test the application |

Figure 5.2 provides an adaptation of the design science research process to represent the research structure of this study. Following the requirements analysis conducted, the artefact design is demonstrated in the next chapter.

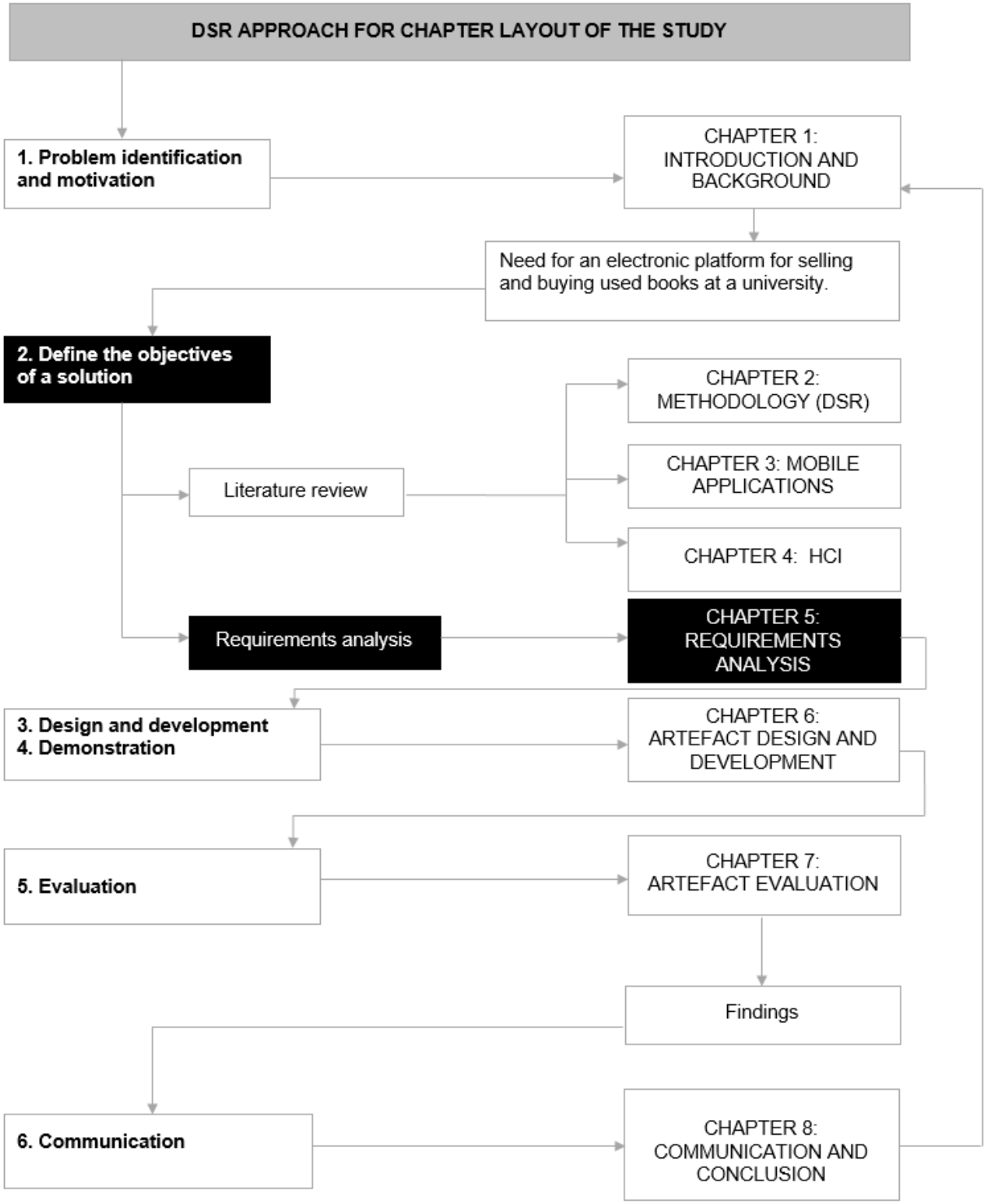



**Figure 5-2: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

# CHAPTER 6: ARTEFACT DESIGN AND DEVELOPMENT

## 6.1 Introduction

The goal of this research is to design a mobile application for the trading of used books at a university following a design science research approach. For the researcher to achieve this, a literature review of DSR methodology was formulated and discussed in Chapter 2 in order to structure the research process followed in this study. The third and fourth activities of the DSR process is presented in this chapter which is: design and development, and demonstration.

The chapter provides a discussion on the design, development and demonstration of the artefact. In order to achieve this, all objectives of the “define the objectives of a solution” activity of the DSR process model will be incorporated.

This chapter is partitioned into the following sections aimed at elucidating the sub-cycles of the design and development activity process: Mobile-D is discussed in Section 6.2; refined guidelines for the design of a mobile application for the trading of used books at a university is presented in Section 6.3, the design, development and demonstration of the artefact in Section 6.4; and finally, the conclusion in Section 6.5.

## 6.2 Mobile-D applied

A hybrid mobile application was built using the capabilities of HTML 5 and CSS 3, including embedded SQL databases, local storage, animations, canvas, web sockets and video playback to make it appear and behave as a native app.

As the goal of this study was to design a mobile application, a suitable development methodology, Mobile-D, was used as a guideline for the designed application. Figure 6.1 explains how Mobile-D was implemented in the development of the mobile application for the trading of used books at a specific university.

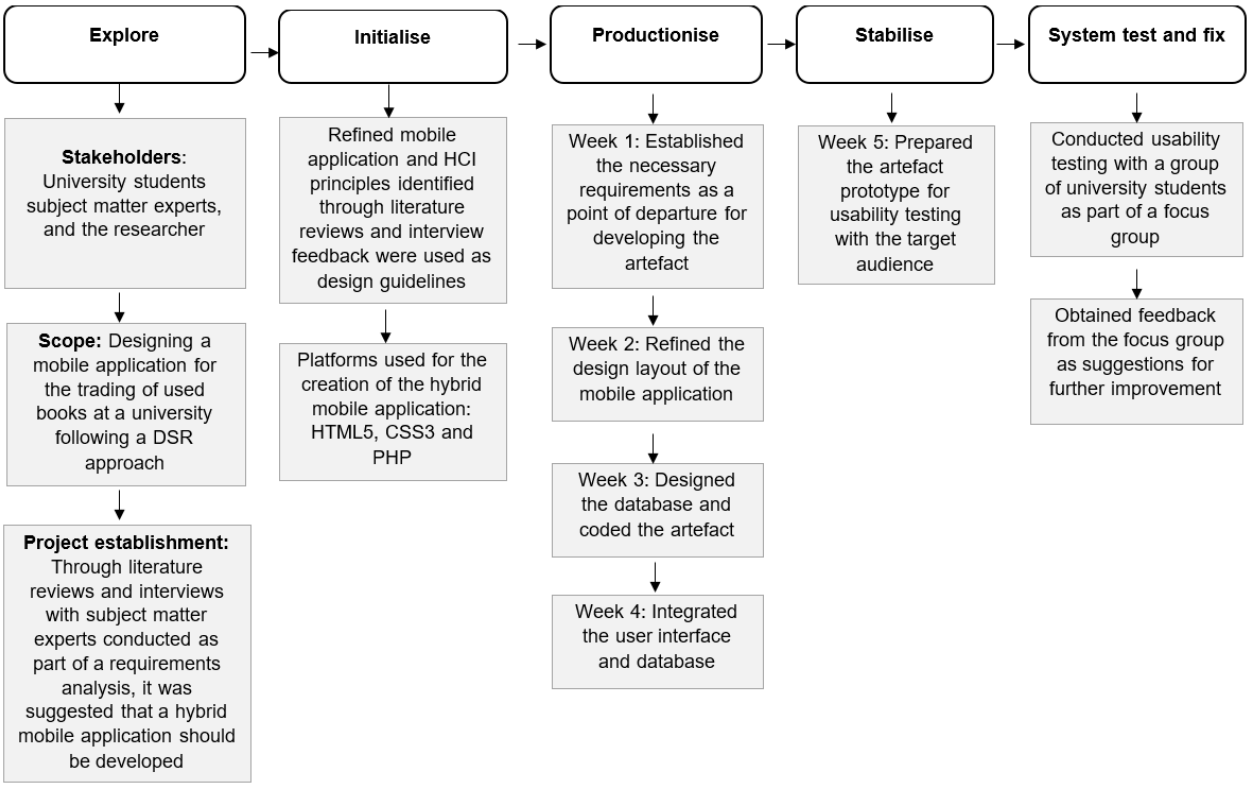



**Figure 6-1: Mobile-D implementation in the mobile application for the trading of used books at a specific university.**

Table 6.1 provides a detailed explanation on the implementation of the Mobile-D approach to creating the mobile application for the trading of used books at a specific university.

**Table 6-1: Mobile-D implementation explained in the mobile application for the trading of used books at a specific university.**

| **Mobile-D phases and stages application to the development of the prototype.** |
|---|
| **Explore:** Based on the literature review conducted on HCI and mobile applications, and interviews conducted with HCI and mobile design experts of a specific university, it was concluded that a hybrid mobile application should be developed. |
| **Initialise**: Refined HCI and mobile design principles, and interview feedback with subject matter experts were used to guide the development of the artefact using the following platforms: HTML5, CSS3 and PHP. |
| **Productionise**: Development of the artefact prototype took approximately four weeks to complete. The first week consisted of determining all requirements necessary as point of departure for the artefact. The second week was focused on the design of the application. The third week addressed the coding of the application and the database design. The fourth week |

| |
|---|
| consisted of interface and database integration and the preparation of the application for testing by the audience group (leading into the fifth week). As the artefact is a prototype to be evaluated for use, it was not possible to fully productionise the mobile application at this stage. |
| **Stabilise and system test & fix:** The target audience consisted of students of a specific university. A group of students were provided with the opportunity to test the application (fifth week). After the artefact was tested by members of its target audience, a semi-structured focus group interview was conducted to determine suggestions for improvement (Chapter 7). |

The following section discusses guidelines that was utilised in the design of the mobile application for the trading of used books at a specific university.

### 6.3 Refined guidelines for the design of a mobile application matched with coded data

In this section, enriched guidelines for designing a mobile application as proposed in Chapter 4, Table 4.6 were matched with codes identified in the requirement analysis. These guidelines are used in the design and development of the mobile application for the trading of used books at a university. Table 6.2 presents the refined guidelines for designing a mobile application (mobile design principles and mobile design HCI principles) matched to the codes found as part of the requirements analysis. These guidelines allowed the researcher to design and develop a mobile application in an efficient and effective manner. Furthermore, these guidelines were used to facilitate the creation of a mobile application which will allow students of a specific university to trade used books in an accessible manner. Table 6. 2 suggests the refined guidelines that is used to design and develop the mobile application for the trading of used books at a university.

**Table 6-2: Refined guidelines to design a mobile application for a specific university.**

| Code groups | | Mobile principles | HCI principles |
|---|---|---|---|
| 1. | Platform selection and interface design<br>• Use hybrid platform to create a responsive mobile web application<br>• Create a pleasant user interface (useful and friendly) | M1, M2, M3, M4, M5,M6,M7,M8,M12, M19, M18, M20 | H1,H2,H3,H4, H6, H8, H9 |
| 2. | Colours:<br>• Use negative contrast and corporate colours of the institution where the app will be used | M3, M5, M6, M10, M11, M12, M22 | H5, H6, H8 |

| | | | |
|---|---|---|---|
| 3. | Information:<br>• Include the following information: Title of the book, author of the book, ISBN, price of the book, owner of the book details (cell phone and email address), and the trading location. | M1, M5,M16, M18, M19, M21 | H2, H7, H8, H9 |
| 4. | Features:<br>• Integrate the application with LMS of the institution<br>• Include barcode, camera and calendar features | M2, M4, M7, M13, M14, M15, | H3, H4, H5, H9 |
| 5. | Test the application:<br>• Use targeted audience to test the application | M3, M9 | H6, H8 |

The next section showcases the design, development and demonstration of the mobile application for the trading of used books at a specific university.

### 6.4 Design, development and demonstration

Based on interviews conducted, codes were identified and organised in code groups later matched with mobile application design principles and HCI mobile application design principles (Table 6.1). The design and development process will use the refined guidelines to construct a mobile application for the trading of used books at a specific university.

#### 6.4.1 Platform selection and interface design

- **Platform selection**

  Based on interviews conducted with HCI and mobile design experts it was recommended to utilise a hybrid platform to develop the app. HTML5 and supporting software was chosen as suitable hybrid platform for the design of the mobile application for the trading of used books at a specific university. A detailed overview was given in Section 6.2.

- **Interface design**

  The design of the mobile application was completed page for page and later combined to constitute a fully working application. The application consists of five pages. Figure 6.2 to Figure 6.6 demonstrates the interface design of the application. A brief summary that addresses the code group, mobile principles and HCI principles that informed the design and development of the mobile application is presented.

