CHAPTER 4 - RESEARCH DESIGN AND RESEARCH METHODOLOGY

4.1 INTRODUCTION

The purpose of this chapter is to set out the research design used and methodology followed in the research. Mouton (2001:56) describes the research design as an *architectural design or blueprint* of a research project and the execution of the design, the research process or methodology as the *construction process using methods and tools*. The focus of the research design is on the type of study planned to reach specific outcomes. The process to follow and the methodology of the research is chosen to support the outcome and the significance of the results. Therefore, in all research the underlying philosophical assumptions of the research, approach, strategy, research design and methodology followed in the research needs to be discussed.

Research is often initiated when there is a need to find a solution or a better solution than exists to a problem or to contribute new knowledge or inventions. The objectives of the research were to identify human factors that impact on EA acceptance and to propose a framework of human factors to assist organisations for management of EA acceptance. The paradigm of design science research (DSR) was selected for the research.

In Section 4.2, a conceptual overview of the research process followed is provided. Different research philosophies are discussed in Section 4.3. In Section 4.4, the paradigm of design science is presented and described from the viewpoint of general systems in organisations. Reasons for choosing DSR as a paradigm and approach in my research are provided to position the relevance of the research as design research. In sections 4.5 to 4.7, the literature is used for a general discussion of design research strategy and method, data collection methods and data analysis. In Section 4.8 the research plan followed in the research is presented in detail. The strategy of design research used for the research is discussed and the data collection methods and analysis techniques of the research are described. The chapter concludes with a discussion of the ethical considerations of the research and the outcome of the research.

4.2 RESEARCH PROCESS

In an initial orientation process, the 6Ps framework of Oates (2006:11) was used to establish a conceptual map of the complete research process. According to Oates (2006:11), the 6Ps of research represent the purpose, product(s), process, participants, paradigm and presentation of the research. Questions to guide the research as suggested by Oates (2006:11) are listed in Table 4.1.

According to Oates (2006:8), a thesis is a logical argument consisting of referenced work carried out by other people as well as self-constructed work, actions and ideas of a researcher, presented in a written report.

Table 4.1: 6P research framework with guideline questions (Oates, 2006)

6Ps OF RESEARCH	CONCEPTUAL GUIDELINES
1. Purpose	What is the research problem under investigation? What are the reasons for doing the research? What are the objectives (more general) and aims (more specific) of the research? Is the research relevant to the field of study and to other people?
2. Paradigm	What is the underlying philosophical research paradigm assumed?
3. Process	What is the format and layout of the conceptual framework of the researcher? How was the research conducted? What is the research strategy? What data collection methods were used? How was the data analysed? What conclusions were drawn? Was the research process done in a systematic way and is it valid research process? What are the boundaries of the research? What are the limitations of the research?
4. Participants	How is the researcher involved in the research? What are the legal and ethical implications of the research? Consideration and respect for all people directly or indirectly involved in the research.
5. Products	What are the expected and unexpected outcomes of the research? What is the contribution of knowledge to the subject of study, field of interest or research community? What aspects of the research need further investigation?
6. Presentations	How is the research communicated to others who are interested? Is the research professionally conveyed by means of a dissertation, thesis, conference contribution, article or product?

In this study all aspects of research as described by the 6Ps of research by Oates (2006:11) were considered (Figure 4.1). In this chapter, the first three Ps (purpose of the research, philosophical paradigm and plan of the research) are discussed. Section 4.3 is used to discuss the philosophical grounding of the research. In Section 4.9 the purpose of the research is discussed and a detailed plan of the research is provided. The last three Ps are addressed in later chapters, where the execution of the research is described.