1. **Login**

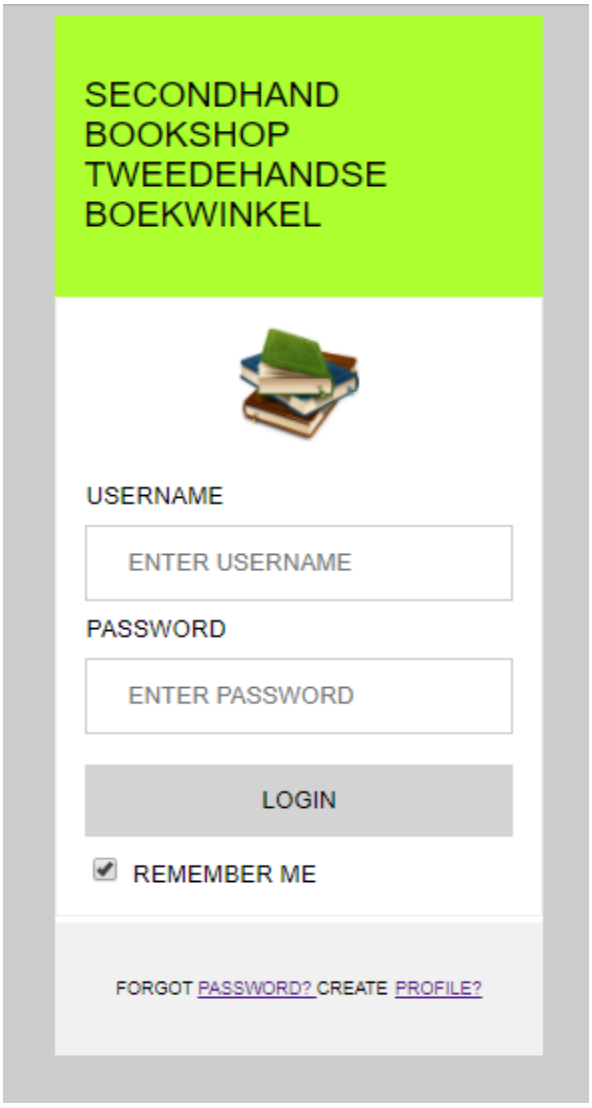



**Figure 6-2: The first form of the designed application**

**2. Create a student profile**

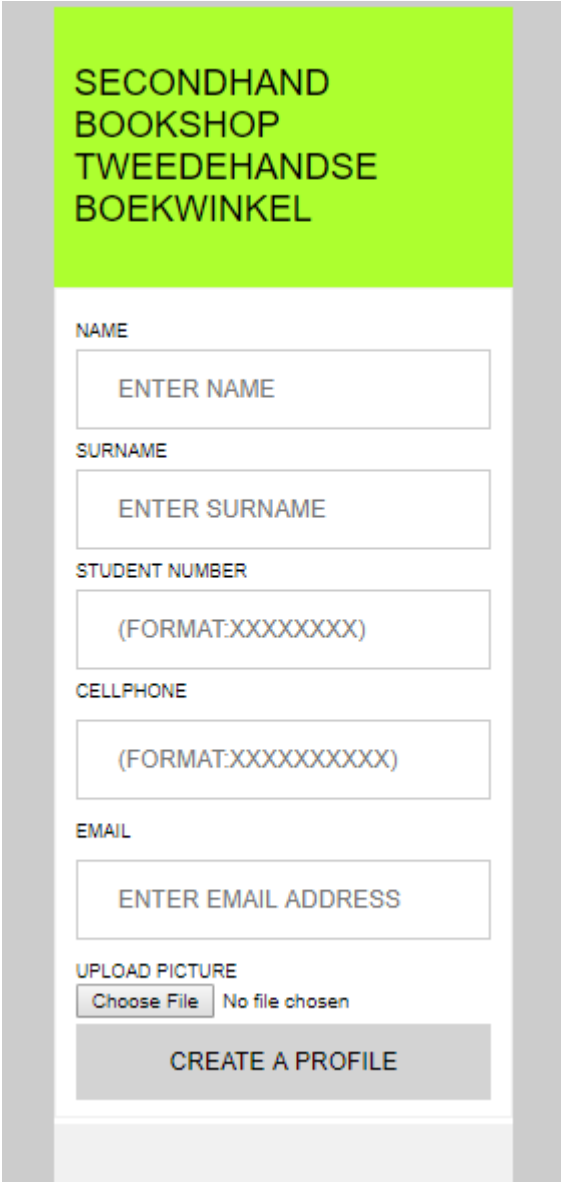



**Figure 6-3: Create a student profile form.**

3. **Find Books**

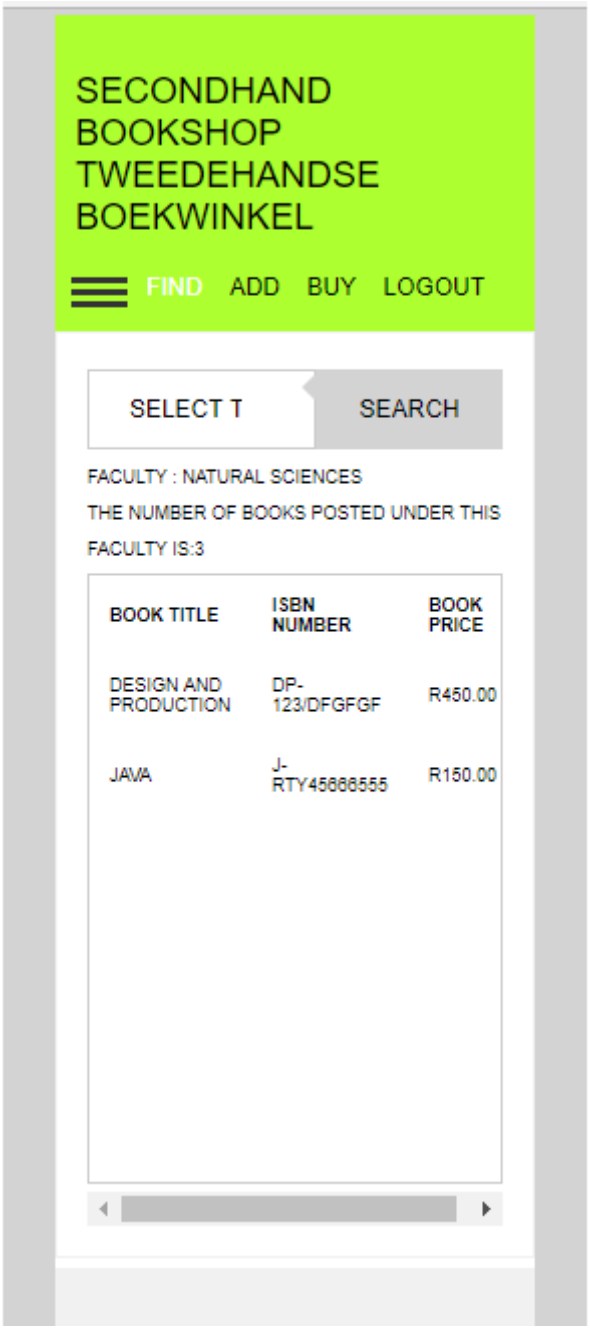



**Figure 6-4: Find books form.**

4. **Add Book**

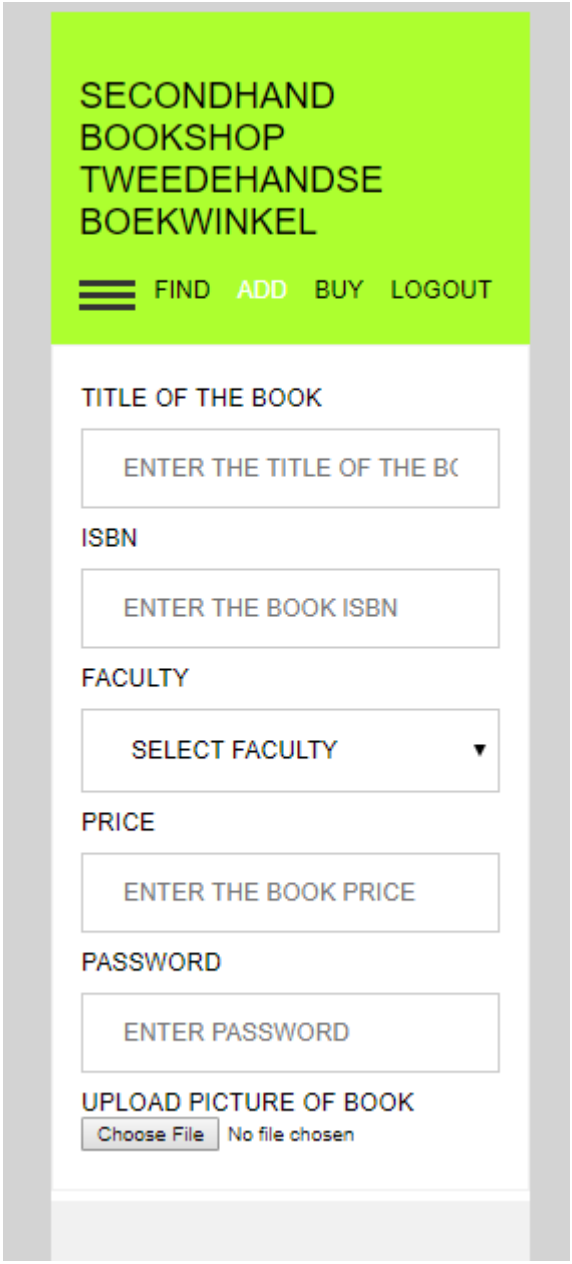



**Figure 6-5: Add book form.**

5. **Buy a book**

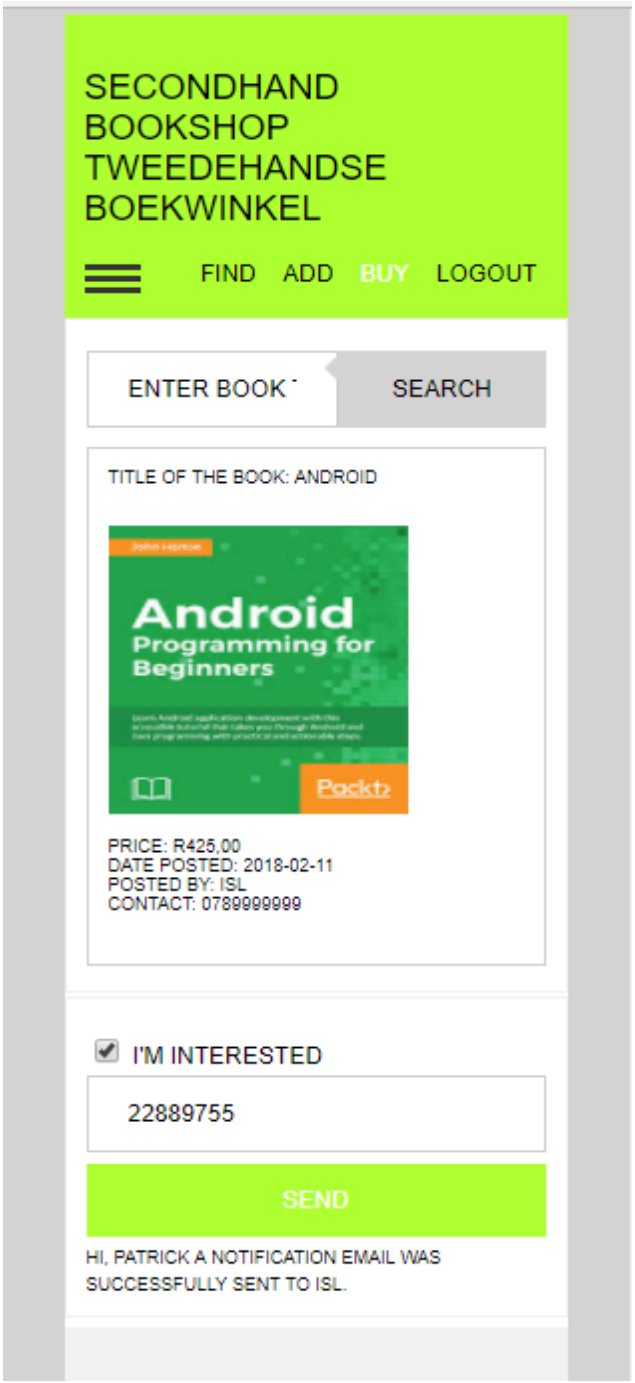



**Figure 6-6: Buy a book.**

**Code group**

Platform selection and interface design (Use hybrid platform to create a responsive web, create a pleasant user interface (useful and friendly)): Based on the on the requirements analysis conducted, HTML5 was selected for the design of the mobile application.

**Principles incorporated**

M1, M2, and M3: Navigations are self-evident and information is not overloaded on the application.

M4, M5, and M6: Text content is legible and the interface elements are clearly visible.

M7, M8, and M12: The amount of typing required is minimised and controls are designed based on hand position.

M19, M18, and M20: the mobile application is useful, includes only relevant, information and can only be used to buy and sell used books for a specific purpose.

H1, H2 and H3: Sequences of actions are required in similar situations (e.g. when logging in with a wrong student number the application will direct the user to the create profile form).

H4, and H6: The mobile application offers a simple error handling process (e.g. in a situation where the user makes a mistake an error message box will popup notifying the user about the error). Figure 6.7 shows a message box requesting the user to upload the correct picture format.

H8, and H9: The designed application uses the discoverability principle (e.g. In Figure 6.6 a non-authorised file format is uploaded and the system reject the file, notify the user about the error).

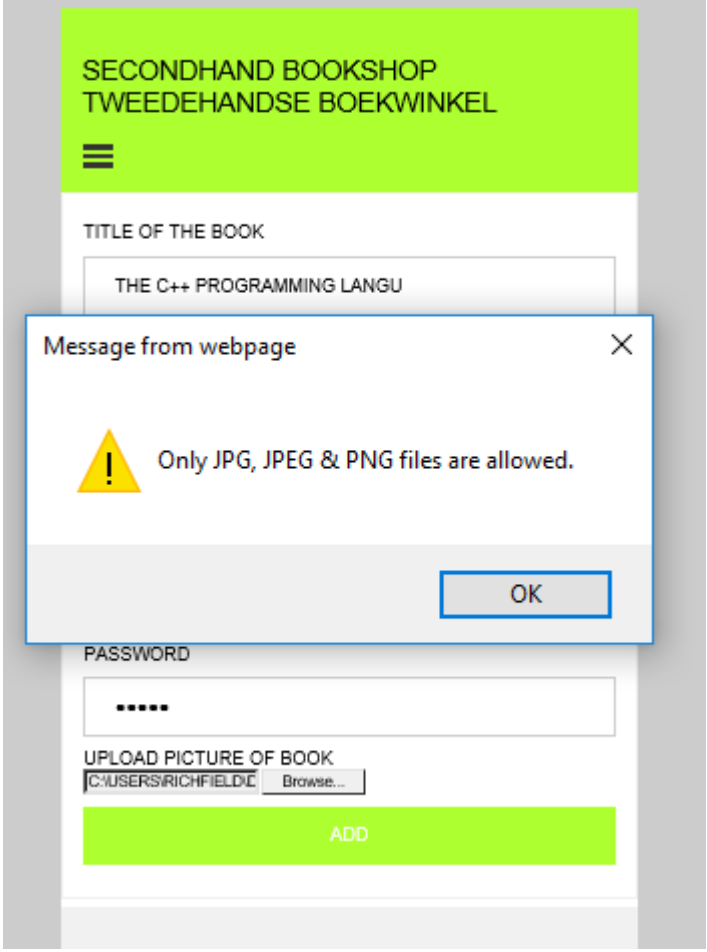



**Figure 6-7: Error handling process.**

### 6.4.2 Colours

An intersecting combination of negative contrast and a selected corporate colour (green) is used in the application. With reference to Figure 6.7, a form with the combination of the green and negative contrast is depicted.

**Code group**

Colours: use negative contrast and corporate colours of the institution where the app will be used. Based on the requirements analysis conducted with HCI and mobile design experts it was suggested that negative contrast is the recommended choice for viewing content. Green was chosen as a corporate colour for the application.

**Principles incorporated**

M3, M5, M6, M10, and M11: The designer chooses primary, secondary, and accent colours for the app that support usability to ensure sufficient colour contrast between elements so that users

with low vision can see and use the app. Text on the designed app is legible at a typical viewing distance without zooming.

M12, and M22: The designer ensures that the amount of text is restricted in the application.

H5, H6, and H8: There is a connection between controls in terms of colours and relationship between the properties of the object and the capabilities of the agent interacting with the object.

### 6.4.3 Information

With reference to the requirements analysis conducted it was recommended to include the following information on the form: Information about the book (Title, Author, ISBN, price of the book), Database of available books, and Information about the owner of the book (Cell phone number, email), Categorise books per subject, trading location. Figure 6.8 shows two forms portraying the requested information.

**Code group**

Information: Include the following information: Title of the book, author of the book, ISBN, price of the book, owner of the book details (cell phone and email address).

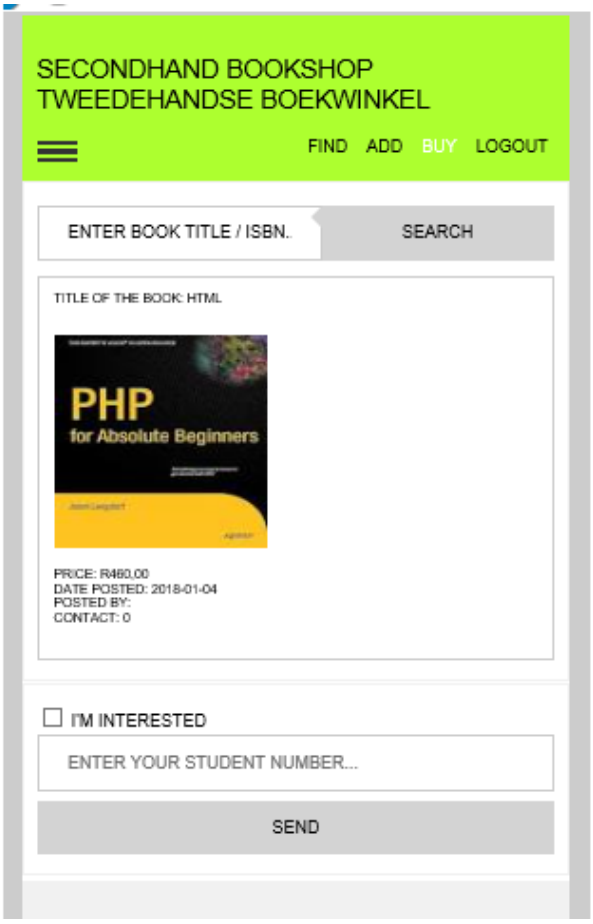
**Principles incorporated**

M1, M5, and M16: The developer ensures that information on the application is legible and not overloaded.

M18, M19, and M21: The developer only includes relevant information as recommended by HCI and mobile design experts (Figure 6.7).

H2, and H7: For every operator action, there is an informative system feedback.

H8, and H9: A design dialog to yield closure was implemented so that the user knows when they have completed a task. Figure 6.8 shows closure on a purchasing process. A notification is displayed on the “Buy form” that a message was successfully sent to the owner of the book.



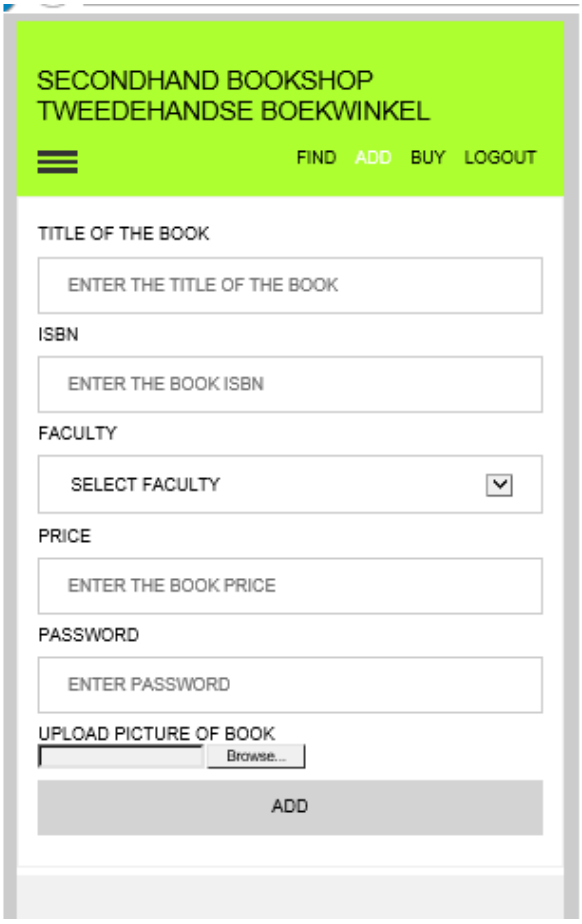




**Figure 6-8: Recommended Information on forms.**

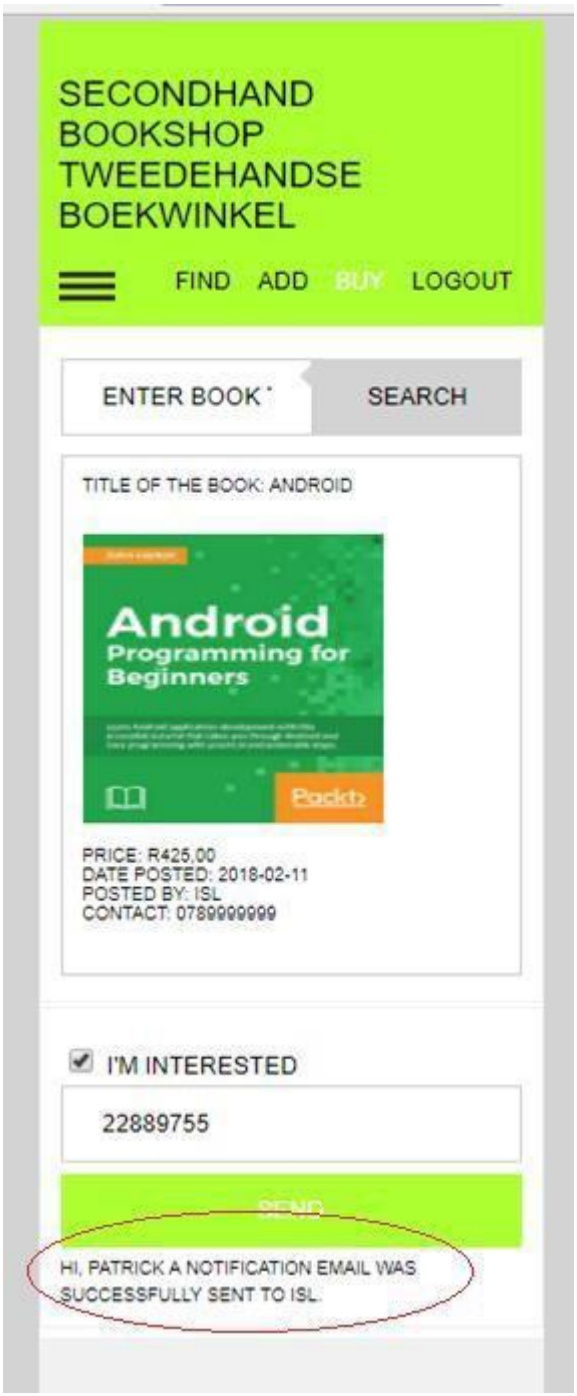



**Figure 6-9: Example of a design dialog to yield closure.**

### 6.4.4 Features

With respect to the interviews conducted it was requested to include the following features on forms: Barcode, learning management system for the institution, camera and calendar. Figure 6.10 shows various features implemented on the “ADD form” including:

1. Scan barcode
2. Learning management system (LMS) – the password entered is the same as the password used by the user at the institution.
3. Picture upload.

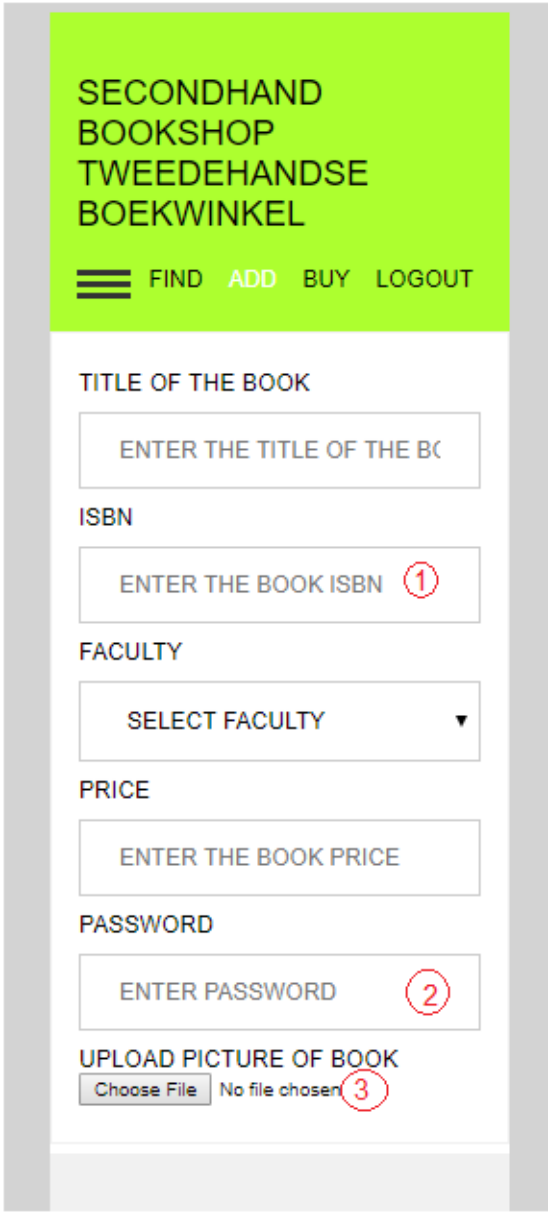



**Figure 6-10: Example of barcode, LMS, and picture upload implementation.**

**Code group**

Features: Integrate the application with LMS of the institution. Include barcode, camera and calendar features.

**Principles incorporated**

M2, M4, and M7: The developer made targets big enough so that they are easy for users to tap and navigations are self-evident on the application.

M13, M14, and M15: Orientation lock for portrait and landscape orientation was added.

H3, H4, H5, and H6: Good mapping between controls are enhanced through spatial layout and temporal contiguity. Further, the developer implemented a relationship between the properties of objects and the capabilities of the agent interacting with the object.

### 6.4.5 Testing of the application

With reference to the interviews conducted it was recommended that the application be tested by the targeted audience. The target audience include students of the specific university that will use the application to trade used books. Chapter 7 will provide an overview of the evaluation and usability testing of the application.

## 6.5 Conclusion

The refined guidelines for the design of a mobile application matched with coded data were discussed and applied to the creation of the artefact in this chapter. Furthermore, the chapter provided a demonstration of the implementation of the refined guidelines through the design and development of the artefact. The evaluation of the designed application will be explored in Chapter 7.

Figure 6.11 provides an adaptation of the design science research process to represent the research structure of this study.

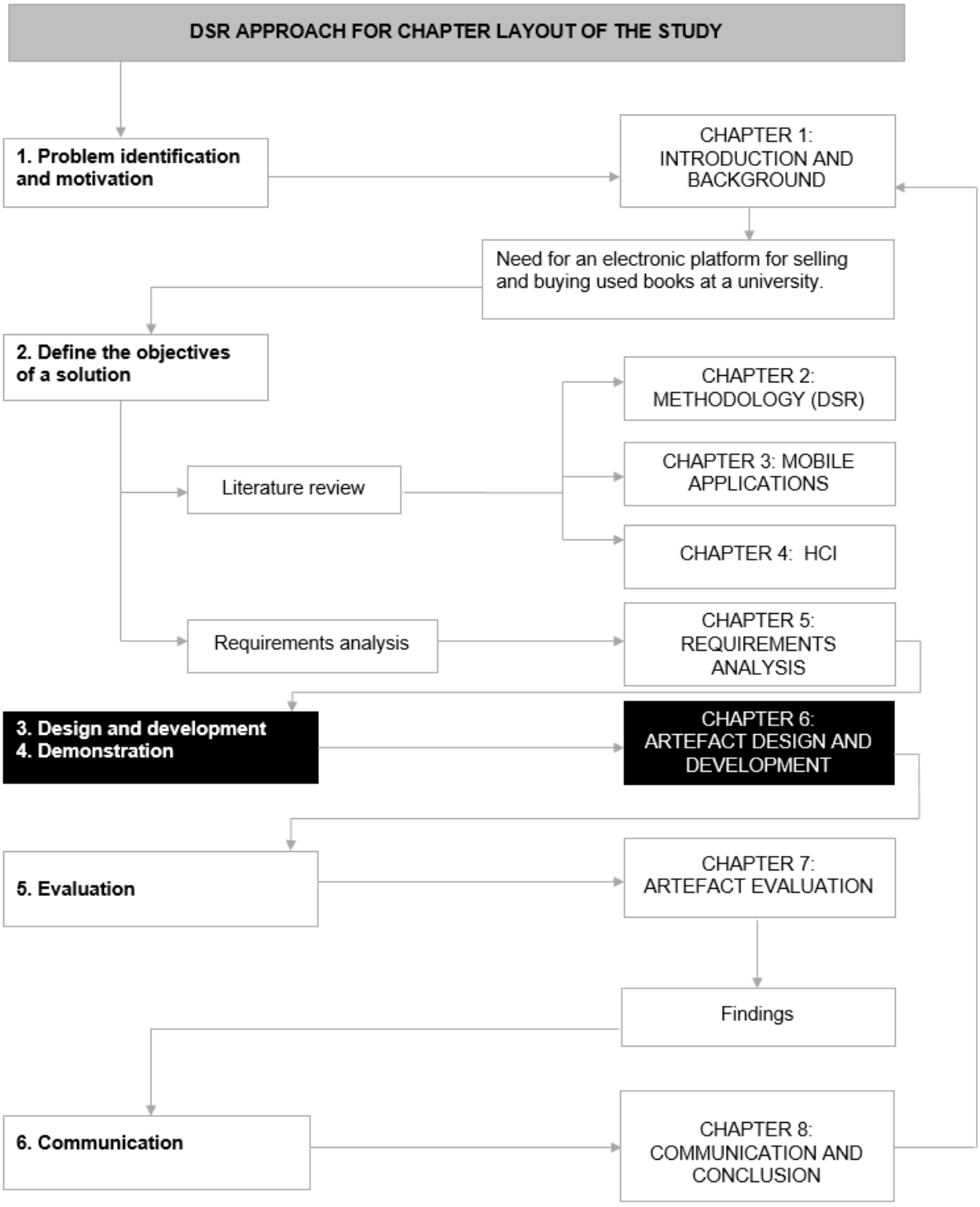



**Figure 6-11: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

# CHAPTER 7: ARTEFACT EVALUATION

## 7.1 Introduction

The goal of the research in this study was to design a mobile application for the trading of used books at a university following a design science research approach. In this chapter, the evaluation of the designed application by the target audience is discussed.

Data was collected through a focus group held with participants from the target audience of the designed mobile application. Section 7.2 will discuss the evaluation phase of the DSR process model. The following section will include two subsections which are: the participants of the focus group (7.2.1), and the data collection process (7.2.2). The data analysis method that was used in the evaluation phase will be discussed in Section 7.3. This section will include a report on the coding and themes identified in the data as well as the recommendations for further improvements identified from the data analysis process. Improvements identified through the data analysis is summarised in Section 7.4. The chapter will conclude with a summary in Section 7.5.

## 7.2 Evaluation phase

The evaluation phase is the fifth stage of the design science research process model. In this phase, the views of members of the target audience concerning the designed application are determined. This phase concludes the proposed refined guidelines to design a mobile application for the trading of used books at a university (Table 6.2) which states that the prototype of the application should be tested on members of the target audience. The views of members of the target audience will be determined by conducting a focus group with required participants. The feedback will aid in providing recommendations for further improvement of the design of the artefact.

### 7.2.1 Participants

According to Lazar *et al.* (2010b:193), a focus group is generally a semi-structured or unstructured interview. Krueger (1994) suggested that groups of five to seven participants are more appropriate for a focus group. Furthermore, Lazar *et al.* (2010b:190) stated that unstructured or semi-structured focus group interviews can be useful when one is looking to dig deeper, in search of critical comment, design requirements, and other insight.

A focus group was conducted with six participants and qualitative data was obtained. The six participants were students from the specific university – typical users of the proposed artefact. Focus group interview participants are listed in Table 7.1.

**Table 7-1: Participants list**

| Atlas Doc Reference | Participant Name | Year of study | Qualification Registered for |
|---|---|---|---|
| D:1 | Participant 1 | First | BSc |
| D:1 | Participant 2 | Second | BSc |
| D:1 | Participant 3 | Second | BCom |
| D:1 | Participant 4 | Second | BCom |
| D:1 | Participant 5 | Third | BCom |
| D:1 | Participant 6 | First | BCom |

The reason a focus group was chosen as the data gathering method was to provide a comfortable environment for the students amongst peers, which may not be the case if individual interviews were used because they are not experts and may feel intimidated.

The participants were provided with various electronic devices (which included tablets, cell phones, and laptops) to evaluate the mobile application. The participants were asked questions after the evaluation in order to provide suggestions for improvement of the mobile application.

Participants were asked a series of questions (Table 7.2) as part of the semi-structured focus group interview. The focus group interview with the participants was audio-recorded and the relevant sections of the interview were then transcribed for use in the data analysis phase. All participants signed a written letter of consent which is presented in Appendix B.

The focus group interview questions were structured around the applicable HCI principles and mobile application principles presented in Chapter 4. All questions found in literature for this study are given in Table 7.2 alongside key principles they are derived from.

**Table 7-2: Focus group questions adapted from literature.**

| | Question found in literature | Mobile principles code | HCI principle code | Question translated for the purpose of this study |
|---|---|---|---|---|
| 1. | How and when do you use the design? (Krueger & Casey, 2002:9) | M18, M19, M20 | H1, H2, H3, H4 | (After having interacted with the mobile application) In your own words, describe what the mobile application was created for? |
| | Give a general description of this design (Jordan, 1998:22). | | | |
| 2. | Who do you think should evaluate the usability of games? (Federoff, 2002:30) | M9, M10, M12 | H8 | Should this type of mobile application be tested for usability (i.e. user friendliness) before it is released to the public? |
| | When do you think usability evaluations should be performed? (Federoff, 2002:30) | | | Who do you think should test this type of mobile application? Why? |
| | Do you think usability evaluation techniques vary according to game genre? If so, how? (Federoff, 2002:30) | | | What is the best method for testing this type of mobile application? |
| | Does usability test measure something of relevance? (Nielsen, 1994:13) | | | |
| 3. | Tell me about positive experiences you've had with the application? (Krueger & Casey, 2002:9). | M, M2, M3, M4, M5, M6, M7,M16, M17, M21 | H1, H2, H3, H4, H5, H7, H8, H9 | Which feelings did you experience while interacting with the application? Why? |
| | What elements do you think help to create a successful game? (Federoff, 2002:30) | | | |
| | What advice would you give to designers aiming to produce pleasurable products? (Jordan, 1998:22) | | | Which elements of the mobile application was well designed? |
| | Which aspects of the design are particularly appealing? (Jordan, 1998:22) | | | |
| | What types of feeling does this product engender? (Jordan, 1998:22) | | | |

| | | | | |
|---|---|---|---|---|
| | When do you experience these feelings? (Jordan, 1998:22) | | | Which elements of the mobile application worked correctly? |
| | What design elements add to the usability of a game? (Federoff, 2002:30) | | | |
| 4. | Tell me about disappointments you've had with the application? (Krueger & Casey, 2002:9). | M9 | H6 | Which elements of the mobile application was poorly designed? |
| | What needs improvement? (Krueger & Casey, 2002:9) | | | Which elements of the mobile application worked incorrectly? |
| | What are the potential problems in using or understanding the model? (Kontio *et al.*, 2004:8) | | | Were you disappointed with any of the features on the mobile application? |
| 5. | Is the model packaged well for operational use? (Kontio *et al.*, 2004:8) | M18, M19, M20, M21, M22 | H5, H1 | Is the mobile application well presented? |
| | How it could be packaged better? (Kontio *et al.*, 2004:8) | | | Which platform do you think is the best choice for this type of application? For example, should it be a website or a mobile application or a different choice? Why? |
| 6. | How should you write the help information to best teach people how to correctly use the system? (Nielsen, 1994:12) | M2, M3, M5, M6, M10, M11, M12 | H8, H2 | Which options would you include to teach the user how to use the system? |
| 7. | What are the potential challenges in selling or using it? (Kontio *et al.*, 2004:8) | M7, M13 | H8 | What are the potential challenges in selling or using this type of mobile application? |
| 8. | Let's list these on the flip chart. If you had to pick only one factor that was most important to you, what would it be? (Krueger & Casey, 2002:9) | M17, M16, M21 | H2, H5 | Of all the mobile application elements we've talked about, what is most important to you? |

| | | | | |
|---|---|---|---|---|
| | What brought about the change? Of all the things we've talked about, what is most important to you? (Krueger & Casey, 2002:9) | | | What would you have done differently? |

Table 7.3 presents a list of all questions asked to participants of the focus group interview. Questions were open ended to allow participants to provide a rich overview in their responses.

**Table 7-3: Focus group questions.**

| | **Focus group questions formulated for the purpose of this study** |
|---|---|
| 1 | (After having interacted with the mobile application) In your own words, describe what the mobile application was created for? |
| 2 | Should this type of mobile application be tested for usability (i.e. user friendliness) before it is released to the public? |
| 3 | Who do you think should test this type of mobile application? Why? |
| 4 | What is the best method for testing this type of mobile application? |
| 5 | Which feelings did you experience while interacting with the application? Why? |
| 6 | Which elements of the mobile application was well designed? |
| 7 | Which elements of the mobile application worked correctly? |
| 8 | Which elements of the mobile application was poorly designed? |
| 9 | Which elements of the mobile application worked incorrectly? |
| 10 | Were you disappointed with any of the features on the mobile application? |
| 11 | Is the mobile application well presented? |
| 12 | Which platform do you think is the best choice for this type of application? For example, should it be a website or a mobile application or a different choice? Why? |
| 13 | Which options would you include to teach the user how to use the system? |
| 14 | What are the potential challenges in selling or using this type of mobile application? |
| 15 | Of all the mobile application elements we've talked about, what is most important to you? |
| 16 | What would you have done differently? |

### 7.2.2 Focus group process

Once the questions were structured and finalised, a focus group with members of the target audience was held. This was held after the development of the mobile application in order to evaluate the design and development of the artefact.

The focus group was conducted in a semi-structured and open ended manner. Participants were able to exchange ideas and freely express themselves.

The focus group was held at the university for which the mobile application was developed. It consisted of participants who are students at the university, from different fields of study and different ages. As a result, participants were able to offer comprehensive individual answers. This produced sufficient data to work with. The transcribed focus group interview is presented in Appendix F.

## 7.3 Data analysis

Concerning this study, content analysis was used to analyse the data. The body of text that was analysed is the transcribed focus group interview. An overview of the eight steps for performing content analysis within the context of the evaluation of the artefact is given in Table 7.4 and further discussed in this section.

**Table 7-4: 8 step to performing content analysis (Zhang & Wildemuth, 2009:3)**

| Step name | Application in this research |
|---|---|
| Prepare the data. | This was performed by transcribing the focus group interview and removing personal and identifying data as described in Section 7.3.1 |
| Define the unit of analysis. | Content analysis is being performed and the research seeks out the experiences and challenges of participants. These challenges and experiences were documented and constitutes a unit of analysis as discussed in Section 7.3.2. |
| Develop categories and a coding scheme. | Research areas and aspects for investigation were identified in literature. These were used to develop the questions. The main categorisation of data is done after coding of all the text. This process is described in Section 7.3.3. |

| | |
|---|---|
| Test your coding scheme on a sample of text. | Parts of the focus group interview was coded as the initial sample. In Section 7.3.4, some excerpts from these are presented with the discussion of how they were tested. |
| Code all the text. | The rest of the focus group interview was coded and described in Section 7.3.5 new codes were created. These codes were used in the next step of coding where consistency was verified. |
| Assess the coding consistency. | Related codes were grouped together to ensure consistency in reporting as discussed in Section 7.3.6. |
| Draw conclusions from the coded data. | After using Atlas.ti to create code categories, themes were identified to allow analysis. These themes are presented in Section 7.3.7. |
| Report your methods and findings. | From the conclusions drawn in the previous step, the insight gained is used as recommendations for improvement for the design of the artefact in Chapter 8. |

### 7.3.1 Prepare the data

The focus group interview conducted was transcribed and returned in written format. The responses were edited to ensure that no identifiable information, e.g. name of participant, was included. The transcription was not corrected in terms of grammar, punctuation, and spelling. Any idiom used during the focus group process were kept in the written format to showcase the level of contentment that the participants may have felt. Also, idioms were kept in an attempt to make the environment of the focus group interview transparent to the reader.

### 7.3.2 Define the unit of analysis

When conducting content analysis, a unit of analysis may be seen as the 'what' or 'who' that shall be analysed e.g. a word or sentence. Each answer with respect to the other answers provided by the participants will be analysed. A single question and the response was defined as the unit of analysis. This was then compared to different expressions of a concept between participants.

### 7.3.3 Develop categories and a coding scheme

Questions were found in the literature review and human-computer interaction principles were applied alongside mobile application design principles to categorise them for the focus group. In this manner, these principles served as categorisation of the questions. Final categories could only be identified after the content analysis was finalised.

### 7.3.4 Test your coding scheme on a sample of text

As content analysis is being used, the text is coded according to the selected unit of analysis. The chosen unit of analysis is the response per participant per question.

For the researcher to test the coding method, parts of the focus group interview was coded. The researcher tested the coding scheme on the responses of three participants to a particular question. Table 7.5 demonstrates the coding of Participant 2, Participant 3 and Participant 5's responses to a question on well-designed components of the mobile application.

**Table 7-5: Code Excerpt 1: Report for Query: Mobile components well designed**

| **Report for Query: Mobile components well designed**<br>Resulting quotations (3) |
|---|
| **D 1: Focus Group transcription - 1:6 Participant 2: The registration. The logging in and creating an accoun… (1491:1561)**<br>Participant 2: The registration. The logging in and creating an account |
| **D 1: Focus Group transcription - 1:7 Participant 3: Being able to put a profile picture on your thingy, wha… (1608:1703)**<br>Participant 3: Being able to put a profile picture on your thingy, what do you call it? Profile. |
| **D 1: Focus Group transcription - 1:8 Participant 5: And also, being able upload a picture of the book that… (1705:1861)**<br>Participant 5: And also, being able upload a picture of the book that you are selling and that you can also view the book that you are actually going to buy. |

The researcher was able to categorise three responses from Participant 2, Participant 3 and Participant 5 that offered insight into well designed components of the mobile application. By analysing the responses of each participant and then applying the analysis to the interpretation of the entire collection of data, the researcher was able to achieve a comprehensive understanding.

### 7.3.5 Code all the text

In the fifth step of content analysis, codes were created as they were discovered within the text. The researcher used Atlas.ti to code the focus group interview. Once all the text was coded, codes discovered at the end of the analysis were reused on the text analysed at the beginning of the analysis in order to ensure consistency. Table 7.6 shows the code counts of codes discovered in the focus group interview.

**Table 7-6: Summary of codes discovered in the focus group interview.**

| | Frequency | Totals |
|---|---|---|
| Feelings about the application | 1 | 1 |
| Important features on the app | 4 | 4 |
| Mobile component poorly designed | 3 | 3 |
| Mobile component well designed | 3 | 3 |
| Options to include on the app | 7 | 7 |
| Participants design suggestion | 7 | 7 |
| Presentation of the application | 3 | 3 |
| Testing of the application | 2 | 2 |
| Type of application (Website, mobile app)... | 3 | 3 |
| Who should test the application | 2 | 2 |
| Totals | 35 | 35 |

Due to the semi-structured nature of the interviews, the participants were free to address multiple topics per response.