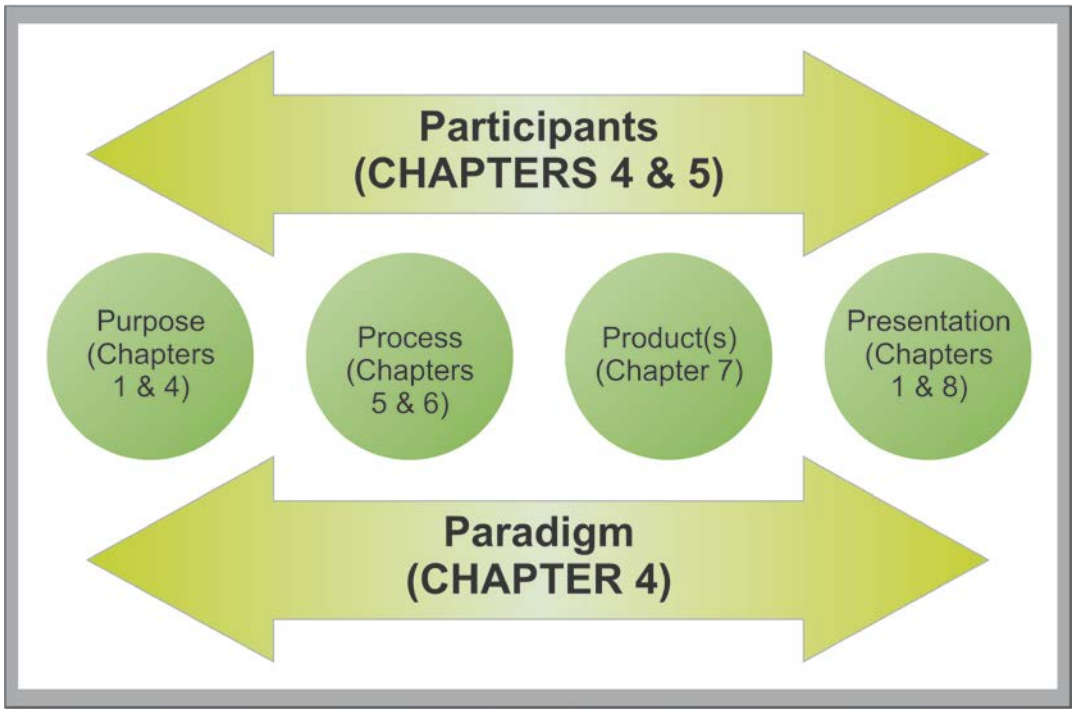

Figure 4.1: **Adopted from the 6Ps of Research** (Oates, 2006:11)

4.3 PHILOSOPHICAL GROUNDING

Research paradigms describe the underlying philosophical views of groups of people about the world they live in and the research they conduct (Oates, 2006:12). Olivier (2004:26) stresses that in IS and IT, a paradigm serves not only as a guide in research but also in construction and implementation of systems.

In IS and IT research, four primary philosophical groundings or basic belief systems of researchers are described – ontology, epistemology, methodology and axiology:

- *Ontology* is a reflection of the nature of science or the nature of reality. In scientific research, the philosophical stance of the researcher describes how a researcher ontologically reports about facts within a field of knowledge. For example, a positivist stance will reveal facts concerning the as-is world whereas a phenomenological stance is characterised firstly by a notion of revealing the mental processes of observers rather than describing the real world (Checkland, 1999:315; Dietz, 2010:8).
- *Epistemology* reflects the relationship between someone as an inquirer and the object of inquiry – how a researcher reflects about the nature of knowledge or reports the truth about knowledge gained. For example, in design science research an epistemology of 'knowing through making' describes the relationship in context between researcher and object of construction (Vaishnavi *et al.*, 2013).
- *Methodology* entails 'developing or constructing' – an investigation of impact of a development or construct in its context of use.
- *Axiology* reflects the values of a researcher in relation to the environment of research (Adebesin *et al.*, 2011:310; Mouton, 2001:249; Vaishnavi *et al.*, 2013). Adebesin *et al*. (2011:5) adapt and summarise the

four philosophical assumptions as described by Guba and Lincoln (1994:105), Vaishnavi and Kuechler (2013) and Terre Blance and Durrheim (2006:586).