### 7.3.6 Assess the coding consistency

In order to prevent inconsistencies, codes were grouped together into families. Families are codes that are grouped according to their similar topics (Zhang & Wildemuth, 2009:4). These codes are given in Table 7.7. The merged codes retained the code name of the code with the most instances.

**Table 7-7: Codes merged due to high degree of similarity.**

| | Focus group transcription |
|---|---|
| Options to be included on the app | 9 |
| Participants design suggestions | 7 |
| Totals | 16 |

Using the code families as discussed previously, the researcher was able to distinguish two themes that were present in the data. Figure 7.1 shows the two code groups (themes) under Atlas.ti.

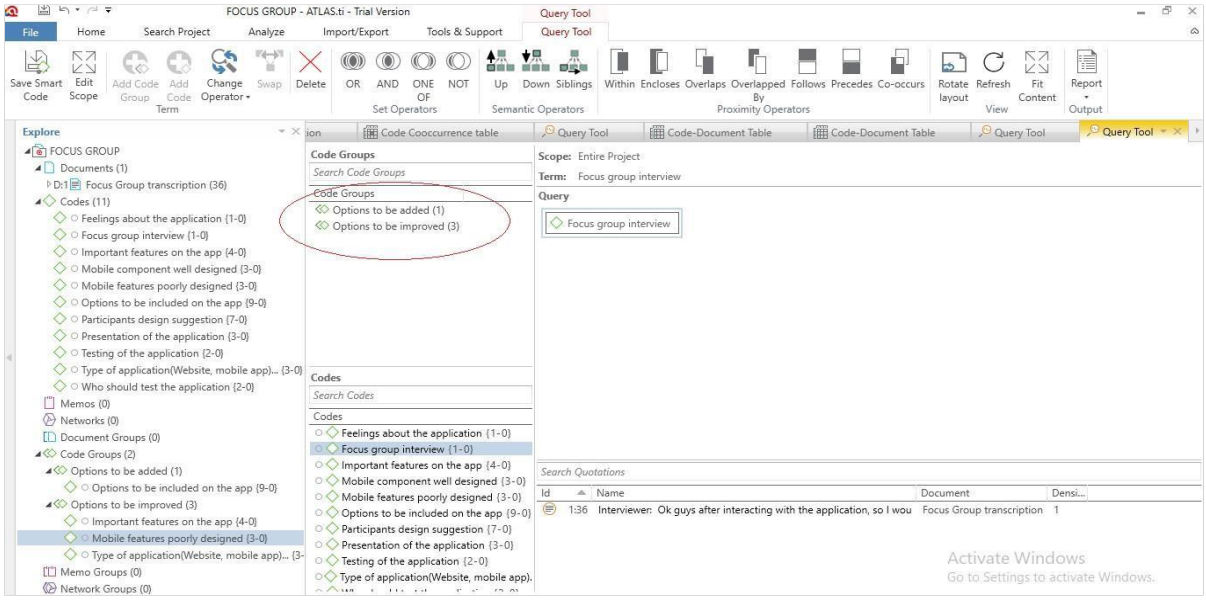



**Figure 7-1: Illustration of the two code groups in Atlas.ti**

The first theme identified is “Options to be added”, this theme include all recommendations from the target audience that comment on missing features on the designed application. The second theme of “Options to be improved” includes all recommendations on features that were consider as poorly designed by the target audience. Table 7.8: Code Excerpt 2 presents the theme: “Options to be improved”.

**Table 7-8: Code Excerpt 2 Options to be improved.**

| |
|---|
| **Report for Query: Options to be improved**<br><br>Resulting quotations (10)<br><br>---<br><br>**D 1: Focus Group transcription - 1:9 Participant 2: Struggling to upload books (2002:2042)**<br><br>**1 Codes:**<br><br>○ **Mobile features poorly designed**<br><br>**1 Groups:**<br><br>Options to be improved |

**D 1: Focus Group transcription - 1:10 Participant 5: As well as searching for books. You would have to copy… (2045:2383)**

**1 Codes:**

- **Mobile features poorly designed**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:11 Participant 5: Oh, and also to search for a specific book that you wan… (2416:2794)**

**1 Codes:**

- **Mobile features poorly designed**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:15 Participant 6: I say both. (3768:3793)**

**1 Codes:**

- **Type of application (Website, mobile app)...**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:16 Participant 3: I say also both. (3795:3825)**

**1 Codes:**

- **Type of application (Website, mobile app)...**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:17 Participant 5: I think if you are using it once, for one book. I won't… (3827:4163)**

**1 Codes:**

○ **Type of application (Website, mobile app)...**

**1 Groups:**

Options to be improved

---

**D 1: Focus Group transcription - 1:23 Participant 1: Usability (6106:6129)**

**1 Codes:**

○ **Important features on the app**

**1 Groups:**

Options to be improved

---

**D 1: Focus Group transcription - 1:24 Participant 3: Ya, as he said usability, because most of us want to se… (6210:6332)**

**1 Codes:**

○ **Important features on the app**

**1 Groups:**

Options to be improved

---

**D 1: Focus Group transcription - 1:25 Participant 5: Because we want to get new books as soon as we can. So,… (6334:6525)**

**1 Codes:**

○ **Important features on the app**

**1 Groups:**

Options to be improved

---

**D 1: Focus Group transcription - 1:26 Participant 5: Oh, and if you had the option, if you see, no, you know… (6576:6777)**

**1 Codes:**

○ **Important features on the app**

**1 Groups:**

Options to be improved

Table 7.9: Code Excerpt 3 presents the theme: “Options to be added” with nine resulting quotations.

**Table 7-9: Code Excerpt 3 Options to be added.**

**Report for Query: Options to be added**

Resulting quotations (9)

---

**D 1: Focus Group transcription - 1:18 Participant 2: Eh, ya I think we should. (4295:4335)**

Participant 2: Eh, ya I think we should.

---

**D 1: Focus Group transcription - 1:19 Participant 2: Because it is not that easy. It is not an easy app to u… (4337:4647)**

Participant 2: Because it is not that easy. It is not an easy app to use, this one. It is not that easy, like you have to go through a lot of stuff like, when you want to buy you have to go there and search, you have to find search and you have to copy then people will have to know to copy and stuff like that.

---

**D 1: Focus Group transcription - 1:20 Participant 4: If you weren’t here I wouldn’t, I didn’t know that I n… (4649:4795)**

Participant 4: If you weren’t here I wouldn’t, I didn’t know that I needed to copy. I’m busy trying to press. (says something in another language)

---

**D 1: Focus Group transcription - 1:21 Participant 5: Then you click the menu and the options appear. I think… (4797:4976)**

Participant 5: Then you click the menu and the options appear. I think maybe if it was just today and say oh no I want to buy it now, I’m selling, rather than clicking on the menu.

---

**D 1: Focus Group transcription - 1:22 Participant 4: At least if it is appearing just like you know like eFu… (5055:5197)**

Participant 4: At least if it is appearing just like you know like eFundi, you just login. Not like a hidden icon, you just click and it shows.

---

**D 1: Focus Group transcription - 1:27 Participant 5: And now it pings on your phone, because let’s say you h… (6796:7411)**

Participant 5: And now it pings on your phone, because let’s say you have an app you created the account. If it pings you when someone interested in the book so and so

and so. The person can act now and say the book has been sold or the book is still available. Negotiate on price and stuff like that within the app itself. Because if it is like that, it is way easier, because like I just use the same things instead of maybe airtime, you are going to delay because you first need to get off the app, text them the number it's going to take a minimum, say by 5 'o clock, you've already forgotten your numbers again.

---

**D 1: Focus Group transcription - 1:28 Participant 6: 'Cos so let's say like other people they are only the t… (7482:7732)**

Participant 6: 'Cos so let's say like other people they are only the textbook and the numbers, so when I go home, so when I save them in java, there is Java group 1, Java what not. So, I think if there would be a way to communicate on the site itself.

---

**D 1: Focus Group transcription - 1:29 Participant 1: Ok, like this guy said, the book should have at least… (8191:8307)**

Participant 1: Ok, like this guy said, the book should have at least, where you would be able to add through pictures

---

**D 1: Focus Group transcription - 1:35 Participant 3: If you could, like, allow the seller to add comment or… (11250:11439)**

Participant 3: If you could, like, allow the seller to add comment or reviews on the book. If like say, this one page is missing, the seller could say this one page. (interviewer interrupts)

The code groups are useful when analysing data with the view of developing themes. Each theme is discussed in the following section.

### 7.3.7 Conclusion from the coded data.

The researcher made use of code groups developed in Section 7.3.6 to extract themes in the data. Two themes were identified which are: options to be improved and options to be added. These themes are explained in the coming sections.

The elucidation of each theme will start with a brief explanation of the theme, followed by a list of recommendations provided by the target audience. Furthermore, a presentation of all codes that support the theme is given in a table format.

○ **Theme 1: Options to be added**

The participants of the focus group expressed their views after reflecting on the options to be added on the application and recommended the following:

1. Incorporate the user manual on the first page (Login page).
2. Allow categorisation of books per module.
3. Provide a notification when the book is posted, bought and also when logging in for the first time.
4. Allow more than one picture of the book to be uploaded on the “add book” page.
5. Allow the seller to add comments or reviews on the book.

Table 7.10 shows a detailed report query of group code “Options to be added” with 8 resulting quotations.

**Table 7-10: Code Excerpt 4: Report for Query Code Group: Options to be added.**

**Report for Query: Options to be added**

Resulting quotations (8)

---

**D 1: Focus Group transcription - 1:19 Participant 2: Because it is not that easy. It is not an easy app to u… (4337:4647)**

Participant 2: Because it is not that easy. It is not an easy app to use, this one. It is not that easy, like you have to go through a lot of stuff like, when you want to buy you have to go there and search, you have to find search and you have to copy then people will have to know to copy and stuff like that.

**1 Codes:**

○ Options to be included on the app

**0 Memos**

**0 Hyperlinks**

---

**D 1: Focus Group transcription - 1:20 Participant 4: If you weren’t here I wouldn’t, I didn’t know that I n… (4649:4795)**

Participant 4: If you weren't here I wouldn't, I didn't know that I needed to copy. I'm busy trying to press. (Says something in another language)

**1 Codes:**

○ Options to be included on the app

**0 Memos**

**0 Hyperlinks**

---

**D 1: Focus Group transcription - 1:21 Participant 5: Then you click the menu and the options appear. I think… (4797:4976)**

Participant 5: Then you click the menu and the options appear. I think maybe if it was just today and say oh no I want to buy it now, I'm selling, rather than clicking on the menu.

**1 Codes:**

○ Options to be included on the app

**0 Memos**

**0 Hyperlinks**

---

**D 1: Focus Group transcription - 1:22 Participant 4: At least if it is appearing just like you know like eFu… (5055:5197)**

Participant 4: At least if it is appearing just like you know like eFundi, you just login. Not like a hidden icon, you just click and it shows.

**1 Codes:**

○ Options to be included on the app

**0 Memos**

**0 Hyperlinks**

**D 1: Focus Group transcription - 1:27 Participant 5: And now it pings on your phone, because let's say you h… (6796:7411)**

Participant 5: And now it pings on your phone, because let's say you have an app you created the account. If it pings you when someone interested in the book so and so and so. The person can act now and say the book has been sold or the book is still available. Negotiate on price and stuff like that within the app itself. Because if it is like that, it is way easier, because like I just use the same things instead of maybe airtime, you are going to delay because you first need to get off the app, text them the number it's going to take a minimum, say by 5 'o clock, you've already forgotten your numbers again.

**1 Codes:**

○ Options to be included on the app

**0 Memos**

**0 Hyperlinks**

---

**D 1: Focus Group transcription - 1:28 Participant 6: 'Cos so let's say like other people they are only the t… (7482:7732)**

Participant 6: 'Cos so let's say like other people they are only the textbook and the numbers, so when I go home, so when I save them in java, there is Java group 1, Java what not. So, I think if there would be a way to communicate on the site itself.

**1 Codes:**

○ Options to be included on the app

**0 Memos**

**0 Hyperlinks**

---

**D 1: Focus Group transcription - 1:29 Participant 1: Ok, like this guy said, the book should have at least… (8191:8307)**

Participant 1: Ok, like this guy said, the book should have at least, where you would be able to add through pictures

**2 Codes:**

○ Options to be included on the app / ○ Participants design suggestion

**0 Memos**

**0 Hyperlinks**

---

**D 1: Focus Group transcription - 1:35 Participant 3: If you could, like, allow the seller to add comment or… (11250:11439)**

Participant 3: If you could, like, allow the seller to add comment or reviews on the book. If like say, this one page is missing, the seller could say this one page.

**2 Codes:**

○ Options to be included on the app / ○ Participants design suggestion

**0 Memos**

**0 Hyperlinks**

○ **Theme 2: Options to be improved**

The participants of the focus group expressed their views after reflecting on the options to be improved on the application and recommended the following:

1. Make visible menu items - remove the menu button.
2. Remove the copy and paste function for buy book option - make it a link.
3. Allow all picture formats to be uploaded.
4. Allow searches for a specific book.

Table 7.11 shows a detailed report query of group code “Options to be improved” with 10 resulting quotations.

**Table 7-11: Code Excerpt 5: Report for Query Code Group: Option to be improved.**

**Report for Query: Options to be improved**

Resulting quotations (10)

---

**D 1: Focus Group transcription - 1:9 Participant 2: Struggling to upload books (2002:2042)**

Participant 2: Struggling to upload books

**1 Codes:**

- **Mobile features poorly designed**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:10 Participant 5: As well as searching for books. You would have to copy… (2045:2383)**

Participant 5: As well as searching for books. You would have to copy and there were not specific instructions as to whether, what you had to do, because if you do not know, then you have to copy and I think that is a long process. It would be easier to just click on the thing and the specific book will appear. I think that will be good.

**1 Codes:**

- **Mobile features poorly designed**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:11 Participant 5: Oh, and also to search for a specific book that you wan… (2416:2794)**

Participant 5: Oh, and also to search for a specific book that you want, rather than only going to the faculty and all the books appearing, because, say there are 500 students who have all

uploaded their books, so now you would have to go through all the books and the specific year that you are doing. You also have a specific year and a specific book so that it saves you time.

**1 Codes:**

- **Mobile features poorly designed**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:15 Participant 6: I say both. (3768:3793)**

Participant 6: I say both.

**1 Codes:**

- **Type of application (Website, mobile app)...**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:16 Participant 3: I say also both. (3795:3825)**

Participant 3: I say also both.

**1 Codes:**

- **Type of application (Website, mobile app)...**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:17 Participant 5: I think if you are using it once, for one book. I won't… (3827:4163)**

Participant 5: I think if you are using it once, for one book. I won't need to download the app, I would just go on the website, upload it and come later on and check it on the website. But if

maybe you are dealing in books, then I need the app and I would need to have it on my phone to constantly check-up and uploading and all of that.

**1 Codes:**

- **Type of application (Website, mobile app)...**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:23 Participant 1: Usability (6106:6129)**

Participant 1: Usability

**1 Codes:**

- **Important features on the app**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:24 Participant 3: Ya, as he said usability, because most of us want to se… (6210:6332)**

Participant 3: Ya, as he said usability, because most of us want to sell our books so if that's possible then we are happy.

**1 Codes:**

- **Important features on the app**

  **1 Groups:**

  Options to be improved

---

**D 1: Focus Group transcription - 1:25 Participant 5: Because we want to get new books as soon as we can. So… (6334:6525)**

Participant 5: Because we want to get new books as soon as we can. So, if it's that easy to use, then you take your book and say eish

I feel like selling my book, click here and then you done.

**1 Codes:**

- **Important features on the app**

**1 Groups:**

Options to be improved

---

**D 1: Focus Group transcription - 1:26 Participant 5: Oh, and if you had the option, if you see, no, you know… (6576:6777)**

Participant 5: Oh, and if you had the option, if you see, no, you know like OLX function. If I like it, if I am interested, when it sends your email it has your number, on the app itself, communicating.

**1 Codes:**

- **Important features on the app**

**1 Groups:**

Options to be improved

### 7.4 Improvements identified through the data analysis

The researcher reviewed each code and theme in order to identify possible improvement areas for the mobile application. The identified areas of improvement for the first prototype of the mobile application are presented in Table 7.12.

**Table 7-12: Suggested improvements from the target audience (focus group).**

| Improvements identified through the data analysis |
|---|
| 1. Incorporate the user manual on the first page (Login page). |
| 2. Allow categorisation of books per module. |

| |
|---|
| 3. Provide a notification when the book is posted, bought and also when logging for the first time. |
| 4. Allow more than one picture of the book to be uploaded on the add book page. |
| 5. Allow the seller to add comment or reviews on the book. |
| 6. Make visible menu items - remove the menu button. |
| 7. Remove the copy and paste function for buy book option - make it a link. |
| 8. Allow all picture formats to be uploaded. |
| 9. Allow searches for a specific book. |

## 7.5 Conclusion

In this chapter, the evaluation of the designed application was discussed. The chapter began with an introduction of the research design used within the evaluation phase. Data collection and analysis methods were then discussed. Also, the transcript from the focus group was coded and themes were drawn from the data.

Figure 7.2 provides an adaptation of the design science research process to represent the research structure of this study. The final phase in the design science research cycle “the communication phase” will be discussed in the following chapter.

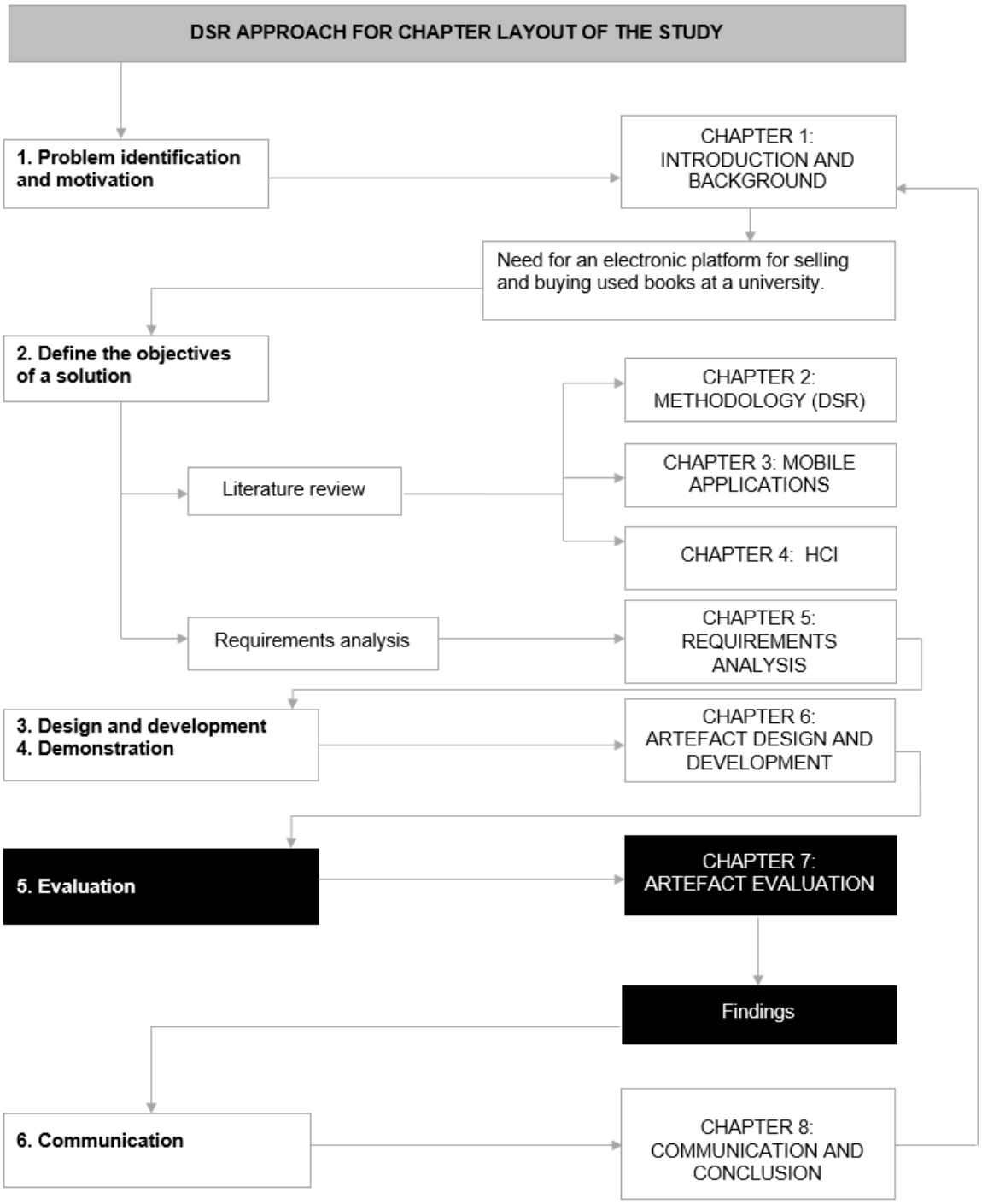



**Figure 7-2: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

# CHAPTER 8: COMMUNICATION AND CONCLUSION

## 8.1 Introduction

The goal of this study was to design a mobile application for the trading of used books at a university by following a design science research approach. For this goal to be achieved a DSR methodology was adopted and an overview provided in Chapter 2. The researcher presents the final activity of DSR process model in this chapter, which is: Communication.

According to Peffers *et al.* (2007:82), the communication activity is a summary of what has been learned from this DSR project. Furthermore, Peffers *et al.* (2007:82) stated that communication contributes to the body of knowledge by grouping the lessons learned while the artefact was being created. In other words this can be considered as a self-evaluation process, which will be discussed using the questions provided in the checklist by Hevner and Chatterjee (2010:20).

The aim of this chapter is to communicate and conclude this DSR study. The chapter presents the summary of all the key concepts from the previous chapters while addressing the objectives of the study. This chapter is divided into the following sections: a summary of research findings of the study within the context of DSR (Section 8.2); and, the conclusion of the study (Section 8.3).

## 8.2 Research findings and contribution of the study

The primary objective, the theoretical objectives and empirical objectives are revisited in this section by portraying the manner in which these objectives were addressed in this DSR study.

> **The primary objective of this study was:**
> To design a mobile application for the trading of used books at a university by following a design science research approach.

To achieve the primary objective, the secondary objectives were proposed according to the six activities of the design science research process model as given in Table 8.1.

**Table 8-1: Objectives of the study according to the DSR process model.**

| DSR process | Description |
|---|---|

| | |
|---|---|
| **Problem identification and motivation** | **Theoretical objectives**<br>• To identify the research problem.<br>• To motivate the process for conducting the research.<br>• To determine the required fields of research to inform a solution for the research problem. |
| **Objectives of a solution** | **Theoretical objectives**<br>• To understand the concept of design science research.<br>• To understand the concept of mobile applications and its design principles.<br>• To understand the concept of human-computer interaction and its design principles.<br>• To form a conceptual link between mobile application principles and HCI principles.<br>**Empirical objectives**<br>• To conduct interviews with expert participants as part of a requirements analysis for the artefact<br>• To analyse the feedback obtained from the requirements analysis using interpretive content analysis. |
| **Design and development** | **Theoretical objectives**<br>• To form a conceptual link between mobile application principles, HCI principles and the analysed feedback obtained from the requirements analysis.<br>**Empirical objectives**<br>• To design and develop a mobile application for the trading of used books given the consolidated guidelines derived from mobile application principles, HCI principles and the requirements analysis. |
| **Demonstration** | **Theoretical objectives**<br>• To present the artefact by means of screenshots with explanations of how the literature and requirements analysis informed the design process.<br>**Empirical objectives**<br>• To demonstrate the artefact to target audience using different mobile devices. |
| **Evaluation** | **Empirical objectives**<br>• To conduct a focus group with participants from the target audience as part of the evaluation of the artefact.<br>• To analyse the feedback obtained from the evaluation using interpretive content analysis.<br>**Theoretical objectives**<br>• To report on the feedback received from the evaluation of the artefact. |

| | |
|---|---|
| **Communication** | **Theoretical objectives**<br>• To communicate the design science research approach followed for designing a mobile application for the trading of used books at a university.<br>• To communicate limitations and future research within the context of the study by reflecting on recommendations for further improvement of the artefact. |

The following sections reflect on how the objectives of the study were addressed.

### 8.2.1 Problem identification and motivation

The context and scope, as well as the problem statement and research objectives of the study were introduced – this constitutes the first activity in this DSR study. The problem statement indicated that the trading of used books could alleviate financial strain as expensive books were identified as one of the factors that influence student dropout rates. At present, there is only a paper-based, face-to-face method of trading used books at the specific university which may delay sales. The need exists for an electronic platform for the trading of used books at a specific university.

The suggested solution was to create a mobile application for the trading of used books at a university. To inform the design of the artefact, the fields of mobile application principles and human-computer interaction principles were suggested for review. Furthermore, to provide scientific rigour to the study, design science research was suggested as the paradigm of reference.

The research contribution addressed in this study is the DSR process followed during the creation of the artefact. By elucidating aspects of design science research throughout the design process, and including necessary data gathering methods for requirements analysis and evaluation, a scientific structure for the development of the artefact was presented.

### 8.2.2 Objectives of a solution

The objectives of a solution activity constitutes the second activity of this DSR study.

#### 8.2.2.1 Design science research

The design and development of an artefact is an important requirement of the primary objective, the empirical objectives, and the theoretical objectives. In Chapter 2, DSR methodology was discussed addressing the first theoretical objective, through a review of the known literature.

Hevner and Chatterjee (2010:19) declare that the main goal of DSR is to construct and contribute non-existent and interesting design science knowledge in a precise area of interest according to an acceptable metric. Various approaches are provided to direct researchers in conducting DSR. However, the design science research methodology approach suggested by Peffers *et al.* (2007:54) provided a process model of DSR which is composed of six activities that constituted the structure for this DSR study.

The DSR methodology is found to be a problem-solving research paradigm, where the researcher is interested in obtaining new knowledge through artefact development. The value of the artefact was fundamental to this DSR study; therefore, the philosophical position taken is that of DSR. A diagram was provided at the end of each chapter to guide the reader on the structure of the research by indicating the activity addressed in the in the DSR process.

#### 8.2.2.2 Mobile applications

An understanding was gained of the mobile application through a review of the existing literature in Chapter 3. A mobile application, commonly known as an app, is a kind of application software developed to work on mobile devices, such as tablets and smartphones (Cueto-Manzano *et al.*, 2015:119). Mobile applications include internet applications that operate on smartphones and various mobile devices (Beal, 2017). Further, Beal (2017) stated that mobile apps may include mobile web site bookmarking utilities, a mobile-based instant messaging client, Gmail for mobile, and many other applications. White (2013:8) stated that mobile applications are categorised into three types which are: native applications, non-native applications or browser applications, and lastly hybrid applications. Mobile development methodologies were shortly discussed and Mobile-D was identified as an acceptable approach to apply in the study. The five phases of the Mobile-D model namely, explore, initialise, productionise, stabilise, and system test & fix were applied in the research (Table 3.6).

Chapter 3 was concluded with a table that provided a consolidated list of guidelines for mobile application design.

#### 8.2.2.3 Human-computer interaction

An understanding was gained of the human computer interaction through a review of the existing literature in Chapter 4. HCI is the study of understanding how people interact with computers throughout their lives (Froese *et al.*, 2014:6). HCI is well known for its interdisciplinary area of research and practices, calling upon diverse disciplines such as sociology, human factors, information systems, computer science, psychology, and visual design (Poole, 2013:403). An HCI

approach gives insight into the usefulness, the usability, and the capability of a computer interface to the satisfaction of users' needs (Perkins *et al.*, 1989:136). Also, HCI provides explanation on pertinent preoccupations including understanding how technology works to engage a target audience in a given environment (Starren *et al.*, 2006). In short, HCI offers complementary meaning into activities ranging from the design to the development and the evaluation of an application.

Chapter 4 was concluded with an enriched list of guidelines that included principles for mobile application design (from Chapter 3) with added suggested HCI principles for mobile application design. *This proposed list of guidelines constitutes the conceptual link formed between mobile application principles and HCI principles*.

#### 8.2.2.4 Requirements analysis: Interview data gathered and analysed

Interviews were conducted with subject matter experts from the specific university as part of a requirements analysis for the artefact. The data analysis is presented in Chapter 5. Face to face and one-on-one interviews were conducted at a specific university with four participants using questions adapted from literature. During each individual session, participants were asked a series of questions in open ended interviews. The interviews with the four participants were audio-recorded and the researcher was given an opportunity to engage in conversation with the participants and be provided with detailed explanation on unclear responses. Interviews conducted were transcribed and returned in written format. The data was analysed using interpretive content analysis and findings were used as part of a requirements analysis to inform the design of the artefact.

### 8.2.3 Design and development

The knowledge used to develop the mobile application draws from the descriptive knowledge explored in Chapters 3 and Chapter 4. The literature discusses the human-computer interaction principles in order to identify possible HCI design principles for mobile application. The literature also reviewed mobile applications, specifically mobile application design principles, and how it works to support the research. Additionally, the application of the Mobile-D approach was discussed. Furthermore, the requirements analysis findings were incorporated with the literature to suggest comprehensive guidelines for the design of the mobile application presented in Table 8.2. The design and development activity represents the third activity of this DSR study.

**Table 8-2: Refined guidelines to design a mobile application for a specific university.**

| Code groups | | Mobile principles | HCI principles |
|---|---|---|---|
| 1. | Platform selection and interface design<br>• Use hybrid platform to create a responsive mobile web application<br>• Create a pleasant user interface (useful and friendly) | M1, M2, M3, M4, M5,M6,M7,M8,M12, M19, M18, M20 | H1,H2,H3,H4, H6, H8, H9 |
| 2. | Colours:<br>• Use negative contrast and corporate colours of the institution where the app will be used | M3, M5, M6, M10, M11, M12, M22 | H5, H6, H8 |
| 3. | Information:<br>• Include the following information: Title of the book, author of the book, ISBN, price of the book, owner of the book details (cell phone and email address), and the trading location. | M1, M5,M16, M18, M19, M21 | H2, H7, H8, H9 |
| 4. | Features:<br>• Integrate the application with LMS of the institution<br>• Include barcode, camera and calendar features | M2, M4, M7, M13, M14, M15, | H3, H4, H5, H9 |
| 5. | Test the application:<br>• Use targeted audience to test the application | M3, M9 | H6, H8 |

The artefact that was created is a mobile application for the trading of used books at a university. The application was presented in the form of a hybrid platform developed using HTML5 and supporting software. After the artefact prototype was created, it was demonstrated.

### 8.2.4 Demonstration

The demonstration of the design and development of the artefact were explored in Chapter 6, and constituted the fourth activity in this DSR study. Screenshots of the application were provided with explanations of how principles and feedback were incorporated. Furthermore, the mobile application was demonstrated to the target audience using different mobile devices which included tablets, cell phones and laptops.

### 8.2.5 Evaluation

As part of the fifth activity in this DSR study, a focus group was conducted with six student participants from the specific university for the evaluation of the artefact. The focus group was held at the university for which the mobile application was developed. It consisted of participants who are students at the university, from different fields of study and different ages. As a result, participants were able to offer individual comprehensive answers. This produced sufficient data to work with. The researcher structured the focus group interview questions around HCI principles and mobile application principles presented in Chapter 4. The focus group interview was audio-recorded and the researcher was given an opportunity to engage in conversation with the participants and be provided with detailed explanation on unclear responses. The focus group audio was transcribed and returned in written format. The responses were edited to ensure that no identifiable information, e.g. name of participant, was included. The data was analysed using interpretive content analysis and findings were used as part of suggestions for the improvement of the artefact, as presented in Table 8.3.

**Table 8-3: Suggested improvements for the mobile application.**

| **Improvements identified through the data analysis** |
|---|
| 1. Incorporate the user manual on the first page (Login page). |
| 2. Allow categorisation of books per module. |
| 3. Provide a notification when the book is posted, bought and also when logging for the first time. |
| 4. Allow more than one picture of the book to be uploaded on the add book page. |
| 5. Allow the seller to add comment or reviews on the book. |
| 6. Make visible menu items - remove the menu button. |
| 7. Remove the copy and paste function for buy book option - make it a link. |
| 8. Allow all picture formats to be uploaded. |
| 9. Allow searches for a specific book. |

### 8.2.6 Communication

As part of the sixth and final activity of this DSR study, the communication objectives include providing an overview of the study within the context of DSR, as well as providing limitations and future research opportunities of the study.

#### 8.2.6.1 Communication of the DSR approach followed

The previous sections have provided a comprehensive overview of the DSR approach followed in this study. As a final measure of research rigour, the checklist for self-evaluation provided by Hevner and Chatterjee (2010:20) is addressed in Table 8.4.

**Table 8-4: Checklist for self-evaluation of this DSR study.**

| **Questions** |
|---|
| 1. What is the research question (design requirements)?<br>*What is the process to design a mobile application for the trading of used books at a specific university?*<br>*The design requirements include researching the fields of DSR, mobile application principles and human-computer interaction principles.* |
| 2. What is the artefact? How is the artefact represented?<br>*The artefact is a mobile application designed and developed for the trading of used books at a university. The artefact is represented through demonstration to the reader using screenshots with explanations, as well as to the target audience for evaluation.* |
| 3. What design processes (search heuristics) will be used to build the artefact?<br>*The artefact is designed following a design science research approach, which is informed by a requirements analysis and evaluated through usability testing. Furthermore, the Mobile-D methodology was used as a guideline for the design process.* |
| 4. How are the artefact and the design processes grounded by the knowledge base?<br>*The design process is grounded in the design science research knowledge base, reviewing literature on design principles for mobile applications and human-computer interaction. Additionally, the Mobile-D methodology applied is an agile approach to mobile application development.* |
| 5. What, if any, theories support the artefact's design and the design process?<br>*The artefact follows the scientific process of design science research, with supporting guidelines from the required fields for the artefact.* |

6. What evaluations are performed during the internal design cycles?
   *The artefact is evaluated through demonstration to a focus group, with feedback received during this interview in the form of suggestions for improvement.*

7. What design improvements are identified during each design cycle?
   *The interviews that form part of the requirements analysis serves as an improvement on initial design quality by not only utilising a literature review to inform the design process but also consulting subject matter experts for design input.*
   *The focus group feedback suggests improvements to the designed artefact prototype that will further be addressed as part of a follow-up study.*

8. How is the artefact introduced into the application environment and how is it field-tested?
   *The artefact prototype is evaluated through usability testing by participants from its target group – students at the specified university for which the application is created.*

9. What metrics are used to demonstrate the artefact's utility and improvement over previous artefacts?
   *The artefact presented is a prototype as no previous artefact exists for this purpose. In order to ensure basic design values, a requirements analysis was conducted with subject matter experts to inform the initial design of the artefact.*

10. What new knowledge is added to the knowledge base and in what form (e.g. peer-reviewed literature, meta-artefacts, new theory and new method)?
    *This study contributes to knowledge within the boundaries of the exaptation quadrant of the DSR knowledge innovation matrix (KIM) (Figure 2.6).*

11. Has the research question been satisfactorily addressed?
    *The primary objective and research question of the study concerns the design of a mobile application for the trading of used books at a university following a design science research approach. This objective has been reasonably presented according to the DSR process model in this study.*

#### 8.2.6.2 Limitations and recommendations for future research

During the course of this DSR study, research opportunities were identified. These possibilities present current limitations and areas of improvement for the artefact or the impact of the artefact on the students' emancipation. The researcher intends to continue the research as part of a follow-up study. These possibilities include the following:

- The artefact is restricted to the trading of used books at a specific university; expanding the process to other universities is a research possibility for the artefact and a new DSR study. This may constitute case study research as part of a follow-up study.
- The artefact is limited to only presenting the information of the book and the owner of the book. Expanding the artefact to allow the seller and buyer to communicate through instant messaging on the application is a research possibility for the artefact and a new DSR study.
- Addressing the emancipation of students through the use of the application and analysing the impact that the application has on the financial implications experienced by students also constitutes a research possibility for the artefact and a new DSR study.
- Further research through development could be to expand the artefact to notify students of new activities on the application.
- Full implementation at the specific university for thorough evaluation and redevelopment will provide research with comprehensive findings for a follow-up study.

## 8.3 Closure of the study

The aim of this study was to design a mobile application for the trading of used books at a university by following a design science research approach. The goal was addressed by reviewing existing literature to investigate descriptive and prescriptive knowledge within the context of design science research and subsequently creating an artefact based on the research. As a result, this study contributes to the knowledge within the boundaries of the exaptation quadrant of the DSR knowledge innovation matrix. A final graphical representation of the study layout is depicted in Figure 8.1.

Design science research offers a researcher with the opportunity to structure any artefact creation research project into a logical research-based format that can methodically be presented to other scholars. Within the context of this study, a DSR approach was systematically followed and presented to the reader, for the creation of a mobile application as an artefact. A DSR approach, however, is not limited to one specific type of artefact and the process can be generalised to present and structure any research where an artefact is produced. This study can be reviewed as

an application thereof, and can guide future researchers who want to follow a similar research process.

The researcher wishes to continue the research as part of a follow-up study through further usability testing and implementation, with the possibility of case study research including a similar approach followed for the design of a mobile application for the trading of used books at other universities.