On the basis of these philosophical groundings, four research perspectives or paradigms of relevance to IS and IT research – positivist, interpretive, critical research and design science research – are discussed:

- *Positivist research* is characterised by understanding of reality by objective testing and a single outcome of the truth. In positivist research, researchers perceive themselves and their research as independent of social and physical reality. An example of positivism is research in chemistry or physics where an experimental study is performed, a theory is created or tested, or hypotheses are derived and tested. Although not always the case, the study is repeatable and it may have dependent and independent variables defined. Conducting experiments and gathering of quantifiable data are typical methods used in positivist research. Results are usually quantitatively analysed. Positivist research findings are objectively reported and may be generalised (Bhattacherjee, 2012; March *et al.*, 1995:251; Myers, 2009:284).
- The *interpretive research* paradigm is used in research that tries to make sense of phenomena through exploration or explanation of people's perceptions, language, shared values and meanings in a dynamic social context. Multiple realities are acknowledged when different groups or cultures are studied. Interpretive researchers are not neutral in the research process and researchers are expected to acknowledge their involvement and influence. Examples of typical qualitative methods of research employed are case studies, interviews, observations and action research where the focus is on understanding in context (Adebesin *et al.*, 2011:310; Bhattacherjee, 2012; Hevner *et al.*, 2010:320; Myers, 2009:284; Oates, 2006).
- *Critical research* is conducted in a social context which is also true for interpretive research. In critical research, however, the researcher challenges prevailing political, cultural and power relations in social settings. Critical researchers are motivated by an underlying ethical basis and apart from describing and explaining research environments, they seek to control or improve situations such as, for example, unfair economic-power-related imbalances in social societies. Qualitative methods applied are ethnography, action research and case studies (Adebesin *et al.*, 2011:310; Myers, 2009:284; Oates, 2006).
- *Design science research* concerns research of man-made or artificial constructs, their composition and use and how and where they are implemented. Design science research spans many disciplines, of which engineering is one example. In engineering the creation of artefacts or innovations to solve problems are researched. As opposed to research concerned with natural- and social-world phenomena, design science research is research described as the creation of artificial or man-made artefacts with the purpose of serving human needs in a specified environment (Gustavii, 2006; March *et al.*, 1995:253; Simon, 1996:5). Purao (2002:4) explains the difference between research in natural science and design science when he states that design science research requires *looking ahead to new possibilities* as opposed to *looking back to understand*. Hevner and Chatterjee (2010:320) define design science research as:

  > *A research paradigm in which a designer answers questions relevant to human problems via creation of innovative artefacts, thereby contributing new knowledge to the body of scientific evidence. The artefacts are both useful and fundamental in understanding the problem.*

The matrix of Adebesin (2011:310) depicting four philosophical assumptions and listing the most important aspects to consider when following research paradigms of positivism, interpretivism, critical or constructivism and design was used to describe the philosophy underlying my research. Philosophical assumptions of the four research paradigms discussed are listed in Table 4.2 and the scope of my research is indicated by the coloured blocks.

Table 4.2: Philosophical assumptions of the four research paradigms (Adebesin *et al.*, 2011:310; Terre Blanche *et al.*, 2006:586; Vaishnavi *et al.*, 2013)

	PHILOSOPHICAL ASSUMPTIONS			
RESEARCH PARADIGMS	**ONTOLOGY**	**EPISTEMOLOGY**	**METHODOLOGY**	**AXIOLOGY**
Positivist	- Single, stable reality - Law-like	- Objective - Detached observer	- Experimental - Quantitative - Hypothesis testing	- Truth (objective) - Prediction
Interpretive	- Multiple realities - Socially constructed	- Empathetic - Observer subjectivity	- Interactional - Interpretation - Qualitative	- Contextual understanding
Critical/ Constructionist	- Socially constructed reality - Discourse - Power	- Suspicious - Political - Observer constructing Version	- Deconstruction - Textual analysis - Discourse analysis	- Inquiry is value-bound - Contextual understanding - Researcher's values affect the study
Design	- Multiple, contextually situated realities	- Knowing through making - Context-based construction	- Developmental - Impact analysis of artefact on composite system	- Control - Creation - Understanding

The research paradigm of design science research (DSR) was selected for this study. DSR is used in the design of artefacts or innovations to solve problems or change the state of the world, according to Vaishnavi and Kuechler (2013). Ontologically the design science researcher is involved in the research through multiple contextual situations. As the research progresses through more than one circumscription phase, the researcher is challenged with an epistemology of gaining knowledge in the process of construction, acknowledging and accepting that context affects the process. In my research, this engagement was to gain understanding of the socio-technical work-role context of humans in organisations.