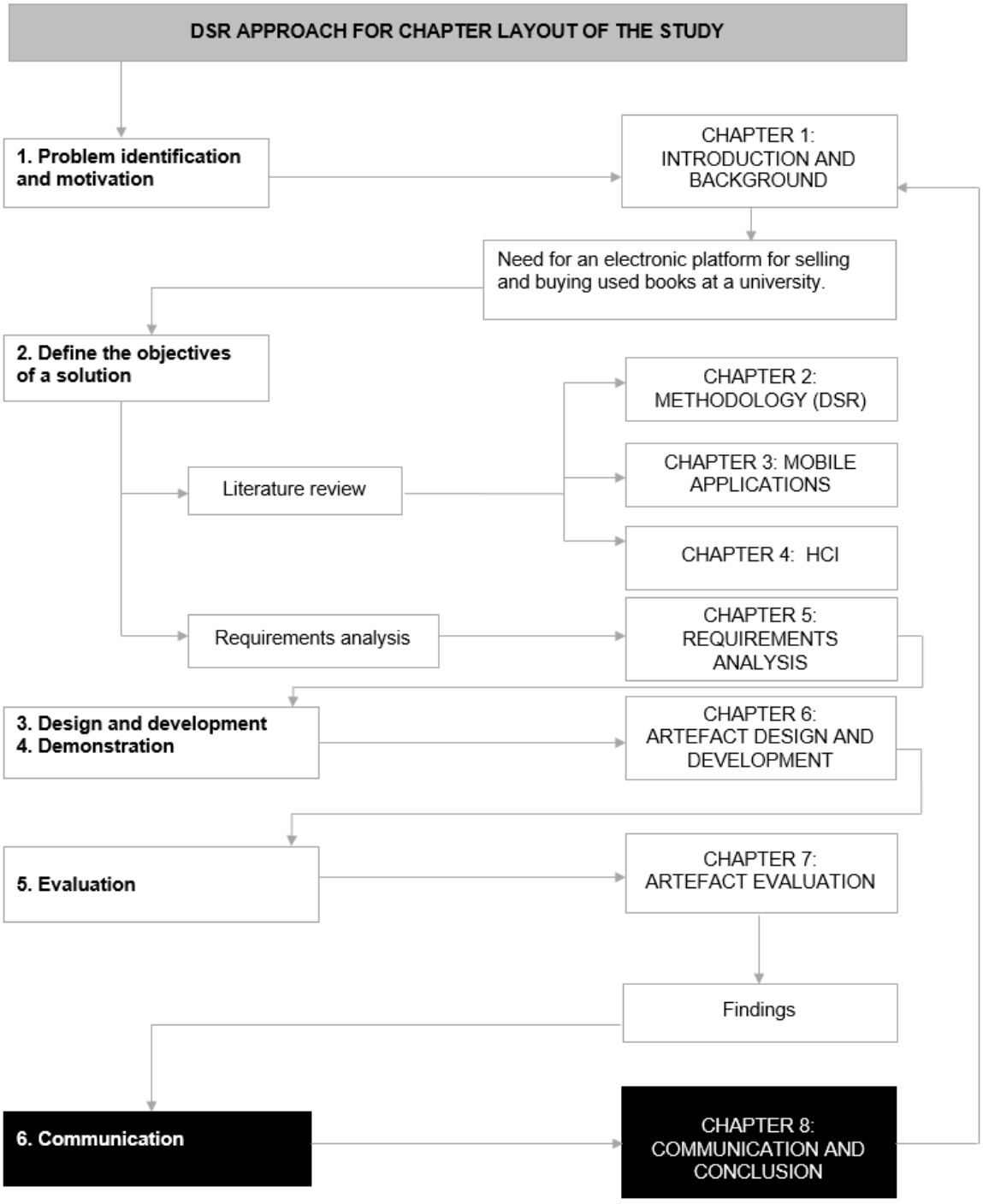



**Figure 8-1: An adaptation of the design science research process to represent the current position in the research structure of this study (Peffers *et al.*, 2007:11).**

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## APPENDIX A: CODE OF CONDUCT FOR RESEARCHERS

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

Research and Innovation

# CODE OF CONDUCT FOR RESEARCHERS

This code of conduct is applicable to all NWU researchers.

As a researcher of the North-West University (NWU), I subscribe to the rules of the NWU Institutional Research Ethics Regulatory Committee (IRERC), all applicable policies of the NWU as well as all national and international laws and regulations applicable to my field of study. Furthermore, I commit myself to abide by the ethical principles and responsibilities as set out in the Singapore statement on Research Integrity (22 September 2010), in any and all research endeavours that I undertake as a researcher of the NWU.

**The four major principles of research integrity to which I will adhere and that will guide my research are:**

- Honesty in all aspects of research;
- Accountability in the conduct of research;
- Professional courtesy and fairness in working with others;
- Good stewardship of research on behalf of others.

**Consequently I will also adhere to the following ethical responsibilities:**

1. I will take responsibility for the originality and trustworthiness of my research.
2. I will stay abreast of and adhere to all institutional, national, and international laws, regulations, and policies applicable and related to my research.
3. I will at all times employ appropriate research methods, base my conclusions on critical analysis of the evidence and report my findings and interpretations fully and objectively.
4. I will keep clear and accurate records of all research that I have conducted in a manner that will allow verification and replication of my work by others, if applicable.
5. I will, where applicable, share my data and findings openly and promptly, in line with external funding rules. This will be done as soon as possible after I have had an opportunity to establish priority and ownership claims.
6. I will take responsibility for my own contributions to publications, funding applications, reports and other representations of my research. I will also and only include authors who meet valid authorship criteria.
7. I will acknowledge the names and roles of those who made significant contributions to my research in publications, including writers, funders, sponsors, and others, but do not meet authorship criteria.
8. In my peer reviews, I will provide fair, prompt and rigorous evaluations and I will respect confidentiality when I review others' work.
9. I will disclose all conflicts of interest (financial and other) that could compromise the trustworthiness of my work in research proposals, publications, public communications, and in review activities.
10. When I publically address a community in the spirit of academic freedom, I will in all stages base my professional comments on research findings (if applicable) and my expertise. I will distinguish between professional comments and opinions based on personal views.
11. Should any irresponsible research practices and/or research misconduct become known to me or brought under my attention, I will report such irresponsible research activities to the appropriate authorities.
12. I will respond to irresponsible research practices or conduct, by taking prompt actions as set out in the procedures of the university. I will also protect those who report misconduct in good faith, to the best of my abilities.
13. I will endeavour to create and sustain an environment that encourage research integrity through education of students, research teams and peers, as well as abide by policies, and reasonable standards for advancement.
14. I will at all times weigh societal benefits against the risks inherent in my work.

Name: ISAAC SENGA Signature: Date: 01/04/2017

Original details: (11664754) P:\9. Research and Post-graduate Education\9.1 Implementation of the research strategy\9.1.5 Ethics\9.1.5.1.3_Code_Conduct_2017.docm
18 July 2017

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## APPENDIX B: ETHICAL CLEARANCE

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT
VAAL TRIANGLE CAMPUS

**FACULTY OF ECONOMIC SCIENCES AND INFORMATION TECHNOLOGY**

**ETHICS CLEARANCE DOCUMENT**

| | |
|---|---|
| Dissertation (M) | X |
| Thesis (PhD) | |
| Article | |
| Hons | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **SUPERVISOR** | | | | | | | |
| Study Leader / Promoter / Author(s) | Mrs. J.T. Janse Van Rensburg | | | | | | |
| | | | | | | | |
| | | | | | | | |
| **STUDENT / AUTHOR** | | | | | | | |
| Name | Lupanda I.S. (22559744) | | | | | | |
| Student / Staff Number | | | | | | | |
| Registered Title of Dissertation or Thesis or Project Title of Article | Designing a mobile application for the trading of used books at [redacted]: A DSR approach | | | | | | |
| School | Accounting | | Economics | | Information Technology | X | |
| **ETHICAL CLEARANCE** | | | | | | | |
| Ethics clearance number | ECONIT-2017-071 | | | | | | |
| Date (of Ethics Sub Committee Meeting) | 14 September 2017 | | | | | | |
| | | | | | | | |

.....
**CHAIRPERSON: ETHICS COMMITTEE**

16 September 2017 ..
**DATE**

.....
**RESEARCH DIRECTOR**

16 September 2017 ..
**DATE**

## APPENDIX C: CONSENT FORM – INTERVIEW PARTICIPANT

RESEARCH ETHICS: CONSENT FORM
Ethical clearance number: ECONIT-2017-071

**DESIGNING A MOBILE APPLICATION FOR THE TRADING OF USED BOOKS AT A UNIVERSITY: A DSR APPROACH**

Isaac Senga Lupanda
Student number: 22559744
Cell: 078 640 6940
Tel: 011 595 4700
104 Lethaba Court, Junkers Street, Vanderbijlpark CE2

| | | Please Initial Box |
|---|---|---|
| 1. | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | ☐ |
| 2. | I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. | ☐ |
| 3. | I agree to take part in the above study. | ☐ |
| 4. | I agree to the interview / focus group / consultation being audio recorded | ☐ |
| 5. | I agree to the use of anonymised quotes in publications | ☐ |

Name of Participant _____ Date _____ Signature _____

| Area of expertise | Years active in area of expertise | Highest qualification |
|---|---|---|
| | | |

Name of Researcher _____ Date _____ Signature _____

Page 1 of 1

## APPENDIX D: CONSENT FORM – FOCUS GROUP PARTICIPANT

RESEARCH ETHICS: CONSENT FORM
Ethical clearance number: ECONIT-2017-071

**DESIGNING A MOBILE APPLICATION FOR THE TRADING OF USED BOOKS AT A UNIVERSITY: A DSR APPROACH**

Isaac Senga Lupanda
Student number: 22559744
Cell: 078 640 6940
Tel: 011 595 4700
104 Lethaba Court, Junkers Street, Vanderbijlpark CE2

| | | Please Initial Box |
|---|---|---|
| 1. | I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. | ☐ |
| 2. | I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason. | ☐ |
| 3. | I agree to take part in the above study. | ☐ |
| 4. | I agree to the interview / focus group / consultation being audio recorded | ☐ |
| 5. | I agree to the use of anonymised quotes in publications | ☐ |
| 6. | I am from the [redacted] University, [redacted] (only tick if true) | ☐ |

| Name of participant | Qualification registered for | Signature | Date of participation in focus group |
|---|---|---|---|
| | | | |

Name of Researcher _____ Date _____ Signature _____

Page 1 of 1

## APPENDIX E: INTERVIEW TRANSCRIPTIONS

**(Personal details have been hidden to maintain privacy)**

**Project: Designing a mobile application for the trading of used books at a university: A DSR approach**

Report created by 22559744 on 2017/10/07

Documents Report – Grouped by: Document Groups: All (4) documents

**Groupless**

**4 Documents:**

**1. Anon 2**

**Interviewer:** Which platform should be used to create a mobile application for the trading of used books at [redacted]?

**Participant 2:** So by platform do you mean the physical platform or do you mean development platform?

**Interviewer:** Development platform.

**Participant 2:** So, it depends. Tell me a bit more, first of all, of what you want to do because there are various different platforms. I would say, for me personally, I don't think an application is necessarily going to be the best answer for you because of the fact that you would need to it on multiple devices, if you want to do it as an actual mobile application. I would say responsive web design platform is better because you'll get a much wider catch-all there. You also won't require anyone to install anything. If you are going to go IOS as well, you would have to use Apple tools specifically, because there isn't really anything that will allow you to cross develop for them. But, you need to give me a bit more about what exactly you want to do. I understand, kind of, what you are hoping to do.

**Interviewer:** What we currently want to do is, to allow students to upload books there and other students can view those books and then make an appointment where they can physically meet with other students and then exchange and complete a transaction. And, then remember since you said that we are having a lot of students who are using different devices with different sizes and then with different platforms so I understand, based on what you said, that it will be better to design a web application.

**Participant 2:** I think so. I think for your specific application that would be better. And then I would probably, my preference would be .net for the backend and then just normal HTML5 for the front. There are intermediary things that you can use to wrap HTML5 as an application as well. So, Cocoon.JS is a pretty good one for that because that will just take your website and basically just make it look like an application on someone's phone. It will package it like an app for you.

**Interviewer:** Thanks so much. Which information should be included in an application for the trading of used books at the [redacted]

**Participant 2:** So, information regarding the students or the books or how do you mean?

**Interviewer:** Information regarding books or I don't know, you are the expert. I want to learn from you.

**Participant 2:** Okay, if you are going to do a trade in, you need to decide on whether money is going to change hands on your platform or off your platform. So will you have a way for students to safely transfer funds? That's very much your first question. Then you'd have to answer that, because remember, if you are expecting them to do something like OLX where they're trading the books themselves and exchange the money themselves, you are facilitating the meeting of students and there is an opportunity for abuse of systems like that. So that's the first one. The second one is you need to decide where the actual trade of the physical asset will happen. Are you going to have a central area where people can place books and other people can say "I would like to buy that book" in which case the transaction happens there or are you expecting them to meet off campus? What is your thought there?

**Interviewer:** You know that there is so many things that are going on, for security concern, from my point of view, it would be better if students can meet on campus and finalise the transaction.

**Participant 2:** I would think that would be better but then you would need to display that information. So you'd have to display where you want this transaction to happen. So that they can set up a meeting point, you could use things like the student centre or whatever the case may be. So that's the first one. The second one is then scheduling. So, if you are going to say "Okay, You've got a book and I would like to buy your book" do we need to be at the same place at the same time? Or are you going to have an intermediary happen? Are you going to partner, say, with someone at the cafeteria in the student centre to say "I'll leave my book there, this is the person who's going to come pick it up" and they will give money and the money will change hands. So how do you see that process happening? That's something

you need to think about. In terms of your information, I would say, it's going to be very heavily search based. It would have to be very heavily search based. You'll have a data base of available books which then basically you'd just have to filter by module code, year etc. You need to have a way of distinguishing editions because obviously for many of our subjects you would have third edition, two years ago but fourth edition now. You'd need to know whether that's actually still a relevant book. You can't just have the name of the books. You'd need to link it on ISBNs or whatever the case may be. In terms of human computer interaction, I mean, do you want to just give students the ability to just scan their book, because there are services that you could use based on the ISBN or the barcode that's on the back. It will give you the information of the book. Because I think from a human interaction point of view, that would be better. So if I'm holding a book in my hand I would scan it to say that this is the actual book that I am selling. You would need to have the price, condition, because obviously if I'm in the market to buy a book and there are three people selling the same book I need to have some way of distinguishing which one is the one that I actually want. For that I would almost suggest looking at Gumtree, OLX and (inaudible 06:00) which are ones that specifically trade in second hand goods just to make sure you are covering all the bases there because these are inherently second hand.

**Interviewer:** Okay, thanks so much. Which manner of displaying information on a mobile application screen is most effective? Should tabs, pagination or infinite scroll be used? Why?

**Participant 2:** I'm very big on single page applications. So basically if I am scrolling through it I need to have a page that I'm searching so if I input all of the information that's relevant to me must go into one page that shows all of the search criteria and the next page should show the best matches for me.

**Interviewer:** Okay, so you are advising me to go for pagination then?

**Participant 2:** Yes. But specifically very targeted search. So, if I'm going onto something like OLX. I'm logging on and I say "I have got R 1000.00, what would be interesting for me to buy?" In this application I am specifically a student that is registered for IPSP 111 and I am looking for a text book for that specific course. So you need to get from me what is relevant.

**Interviewer:** What is the best practice when it comes to designing icons for a mobile product?

**Participant 2:** That's kind of a field in and of itself. I think the most important is to take into account the page design. There's always the standard page design where the top left is where your eye is going to be drawn the most. It will be read left to right and top to bottom. Your icons should be consistent. You should stick to very small colour palette, specifically if it's

going to go to multiple devices and really just stick to the standard 32 x 32 or 64 x 64 icons, if you are going to do that. But, for you, where would you see icons being used in this? Like what icons would you want to use.

**Interviewer:** I think, I'd like to put an [redacted]icon first on the application and then I don't know if I should put pictures of books.

**Participant 2:** So those are not necessarily icons. Logo put top left. Because that is going to be the first place you'll look, it gives you context. Thumbnails will be smaller versions of the images that you've taken of the books. So I would say the standard way of doing that is with something like (participant moves – totally inaudible 08:53). Participant draws and talks about logo placement, criteria placement and listings placement. First one on the listing would be thumbnail. All the other summarized relevant information will then be placed in a table after that. If I click on this (gestures) it will show me the page that now replaces the logo with a larger picture of that thing and all of its relevant information. On the top you want to display for me, where I am now. So here (gestures) I would have things like module and price etc. Things that I can search on. So this (gestures) will change the state of my application. This side (gestures) is going to give me context. This is going to say that based on what I selected previously this is what I am currently displaying. On the left hand side it's telling me what app I'm in and where I can go. On this side (gestures) it is telling me where I am at the moment and what I can see. Here (gestures) I'm going filtered down specifically and I am currently looking at this single book, all of the relevant information I want is here. When you change that (gestures) to a portrait view the context goes on the top. Logo can disappear because you already know you're here because you've opened up the app. You've only got a single context. If you click on that button (gestures) it gives you a drop down with those criteria. (Draws) this gives me context. You can choose to have thumbnails here depending on the size of your screen. It's more relevant for people to see the name of the book, make sure the module is there and the thumbnail on a smaller screen, but that you'll have to test with your specific audience. What they feel is more relevant. If I click here (gestures) though and I go there (gestures) I'm going to show again large image of book and here (gestures) relevant information [N1].

**Interviewer:** Okay, thank you so much. Which colours would be most appropriate to use in the design of a mobile application for the trading of new books?

**Participant 2:** If you are sticking specifically to [redacted]at the [redacted]campus, go for the corporate colours. Because we have already got a pretty good set of colours that will work quite well, I

think, in this sort of application. So, not the green red blue because that is across all of the campuses, if you're looking specifically at Vaal we've got the green.

**Interviewer:** I see that they have changed the colours, if you check on the emails, I don't know if it is only on the emails. It is black and white.

**Participant 2:** So a uni campus concept? But remember if you look at any of the frontend development frameworks, You'll look at something like Bootstrap, it's probably the most widely used, (inaudible 13:17 min) basically these ones do a lot of this heavy lifting for you but you add into it what your palette is. So it would have a primary colour and secondary colour and tertiary colours and all sorts of stuff like that. So it's very easy to adjust that. Because you've got a kind of design that's focused on text books, if you want to make this an app that is specific to the Vaal, use the colours to give the context of where this is specific to.

**Interviewer:** Thank you so much. Do you have any suggestions on how user data input should be managed? Should there be restrictions on user input?

**Participant 2:** I would say it's going to depend on whether you want to make this something that can spin off into a more general application or if you want to keep it specific to [redacted]. If you wish to keep it specific to [redacted] I would actually rather try and integrate with the learning management system (LMS) because because that will already give you the information as to what modules the student is registered for and they can log in with the user details that they've already given the university. Which means that you are never trading in any kind of confidential information. Instead of having them register, log in and all that stuff you would just say "log in with your [redacted] details" and that will be requested over to the authentication server on this side. Which will just come back with a token to tell you whether it's authenticated or not. In which case you never have to hold any personal information. It's all held by [redacted].

**Interviewer:** If I understand you well you say that we should restrict the application only to [redacted] students?

**Participant 2:** If that is your core demographic, because who else would buy second hand text books for specific modules.

**Interviewer:** How important is it for the user to be able to correct mistakes? Why?

**Participant 2:** Which mistakes are you specifically referring to? Mistakes in orders? Mistakes in listings? Mistakes in

…. (Interviewer interrupts)

**Interviewer:** It can be any one. An order or … (Participant 2 interrupts)

**Participant 2:** In general with applications of this nature, if I've placed a listing for my book, until a transaction happens I'm in full control of that. So, I should be able to change any of the information that's on it, if I feel that something is problematic. That's the first thing. The second thing however is going to be complaints in terms of transactions that went bad. You do need to work out a way that you are going to deal with this. If I have placed a listing and (names colleague) buys the book and I then say "Okay, but this is not actually what I wanted, some information was incorrectly added. I wish to have a refund." How will you deal with that? What would be your policy for that?

**Interviewer:** I believe that that at the beginning of the interview I feel we discussed where money should only change hands on campus. After you have posted your book and then we meet and then I checked if it's the correct book that I am looking for then I will have to pay.

**Participant 2:** Okay so you are not going to deal with money on your … (Interviewer interrupts)

**Interviewer:** I'm not going to say anything. I'm going to wait and meet with more experts and will check, based on their assessment, I will decide what … (Participant 2 interrupts)

**Participant 2:** Then I would say that your main concerns will be safety and just to make sure that the people doing the listings can very easily change their information for the listing. If they've done something incorrect.

**Interviewer:** Okay, thanks so much. Which device features should be incorporated into the application and why? For example, geo-location, calendar, weather data, voice recorder etc.

**Participant 2:** If you can use the barcode scanning that would be ideal. Specifically to scan the books so that you can already get the information so that I don't have to specifically go and find the ISBN and find the … (Interviewer interrupts)

**Interviewer:** We scan the book and then information can just (Participant 2 interrupts)

**Participant 2:** And that should be pulled in? So what we scanning I would definitely say. Location would be useful. Simply because, again, you are trying to say "we'll meet up at these predefined safe locations at [redacted]". You could use things like the gate or the student centre because there's guards. It's an inherently safe space. So something similar to where Uber uses your location to go "well I'm currently here and I wish to have a lift" you would have "I am currently here, I have the book". Can we make this transaction happen?"

**Interviewer:** Okay. Are there any options for this type of application that should be more visible than others?

**Participant 2:** For that the reason that I am suggesting something like (inaudible 18:33) is that it becomes user controllable. So you want to have the ability to sort. You want to have the ability to order things in a way that is important to you. So for certain students it may be important to get really high quality books. So I only want to see things in order of what the best quality is because I'm not too concerned about price. For other students price may be the only thing that they're actually interested in. So whatever one is cheapest, regardless of the condition of the book, as I'm only going to use it for one semester. That will be user specific. That should be something that is adjustable by the user. Which is why you want to leverage technology that already does that for you. You do need to go through an exercise on used cases and make sure that you understand what the different classes of users are and how they would move through your application to make sure that you're actually fulfilling that specific need. That's defined by the used case. So if my used case is "I am a student and I am looking for a book for a specific module" you are going to track that through your application to make sure that it's happening appropriately and that the information that would be relevant to me is displayed. Then use a difference used case to say "I am a student and I want to sell a book" you analyse your programme in exactly the same way and go "Well, if I now have that used case, is my current design applicable to that? Yes or no?" and you need to go through initially once you've got your workshop with your students to make sure these are the used cases that you've already defined. Are there other used cases that you've missed based on their needs? And then from that you can actually get that information. But that is not something that you would necessarily decide upfront.

**Interviewer:** Okay. Who should test the mobile application for the trading of used books at the [redacted] for usability?

**Participant 2:** Test the application?

**Interviewer:** Yes.

**Participant 2:** Specifically the people that are going to be in the target audience.

**Interviewer:** The people that are going to use the application, they should be first?

**Participant 2:** They should be the people testing it as well. You'd obviously quarantine it initially so you only release

it to a test audience to work with it. But they are the ideal people to test it.

**Interviewer:** Okay. Have you interacted with similar mobile applications? If so, please name them.

**Participant 2:** Yes, I have.

**Interviewer:** Can you please name them?

**Participant 2:** While working at (company name) I did a whole bunch of gamification on (inaudible 20:56 mins). I did an application for (Retail Company) also with them. I did a whole bunch of exercise based apps for reselling second hand bicycle parts and stuff like that because we were part of the Kubheka programme. I also did a location based game (Mentions University) specifically for students who are in their fourth year and in showing off their projects on the university campus to allow each other to rate each other. A couple others. It's something I've done a couple of times.

**Interviewer:** Okay, thanks so much. My last question. What are the major factors in mobile application design that could contribute to the success or failure of the artefact?

**Participant 2:** Adoption. It's one of the things that you will need to decide is how you are going to distribute it, which is why I also suggested the website thing. If you are expecting the users to log onto the play store and download your application they may not adopt it. So you would need to make sure that there is a campaign to show people why they would want this. Because there are so many applications available. You need to show people, specifically why they would want this and assuming that just because it's good for them is not enough. There's a lot of apps that you don't have on your phone that would be good for you. You need to decide how you are going to do that. Second one is scale of adoption. Because this application will fail if you don't have enough people on it. So you will need to reach a critical mass before it will actually become useful. The third one would be competition. Because there are already platforms out there that do something similar in terms of general second hand goods and you need to decide whether you will add enough value to the student's life to download your app or go onto your website versus something like OLX. Where if they just start an OLX section for [redacted]. What would you offer in your application that would be different to something that's already existing? What is going to differentiate your application?

**Interviewer:** Okay thanks so much. I think we are done. Thanks for your input.

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[N1]Participant 2 draws and explains layout. This may not make any sense without the actual drawing.

2. **Anon 3**

**Interviewer:** Which platform should be used to create a mobile application for the trading of used books at [redacted]?

**Participant 3:** Okay well I think in this day and age you would need to cover your bases. So, I would say make it available for mobile devices on Android, I think IOS you should make it available on Apple devices as well because you miss out on a huge chunk of the market if you don't. A lot of students are investing in good/better phones nowadays. I think another way to do it, maybe when you start out, when you doing your tests and things, your usability tests so that's when you talk to students and see what they think. You should make it available on web, just you know not locked behind any Google Play Store or the App Store just make it available on web via link and let them test it that way. I think that might be a good way to start. But I think in the end you'd have to cover all bases so have it on the Google Play Store. Have it on the App Store. Just to make sure you reach as many students as possible. So I don't think there's any "best" platform. I think try for all platforms. It needs to be responsive of design and that's inclusive design. For everyone. With all devices

**Interviewer:** Thanks so much. Which information should be included in an application for the trading of used books at the [redacted]

**Participant 3:** First to answer that I would need to know. This application would be so that students can sell their used books? So it's a service for them to sell their books?

**Interviewer:** To sell and buy.

**Participant 3:** Okay.

**Interviewer:** They can post books and then other students can view the books, make an appointment, the transaction can be performed online or maybe money should be exchanged like physically or something like that. I want to hear from you. You are the expert.

**Participant 3:** Okay, so no electronic exchanging of money? I think you should allow for that. I'll tell you why. Because a lot of students have bursaries and things like that so they use eFunds, they go to the student centre and they don't use physical money. They have money in that student account. So then they swipe and they can buy whatever they want there with that. So, maybe allow that kind of transactional process to occur as well. From my understanding, what I see it as is sort of like a bid or buy type of thing but for student text books. That's kind of what I envision here so you have your listings and obviously separate them in categories so this will be: your subject, so maybe categorise them by subject. So these are the psychology books, these are the BCom Law books, these are business, that

kind of thing. Have your categories and you have a list of the items that are available there. And you should also be able to present that information in a list format where you can have the students filter out. So you can have them refine the search results. So if I'm looking for a specific communication text book, for example, I search communication and then I can filter the results from what I see, in terms of price, relevance and date when they were uploaded. So I think it needs to be clear as well as how the process works. So, do you set up a meeting? Do you have contact details which you can call or email and then you meet up in a specific place and then you exchange money. I think that needs to be the first thing you see as soon as you open that. Then you jump into the more list based search, kind of think like Takealot.

**Interviewer:** Okay, thanks so much. Which manner of displaying information on a mobile application screen is most effective? Should tabs, pagination or infinite scroll be used? Why?

**Participant 3:** I think you will need to have scroll obviously for your list of books. I think the main aim here, in terms of ATI[N1] is to make this app as user friendly as possible. So your UI needs to reflect usability principles where you want balance, you want all of these ATI things to actually happen. To make it as user friendly as possible. So, I would say start off with a tutorial to help them. Help users understand what's going on and how to make use of your application. After that jump into maybe a dummy buying scenario where the student you know it's just a demo or text or something maybe just a pdf maybe let them download it electronically. That's maybe another thing to consider. But I think things need to be structured in a way because this needs to be organized because if it's not organized I don't think it will be very successful. So, I think what you are doing is a good thing but I think it needs to have a logical flow from introduction, this is what you do with it and then let them use it the way they want to.

**Interviewer:** Okay. What is the best practice when it comes to designing icons for a mobile product?

**Participant 3:** Shoo that's a broad question. I think it all depends on market research for your target audience. Because you are targeting students I think then you would have a more vibrant more fresh approach so you'd have look at latest mobile design trends. For example for the past three four years flat design which is very simplistic simplified design has been what everyone is striving towards doing in terms of web and application development. People want to keep things simple so they follow the "KISS" approach "Keep it simple stupid" that's what you kind of say when you are busy designing. So you have to keep it simple because the users out there are getting used to applications that are well designed and organized in this manner so you have to follow along in the trends. But you can break that a little. If you

have a strong colour theme for instance a strong colour palette you can apply those to the icons but I think you'd have to look at doing good market research, understand that those three lines, for example, that's a symbol that emblemizes a menu button. That's what we call the hamburger, it's got two buns and a pattie in the middle. That's your hamburger menu system. You need to see that your target audience, the student, understands that so I think design a set of icons, let them tell you do they understand it or not. If they don't go back to the drawing board and try another image or symbol or emblem that you think could work. I think it's all trial and error with icons. I think they are very popular and they do make your life a lot easier. I think it's worth the effort.

**Interviewer:** Okay. Which colours would be most appropriate to use in the design of a mobile application for the trading of new books?

**Participant 3:** Okay for something like this, see it could be perceived by students as something that's very boring, although you'll notice that at the beginning of each term, that students sort of stand over there by the Old Mutual building and they sell their text books, so this would obviously be a virtual platform for them to advertise that. So, I think you should sort of take a new fresh approach and make it as vibrant as possible. I think colours like oranges, purples maybe some blues, I think those would work well. You obviously can't stray too far from the academic context because you do want to keep it serious. You don't want people to think that they're going to get scammed by this either. So, I think keep it fresh, keep it youthful, I think that's an important thing. Also look at the psychology of colour that will help you.

**Interviewer:** Thanks so much. Do you have any suggestions on how user data input should be managed? Should there be restrictions on user input?

**Participant 3:** I think in terms of user input what you need to be very careful of is people getting information of other students that might not particularly want out there like cell phone numbers or email addresses. So it should be some system where if I'm interested in your book that you're selling I select it and then there's some form of communication with you so you receive a message or an email but they don't get to see that number on screen. Maybe it's just a sort of anonymous message to you that someone is interested, someone is looking at your book, do you want to send them a reply or something like that because what the POPI (Preservation of Personal Information) act you don't want any problems there because then you could run into some legal issues. So, rather don't allow users to put up all their contact details for everyone to see obviously if they sign up to the service then I think you would want that information because you'd like to send out questionnaires and maybe survey them and ask "Are you happy with the service, how can we improve?". Obviously that is a good way to

communicate with your audience so I think when people sign up they should put in their contact information but it shouldn't be available for everyone to see.

**Interviewer:** Okay, thanks so much. Which device features should be incorporated into the application and why? For example, geo-location, calendar, weather data, voice recorder etc.

**Participant 3:** Features I think you would want it to access your camera on your device whether it be a tablet or a cell phone because you would want to show an image of the book so maybe allow students to take a photo of the book so people can see the condition, maybe a front side and back view of the book just so people who are interested can see what condition it is. Maybe have a conditioning system there that filters in your search results that says "Okay, this is good condition or this is maybe poor condition it's why we are selling it for a cheaper price" so I think camera because you'd need to have some visual aid there. You can't just have a list with words you need something a bit more visual there.

**Interviewer:** Okay I think you have an understanding or an idea of what I want to do?

**Participant 3:** Yes.

**Interviewer:** Okay. Are there any options for this type of application that should be more visible than others?

**Participant 3:** Options. Okay, I think first and foremost it has to be your main selling point so the list of books. So maybe you could have weeks or a month where you run a special on certain types of books because that's something that's not really done right now. Students just haggle with other students right now. They barter. Maybe have a feature or like a sales week or month or period of time where certain selections are cheaper maybe because the users have had their books on for over a certain period of time. I think in terms of options you should always have, okay I'm thinking user interface design now, there's usually a feature where you can turn for example you have predominantly white on your screen with your list of books with maybe a little thumbnail image of each book next to it with a description. You should have an option to turn that off or to turn it dark. So this is usually a light and it's just a switch where it changes the white in your interface into a darker colour. It could be a grey or off black background and then the text switches to white and this is for users who browse at night. That's for night viewing, it's easier on the eyes. So have a night mode, I think that should be an option for sure. I think that's something that's going to be integral to all websites in the future. That's just something I recommend.

**Interviewer:** Okay. Who should test the mobile application for the trading of used books at the [redacted] for usability?

**Participant 3:** Beta testing I think you would need obviously people like myself and Japie and whatever other experts you talking to. Just for some sort of basic input before you start demoing to students. I think also you would need to do a participatory design session with students. Maybe get their input as well. I see you are aiming in that direction which is very good. They are the users and ultimately they should be able to have a say in what this thing looks like. I also think eye tracking wouldn't hurt once you've rolled it out and it's available get an eye tracking study and let students look at things on the screen. So you identify areas of interest. So your menu maybe your options and your lists and your scrolls you identify those as areas of interest and you let students look at those and use the application and see what is distracting, what's good for them, what they like and what they don't like. Definitely eye tracking with the students after you've rolled out then in updates you can implement those changes.

**Interviewer:** Thanks again. In your experience, what are major factors in mobile application design that could contribute to the success or failure of the artefact?

**Participant 3:** It's a tough one. The thing is people are so used to applications nowadays that they sort of come to expect a level of quality so I think if it doesn't meet that responsiveness with that interactive level so you can make things your own and you can turn it to night mode if you're busy scrolling at night or this button doesn't work or it's not connecting properly or the service is slow, I think you need to have that quality seal stamp of approval. I think especially because you're working through the [redacted] they can help you sort of achieve that. Especially with talking to people like us. I think one of the major things is font choice so people choosing incorrect fonts for screens. Colours, people choose colours that don't go well in RGB they work with CMIK which is for print in newspapers and magazines. They don't go for screen colours which work well there. Sometimes those can hurt the eyes and then you simply don't want to use the application anymore. Another thing is apps that aren't updated frequently so then people feel that the app isn't supported, it's kind of like an abandoned thing, why even use the service then. I think it needs to have a level of support from you and other people that are going to help you develop. I think those are the main things. Updates, font choices and then obviously the final one is lack of visuals. I think you need to have something stimulating on screen.

**Interviewer:** Lastly, my last question. Have you interacted with similar mobile applications? If so, please name them.

**Participant 3:** Yes, I think similar to what you were planning I think look at services like Amazon and Takealot obviously that's a lot broader in scope. I mean you can buy basically

anything from those sites. But I think you should take what's been done there and maybe give it a new twist now for your aim. So I think Takealot things like that, Bid or Buy, Gumtree I think that's sort of where you are looking. I think there are ways to improve and sort of fit into our eco system here. Those are the only things I can really think of now.

**Interviewer:** Okay, thanks so much Sir for your input.

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[N1]Unsure if this is what participant says – 04:36 min

**3. Anon 4**

**Interviewer:** Which platform should be used to create a mobile application for the trading of used books at the [redacted]?

**Participant 4:** There are many platforms that exist. The obvious choice would be Android. Most people would say that, but, I think because some students would not necessarily have smartphones but they do have access to computers in the labs at campus. You might create a hybrid application that is accessible from your phone as well as from a computer.

**Interviewer:** Okay. Which information should be included in an application for the trading of used books at the [redacted]

**Participant 4:** Well the application is for the trading of used books so obviously you would want someone to be able create a user profile so that they can access the app first of all. They should be able to do searches for a specific book or for general books maybe. Then they should also be able to perhaps access the information per degree or per curriculum. From the seller's side they should have a user account. They should be able to upload information to the system, new books, and they should be able to delete information if the book is sold.

**Interviewer:** Which manner of displaying information on a mobile application screen is most effective? Should tabs, pagination or infinite scroll be used? Why?

**Participant 4:** Infinite scroll is more often used in web design because this is an application for phone hybrid application. I think I better option would be to use tabs.

**Interviewer:** Okay. Which colours would be most appropriate to use in the design of a mobile application for the trading of new books?

**Participant 4:** Well it's an application for the [redacted] so it would be advisable to use colours that are associated with the [redacted]. The maroon the blue and the green but also from an HEI perspective you don't want too bright colours or that something that will cause eye strain. It's also recommended to use negative contrast which means it's a white background with dark text instead of making a dark application that maybe has a dark navy background with white text because it reads more difficult. So, for most part white backgrounds with black text and then something to associate it with the university. Perhaps also if the application is specifically given on all campuses then there should always be the colour usage specific to on which campus you are at the moment. So, for example, if I'm [redacted] campus and I'm doing searches for [redacted] somewhere on the page maybe on the side a line should be [redacted] so that I always know that I'm on [redacted] part of the site. Or [redacted] for [redacted] or [redacted] for [redacted] campus. Just to know that where you are in that application because you might doing searches for a different campus.[N1]

**Interviewer:** Okay. What is the best practice when it comes to designing icons for a mobile product?

**Participant 4:** Well, icons should always be very specific and observable. The HI principal there is observable. If you see the icon you should always know immediately what is it used for. So, not too small that you can't see what it is and not too big that it takes up too much screens. You are creating it for a student group so icons and cool pictures are always advisable because that's what they relate to more. And then obviously your icon design and the alignment of options should be consistent.

**Interviewer:** Okay. Do you have any suggestions on how user data input should be managed? Should there be restrictions on user input?

**Participant 4:** Well you will have to have some form of database that does user authentication.

**Interviewer:** Okay. So you are saying that we should have a database and then where student or users should get access to information on that database?

**Participant 4:** Yes. So you have to register somehow because you have to be able to use the system and the system has to know that some data is connected to a specific user. So, the only way to manage that is through a secure database.

**Interviewer:** Okay. Which device features should be incorporated into the application and why? For example, geo- location, calendar, weather data, voice recorder etc.

**Participant 4:** You can definitely add the camera feature to take a picture of the book. It would be more advisable actually for the seller to do that so that the user knows that the person actually does have this book. They're not just creating a fake copy and that they can see from the picture if it's the correct book. You might also use the calendar feature of the device to set up meetings to meet with the seller of the book specifically. Something like that.

**Interviewer:** Okay. Who should test the mobile application for the trading of used books at the [redacted] for usability?

**Participant 4:** Well, the application should always be tested by the user group. You're doing a requirement analysis now with staff at [redacted] that has expertise in design and development as well as lecturers. So, it's good to use them for the requirements analysis. You can revisit with the people you interviewed to ask, according to the interview that we had, do you think this application matches what we said. But at the end of the day you have to look at the user. Who is going to use the app and they have to be satisfied with the application. So, in my opinion, it would be better to test the application with the actual users. Which in this case is students at the [redacted].