Ontologically the focus is on EA implementation in more than one enterprise. The organisations involved represented different business sectors and, therefore, different world-views. During the design research (DR) cycle, contextual and unique reality had to be considered. Iteration of four DR sub-cycles resulted in development of the Model of Work-Level Acceptance Framework for EA (Model of WoLAF for EA).

Epistemologically, knowledge gained in one sub-cycle, created awareness of what was needed to initiate a next sub-cycle. The context of operation in each sub-cycle was unique.

Methodologically, WoLAF for EA is developed as an artefact to be used in promoting EA acceptance in organisations or groups of sub-organisations, both of which can be known as an "enterprise".

Axiologically the design science researcher appreciates that artefacts assist in problem solving and bringing about positive change in organisations. Apart from understanding and controlling the main research as well as each sub-cycle development phase, I comprehend and value creative manipulation and control of the research environment (Vaishnavi *et al.*, 2013). In my research the artefact implies improved acceptance of EA in organisations. A framework of human factors identified to impact on EA acceptance was eventually compiled after completion of four DR cycles.

The research paradigm selected for my research, namely that of DSR is described in more detail in Section 4.4.

4.4 DESIGN SCIENCE RESEARCH

Research is a human endeavour, shaped by human reasoning. Sometimes the choice of a research paradigm underlying a study and the research strategy to be followed is obvious. If the research is not typically representative of one paradigm, a combination of paradigms is possible as long as this choice is well described and justified (Oates, 2006:4, 304). In IS the research behavioural science paradigm is used to develop IS theory to provide truth and DSR is used to design and develop artefacts to provide utility. Problems characterised by humans in work roles and the effect of social abilities in business strategy implementation supported by IS (information management and IT) are typical of a research problem drawing from both behavioural and design science knowledge spheres (Figure 4.2). It is therefore possible to combine research paradigms when a combination is called for by the research objectives.

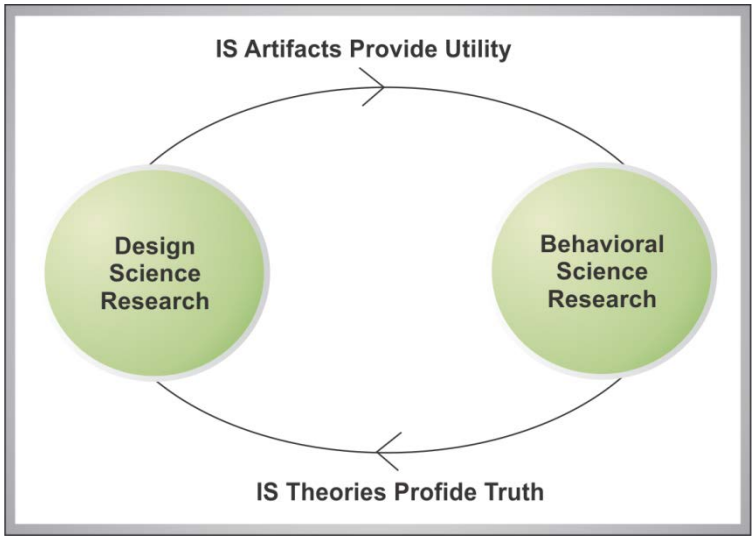

Figure 4.2: Complementary nature of design science and behavioural science research (Hevner *et al.*, 2010:11)