**Interviewer:** Okay. In your experience, what are major factors in mobile application design that could contribute to the success or failure of the artefact?

**Participant 4:** For me, it's always important, especially if you have an application that has a database connected to it, which has large information that needs to be read from it, there should be a search function. Because you don't want a user to be scrolling through an infinite number of books looking for the correct options. So search function is always important. Failure, there are a lot of design aspects that can lead to failure. For example we spoke about observability, if you are looking at a thing and you don't know what it means or what it is used for people will tend not to continue to use it. The most important thing is consistency. You can't have options on a certain page on one side of the page and when you go to the next tab you have to look for it again. Your access options should always be consistent so that the user always knows where to find the right options.

**Interviewer:** Okay and then this is my last question. Have you interacted with similar mobile applications? If so, please name them.

**Participant 4:** Mobile applications I think the most similar is probably Gumtree or OLX so you can have a look at those to see what they did. Something I don't like about them is the fact that they have ads in between but I mean they have to be funded somehow. But the campus app wouldn't have to have ads in between or I wouldn't recommend it. It's always best to keep

an app specifically just for the reason it was created and not to necessarily use it for other promotional reasons.

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[N1] . Participant possibly mixed them up.

**4. Anon1**

**Interviewer:** Which platform should be used to create a mobile application for the trading of used books at the ?

**Participant 1:** There are two major operating systems. One is android and one is IOS (spells our IOS). One is for the majority of phones the other one is for Apples. Apples operating system and according to studies in South Africa most people use Android phones. For that I think you should use Android for you mobile application or to create your mobile application.

**Interviewer:** Okay so you are saying that it will be better to use Android for this study?

**Participant 1:** Yes. That is my (Interviewer interrupts)

**Interviewer:** Your point of view or your idea?

**Participant 1:** Yes.

**Interviewer:** Okay. Thanks so much. Which information should be included in an application for the trading of used books at the

**Participant 1:** Now I must think. You say you want to?

**Interviewer:** Create a mobile application where students can post their books to send them and then others can buy them from that application.

**Participant 1:** Okay, first of all, all the information about the book itself. For instance a title, the authors and for which module it is prescribed or a student can use it for supplementary material. Okay, so information about the book itself. Then the owner of the book or if you don't want to use names and so on at least a contact number where the student can get more information that they are interested in.

**Interviewer:** Which manner of displaying information on a mobile application screen is most effective? Should tabs, pagination or infinite scroll be used? Why?

**Participant 1:** That is going to depend on your layout of your application.

Interviewer 2: How do you want to do it?

**Participant 1:** Of course the layout must be as user friendly as possible. Don't overuse colours and spaces and line breaks and so on. Make it as simple as possible. You can use scroll screens, more than one screen, it doesn't matter and make sure that you can change the screen as well from portrait to landscape. That could also be a possibility. Alright, then a bit of advice. Android is so sophisticated now days it will take care of that by itself. I'm not sure if you must design for phone screens and tablets. My advice would be stay with the phone itself. For the moment. If later on you see there's a need for tablets then you can redo your user interface again or redesign it if you want to. But my advice would be for the first round, the first version, stay with cell phones.

**Interviewer:** Which colours would be most appropriate to use in the design of a mobile application for the trading of used books at the [redacted]?

**Participant 1:** Again it depends on the user interface. Personally I don't like bright colours. Too bright colours. It must be kind of (inaudible 04:10 min) like colours but should be visible. Clearly visible. If you are not sure, start with grey colours. Grey white and black. And then change it to colours that stand out and emphasise things that you want to with a little darker colour but not too dark. It must always be readable. Text as well as your layout. It's very difficult to say you must use (inaudible 04:41 min) image colour. It depends on your first colour used, your background colour will immediately tell you, or show you, which will be the colour of the text. You cannot use a black background and black text. Then black and white will be preferable.

**Interviewer:** So actually you are advising me to stick on grey, white and black for now?

**Participant 1:** That is what I normally do. Stay with black and white and grey colours and then when you come back and you revisit your user interface there you can start with colours. My experience is you spend a lot of time on choosing the colours and the layout as such that you do not complete the application in time. So rather make it very simple interface wise and colour wise and complete your project. Then you can come back and say "Okay, let's play with colours. Let's play with spaces and so on."

**Interviewer:** Okay thanks so much. Do you have any suggestions on how user data input should be managed? Should there be restrictions on user input?

**Participant 1:** That depends on your application itself. Will you allow your user to upload information on their books? About contact numbers? Yes or no?

**Interviewer:** Yes, we going to allow users to input information.

**Participant 1:** Okay, then users must have access. So they will complain later. Now the question is can they upload without any security? Should there be security in the form of a user log in name user name and or a password? And that you must decide yourself. Is the information sensitive? Yes or no? And if you say yes immediately there must be security. If you say no then you must take into account that everybody can then, if there is no blockage, no security everybody can log in and … not even log in if you don't have a log in screen and they can upload data, they can upload incorrect data or nonsense.

**Interviewer:** Okay, still on that question. I want to know, based on your experience or on your point of view on the research that you are conducting. Do you think that we should restrict the information only to [redacted] students, [redacted] students only or the application also can be accessed by people from outside?

**Participant 1:** I think that with the first version, restrict it to [redacted].

**Interviewer:** Okay. Which device features should be incorporated into the application and why? For example, geo-location, calendar, weather data, voice recorder etc.

**Participant 1:** What do you mean device?

**Interviewer:** Like example like geo-location, calendar weather data or voice recorder.

**Participant 1:** In this application I don't think that is necessary. It will complicate it too much. Why do you want to know where this particular student is? You know it's free or open to students of the university. So they will be part of the university. So the information about where the exact location at that moment is not important for the study. The same with speech or anything else. No I would not put that in it will just complicate your application.

**Interviewer:** Are there any options for this type of application that should be more visible than others?

**Participant 1:** Yup. I think the name of the book because it's about text books. The name of the books should be visible. In what module it will be used or is prescribed. And of course the price. Those are the three major things that I want to see when I browse through it.

**Interviewer:** In which manner should user access be limited for a mobile application for the trading of used books at the [redacted]? I think you have answered this already where you explained that I should restrict the application only to students because it is the first version.

**Participant 1:** Correct.

**Interviewer:** So I don't have to repeat myself again on this one. And then we are going to finish now. I only have four questions left, I don't want to take too much of your time. Who should test the mobile application for the trading of used books at the [redacted] for usability?

**Participant 1:** First of all I think best will be used lecturers so that they can see that the appropriate information is there and then you should include a few students as well. I cannot say how many, you should determine that yourself.

**Interviewer:** We have to do it until saturation of information?

**Participant 1:** Yes.

**Interviewer:** Okay so then we were thinking of … But I don't know if I may I need to ask that question now because we are thinking of organising a focus group after the development of the application with students so you are telling me that we don't have to do that. First we have to do that with lecturers then we'll go with students later on.

**Participant 1:** I don't think focus groups at the beginning is necessary.

**Interviewer:** So focus groups are not necessary at the beginning?

**Participant 1:** The way I see it can be that you test it with two or three lecturers and then you'll know exactly what is wrong or what is right.

**Interviewer:** Those lecturers they should be subject matter expert or ordinary lecturer?

**Participant 1:** It can be any lecturer because it's about uploading books. It's not subject related. It can be any books not just for e.g. Science books or Information System books. And again the students as well. It can be any student. It will be good if there are, let's say, in your data examples of Computer Science books and you can use Computer Science students as they can relate to the book and the subject. In general it is not such a restricted application so I will be able or a student should be able to evaluate the system without knowing the contents of the book or the name of the book because it's not about names it's about the function, the operation of your application.

**Interviewer:** Thanks so much. In your experience, what are major factors in mobile application design that could contribute to the success or failure of the artefact?

**Participant 1:** First of all your user name interface. Your user name interface must be very clear. It must be simple to use. It must be effective. So the user experience must be good. So if I take a phone immediately I must be able to operate this app. Otherwise I'm not going to

look at it once again. So ease of use, easy input, easy retrieving of data and a pleasant user experience.

**Interviewer:** What is the best way to improve User Experience (UX) without changing the interface?

**Participant 1:** The best way to improve the user experience without changing the interface. That's a difficult one because normally the user experience or let's say the user interface is a huge part of the user's experience. So if you don't change the user interface you probably not going to change much of the experience itself. So, I don't have concrete examples for you.

**Interviewer:** Should we maybe test the application with subject matter experts and they will give us some feedback and we'll go back to the interface and then finally, so we can change it?

**Participant 1:** Yes you see you've already asked me what will be the factors of (interrupted)

**Interviewer:** I'm saying what is the best way to improve user experience without changing the interface?

**Participant 1:** I don't think there is a best way to do that because as I say the interface is a huge part and that contributes major to your user experience so if you are not going to change the user interface it's not going to change or improve the user experience because that is to me a major part of the user experience. How do I perceive this, is it easy to use? That is the user interface. I'm communicating with the user interface.

**Interviewer:** Thanks so much. The last one. Have you interacted with similar mobile applications? If so, please name them.

**Participant 1:** Well, I've interacted with a lot of applications and this is typically a data base application, where you've got a data base in the background and you must enter data, upload data, and retrieve data. One that I can mention is one that I wrote myself. It's called The Amazing Race that's one that they use on campus and that's typically, more or less, the same as this one where we enter data, we retrieve data at specific times and that there are secure movements and so on.

**Recording stopped at 16:30 min.**

## APPENDIX F: FOCUS GROUP TRANSCRIPTION

**Project: Designing a mobile application for the trading of used books at a university: A DSR approach**

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### D 1: Focus Group transcription

Interviewer: Ok guys after interacting with the application, so I would like to get a feedback from you guys. Who do you think that should test this application? Who do you think that the people that should test the application?

**Participant 1**: Students

**Participant 2**: Students

**Interviewer**: Students? Ok. So, you are saying that students should test the application?

**Participant 2**: Yes.

**Interviewer**: Then what is the best method of testing this type of mobile application? What is the best method of testing this type of application?

Participant 4: I think selling it on our phones, using it on our phones.

**Interviewer**: Ok (interrupts)

Participant 4: Or the computer since we always have access to the computer, if it is possible to login using our computers is going to be the best method.

**Interviewer**: Ok, do you guys have anything to add?

Participants: (Incoherent mumbling)

**Interviewer** So that is fine then.

Then which feelings did you experience while interacting with the application?

Participant 4: For one, I think I was kind of excited. The thought of actually having the opportunity to sell your books online, so I think I was kind of excited. And anxious again, if it was going to be possible to actually do anything.

**Interviewer**: Ok guys. Comment, any comment?

Participants 1: None yet.

**Interviewer**: None yet.

Ok. Which part, or we call it element or component in IT field, which component do you think that was well designed on the application?

**Participant 2**: The registration. The logging in and creating an account

**Interviewer**: Ok the registration. What else?

**Participant 3**: Being able to put a profile picture on your thingy, what do you call it? Profile.

**Participant 5**: And also, being able upload a picture of the book that you are selling and that you can also view the book that you are actually going to buy.

**Interviewer**: Ok then, speaking of what was well designed, and then what, what, which elements did you think were badly or poorly designed?

**Participant 2**: Struggling to upload books.

**Participant 5**: As well as searching for books. You would have to copy and there were not specific instructions as to whether, what you had to do, because if you do not know, then you have to copy and I think that is a long process. It would be easier to just click on the thing and the specific book will appear. I think that will be good.

**Interviewer**: Ok that is good.

**Participant 5**: Oh, and also to search for a specific book that you want, rather than only going to the faculty and all the books appearing, because, say there are 500 students who have all uploaded their books, so now you would have to go through all the books and the specific year that you are doing. You also have a specific year and a specific book so that it saves you time.

**Interviewer**: Ok, thank you so much sir. And then, were you disappointed in any of the features on the mobile application?

**Participant 5**: That was the only one. I would only like to add that option. And the price issue.

**Interviewer**: Price issue?

What is your suggestion? You want the price to have at least a 4-digit?

**Participants**: Yes

**Interviewer**: Ok, thank you so much guys. Is the mobile application well presented?

**Participant 6**: It is.

**Interviewer**: Why do you say it is well presented?

**Participant 4**: Its serves its function.

**Interviewer**: The function?

**Participant 3**: Ya it serves it and it is easy to use. Like everything is just there. There are no additional things that you have to know. It is just like our eFundi.

**Interviewer**: Ok thank you. Which platform, do you think, is the best choice for this type of application? For example, let me give you an example so you can understand, do you want it to be a website or a mobile application or anything different?

**Participant 6**: I say both.

**Participant 3**: I say also both.

**Participant 5**: I think if you are using it once, for one book. I won't need to download the app, I would just go on the website, upload it and come later on and check it on the website. But if maybe you are dealing in books, then I need the app and I would need to have it on my phone to constantly checkup and uploading and all of that.

**Participant 6**: *incoherent

**Interviewer**: Do you think that we should include other options to teach people how to use the system?

**Participant 2**: Eh, ya I think we should.

**Participant 2**: Because it is not that easy. It is not an easy app to use, this one. It is not that easy, like you have to go through a lot of stuff like, when you want to buy you have to go there and search, you have to find search and you have to copy then people will have to know to copy and stuff like that.

**Participant 4**: If you weren't here I wouldn't, I didn't know that I needed to copy. I'm busy trying to press. (Says something in another language)

**Participant 5**: Then you click the menu and the options appear. I think maybe if it was just today and say oh no I want to buy it now, I'm selling, rather than clicking on the menu.

**Interviewer**: Ok, thank you so much guys.

**Participant 1**: Incoherent mumbling

**Participant 4**: At least if it is appearing just like you know like eFundi, you just login. Not like a hidden icon, you just click and it shows.

**Interviewer**: (interrupts participant) you click and it shows there. Ok

**Participant 4**: Ok, I have a question. Like I know that it is not online yet but after it creates your account, does it send you an email to say ok, verify that you've opened an account with us. Here is you dadadadada.

**Interviewer**: So, for now you don't get any email. I think since you have, uhm, raised that, I will see, I will consider that. We should have that option. Once you log on, instead of the app *instill of the application* to show you on the screen, it should also send you an email so it can keep your record under the email.

**Participant 4**: And your password, if you ever have the option to create your own password rather than give X, Y, Z cause it's easy to forget.

**Interviewer**: Oh, ok. It is fine, I will consider that. Ok, from everything we have discussed here, what is the most important to you on the application?

**Participant 1**: Usability

**Interviewer**: Ok, you say usability. And then guys, what is the most important?

**Participant 3**: Ya, as he said usability, because most of us want to sell our books so if that's possible then we are happy.

**Participant 5**: Because we want to get new books as soon as we can. So, if it's that easy to use, then you take your book and say eish I feel like selling my book, click here and then you done.

**Participant 3**: You just go back to your account.

**Participant 5**: Oh, and if you had the option, if you see, no, you know like OLX function. If I like it, if I am interested, when it sends your email it has your number, on the app itself, communicating.

**Interviewer**: Ok.

**Participant 5**: And now it pings on your phone, because let's say you have an app you created the account. If it pings you when someone interested in the book so and so and so. The person can act now and say the book has been sold or the book is still available. Negotiate on price and stuff like that within the app itself. Because if it is like that, it is way easier, because like I

just use the same things instead of maybe airtime, you are going to delay because you first need to get off the app, text them the number it's going to take a minimum, say by 5 'o clock, you've already forgotten your numbers again.

**Interviewer**: Ok.

**Participant 5**: You understand?

**Interviewer**: Mmmhmm.

**Participant 6**: 'Cos so let's say like other people they are only the textbook and the numbers, so when I go home, so when I save them in java, there is Java group 1, Java what not. So, I think if there would be a way to communicate on the site itself.

**Interviewer**: Ok thank you so much, I will consider that and then try to implement it on the application.

And then guys, this is last question I would like at least everyone to comment on that. If you were designing this application without the difficult part. Forget the economics, the IT or the business. If instead you were developing this application. What would you do differently? Like compared to what I've done, but to you do from this application?

**Participant 1**: Ok, like this guy said, the book should have at least, where you would be able to add through pictures

**Interviewer**: Ok.

**Participant 1**: I think that it is going to be important to show the condition of the book and stuff like that.

**Interviewer**: Ok, at least to put more frames where we can show more books to show a picture on the application. Ok good.

**Participant 4**: Ok mine, I would think I would, ya, let's say that Siphiso uploaded his book and appeared his picture and I clicked there and appeared the book, and I see all the pictures and say that I am interested and ya that would for me, that would work.

**Interviewer**: Guys, do you have anything to add?

**Participant 2**: No.

**Interviewer**: You are fine?

**Participant 3**: And then the ISS, is it really necessary for the ISS

**Interviewer**: Which one?

**Participant 3**: The ISS number, that number.

**Interviewer**: No, we are using the IP address because the application is not online. It is running on an Iproxy

**Participant 2**: ISBN, is it really necessary?

**Interviewer**: Yes, when you upload the book, it is necessary, it is very important because you can use the ISB number to go to the internet and check if this is the book that you really looking for. Because books have versions of books and then you can differentiate those versions according to their ISBN number.

Participants 4: Wouldn't the picture do that because you know you looking for this.

**Interviewer**: Ok.

**Participant 4**: Because on the picture itself you can see.

**Interviewer**: So, you are suggesting that we should remove that part of ISB number?

**Participant 4**: Yes, so let's say, as you say. There is a thirteen and a ten of which you are selling, and let's say the book cover is a bit older version of thirteen and I can't upload because mine uses the IS what, what number of 10. You see then it becomes a problem within itself. With the pictures, now I have three different pictures, a back, a front and middle. And then I know the condition, I see the cover. I know ok, this is the book I am looking for. If it is a version that is different like a version from before it's going to write 4th addition or 5th addition.

**Participant 5**: Picture is just a picture because I understand that you put it there for verifying rights. You can go and reference the internet, it verifies. But don't the pictures do that?

**Interviewer**: Ok, no I'll consider your idea. It is a good idea.

**Participant 2**: This thing, this ISBN.

**Interviewer**: ISBN.

**Participant 2**: We need to avoid the long process, maybe you should put a scanner or something.

**Interviewer**: Yes. But now, (**Participant 2** interrupts)

**Participant 2**: Like when uploading, you should put (**Interviewer** interrupts participant)

**Interviewer**: You can scan, I was using a scanner at work, I can scan that ISB number to the phone or my laptop but you cannot go around with a scanner the. (Participant interrupts)

**Participant 2**: Ya but maybe those applications.

**Interviewer**: Oh ok, just a, oh I get your point. It will work. Ok thank you so much.

Guys I think I will take your idea.

**Participant 3**: If you could, like, allow the seller to add comment or reviews on the book. If like say, this one page is missing, the seller could say this one page. (**Interviewer** interrupts)

**Interviewer**: Is missing in this book, ya. So, to allow the seller to also include comment on when they are posting the book. Ya that's a very good suggestion.

**Recording stopped at 14:33 minutes**