On the "Design Science Research in Information Systems and Technology" (DESRIST) webpage, views on philosophical assumptions in IS research are discussed and the statement is made that the metaphysical

assumptions of DSR are unique (Vaishnavi *et al.*, 2013). The reason for this statement is twofold. Firstly, the ontology, epistemology and axiology of DSR are unique and not derivable from other philosophical paradigms and, secondly, during the research process, the epistemological and ontological perspectives of the researcher may change as a result of circumscription phases of the DSR process. Researchers assuming and working from a DSR perspective ontologically perceive a *multiple and contextually-situated* world state and epistemologically believe in *knowing through making* (Adebesin *et al.*, 2011:310; Vaishnavi *et al.*, 2013; Vaishnavi *et al.*, 2013). Hevner *et al.* (2004:75; 2010:5) describe how theories are developed in the behavioural science paradigm of IS to explain human behaviour. The design science paradigm, on the other hand, is applied to develop and create new artefacts to improve human capabilities and organisational operation.

Different terms are sometimes used to describe DSR; for example, Oates (2006) uses "design and creation" to describe DSR. In their description of design science research Vaishnavi *et al.* (2013) distinguish between two areas of research: DSR and design research. According to Vaishnavi *et al.* (2013) and Hevner and Chatterjee (2010:320), DSR as described in IS and IT research is learning through construction of artefacts, their use and usefulness in context. Where understanding of design methods is researched or design is used as a research method (often independent of context as in architecture or engineering), the type of research is generally described as "design research" or "researching design". According to Hevner and Chatterjee (2010:16), DSR research occurs in disciplines of computer science, software engineering and organisation science, while researching design relates more to the fields of architecture and engineering.

Hevner and Chatterjee (2010:57) distinguish between interpretive and means-end research in IS and state that an evaluation study in IS can be interpretive and provide us with an understanding of the effectiveness and efficiency of an artefact. DSR, though, is characterised by design and creation of artefacts and therefore tends to be naturally means-end research. It is clear that DSR ethically cannot be value free because the aim of the researcher is not only to describe and explain the existing world but to also shape it. Therefore, the researcher accepts responsibility for results and sometimes unforeseen consequences of the research.

Researchers argue that DSR can benefit from implementing natural science activities such as justification and theory building. Where natural science uses the activities of discover-and-describe and justify-and-prescribe, design science should not only use build-and-evaluate but incorporate natural science activities of theorise-and-justify according to March and Smith (1995:251) and Orlikowski (1993:309). Orlikowski and Iacono (2001:131) argue that artefacts are dynamic and should be conceptualised and theoretically justified. Outputs of DSR vary and can include constructs, concepts, models, methods, instantiations and better design theories (Hevner *et al.*, 2010:320; Oates, 2006). From this description of DSR, it is evident that questions on *what* is designed (artefact), *how* it is working (related factors in context of its working environment) and *why* it is working (justifying the artefact and its working environment) should be answered in the research.

Research in IS, where humans and artefacts in organisations are studied, draws from the foundational scientific paradigms of behavioural or design science (Hevner *et al.*, 2004:75). Behavioural science is an inclusive concept describing disciplines such as cognitive science and psychology where human behaviour and human interaction are explored. Hevner and Chatterjee (2010:121) explain that where IS research in behavioural science is concerned with a 'business need', theory development or justification to explain that

need, or prediction of IS and human or organisational related phenomena, DSR 'builds and evaluates artefacts to address particular organisational needs' (Hevner *et al.*, 2004:76; March *et al.*, 1995:253). DSR is a relevant research paradigm in IS research where the introduction, use and management of systems and IT in the social organisational environment are investigated (Hevner *et al.*, 2004:75; Orlikowski *et al.*, 2001:133; Purao, 2002:3).

Purao (2002:4) indicates five key elements of design science research (Table 4.3).

Table 4.3: Key elements of design science research (Purao, 2002:4)

KEY ELEMENTS OF DESIGN SCIENCE RESEARCH	MEANING
Design	Point the way
Invention	Not discovery or replication
Teleological stance	Purposeful advancement, ensuring relevance
Axiological perspective	Value orientation
Pragmatic attitude	Focus on making it work, requiring rigour

In the discipline of IT, there are different views on design, development, evaluation and improvement of artefacts and proof of scientifically valid research. March and Smith (1995:251) argue that a duality exists in research in the field of IT because some researchers claim that only production of theories and knowledge in IT can be *classified as science in IT* research while others believe that creation, improvement and knowledge of artefacts in IT have proved to make important contributions to the field of study (Gregor, 2009; Simon, 1988:67; Walls *et al.*, 1992:36). In contrast to natural science research, IT artefacts *are not natural, neutral, universal or given* (Orlikowski *et al.*, 2001:131; Purao, 2002:4). This is in principle confirmed by Hevner and Chatterjee (2010:320) when they state that knowledge and understanding of a design problem and its solution is required in artefact design, creation and application in context. This view is shared by Orlikowski and Iacono (2001:131) when they list premises for theorising about IT artefacts:

- IT artefacts are widely used and influenced by many people with diverse perspectives, cultures and interests;
- time and place of use should be considered;
- IT artefacts comprise many components requiring definition of new concepts and theory building;
- use and form of artefacts may change; and
- IT artefacts are dynamic, complex, changing socio-technical processes.

My research is concerned with the design of a framework for use in an organisational environment and therefore design science as a research paradigm and the research communities of IS and IT apply. In agreement with the ideas of Simon (1996:111) in his description of the *sciences of the artificial*, Hevner *et al*. (2004:75) describe DSR as a strategy used in IS. Hevner (2004:75) explains that IS research identifies needs in an organisational environment that concern people using systems and technology. Drawing from

fundamental, scientific and basic knowledge bases, artefacts are designed, developed, built, assessed, evaluated, justified, refined, tested and proposed to address identified needs. DSR research is relevant when artefacts successfully address identified needs. The research is proven to be rigorous when the research contributes 'new' and valuable knowledge to the IS discipline (Figure 4.3).

DSR in IS is increasingly more accepted as a legitimate research paradigm and approach (Hevner *et al.*, 2010:320; Kuechler *et al.*, 2008:489). Vaishnavi and Kuechler (2013) describe DSR as *knowledge building through making*.

Hevner *et al*. ((2004:87; 2010:205) list DSR contributions for organisations as:

- problem identification and a clear description of an organisational problem;
- demonstrating that no clear solution exists;
- design, development and presentation of an artefact – construct, model, method or instantiation;
- rigorous evaluation and assessment of the utility of the artefact;
- expressing the practical and theoretical added value of the artefact; and
- explaining implications of implementation of an artefact to both technical and managerial members of an organisation.

In a recent explanation, Hevner (2012) emphasised that design in DSR in IS encompasses design first as an artefact (noun – a framework and instantiation in my research); second, as a process (verb – constructing and evaluating a framework); and, third, as a 'wicked' problem (human cognitive and social abilities, inherent flexibility to change artefacts or processes, complex interactions among subcomponents of problem and resulting subcomponents of solution, and unstable requirements and constraints). Pries-Heje *et al*. (2008:731) describe a 'wicked' problem as a problem that is not well defined and can only be expressed in terms of a solution. Approaching the problem is difficult and the approach is characterised by uncertainty. The solution to a 'wicked' problem is expressed in terms of value only; for example, the solution to the problem is stated only as a good or bad solution. The social environment of an organisation lends itself to 'wicked' problems (Pries-Heje *et al.*, 2008:732). Research into human acceptance of EA fits the description of a 'wicked' problem.

According to Hevner *et al*. (2004:81), 'wicked' problems are typically characterised by:

- unstable requirements and constraints;
- difficult-to-define contexts;
- complex interactions of problem components and problem solution;
- malleable processes and artefacts;
- human cognitive dependence for solutions; and
- human social dependence for effective solution.

Hevner and Chatterjee (2010:12) provide the following guidelines for DSR (Table 4.4):

Table 4.4: Guidelines for DSR (Hevner *et al.*, 2010:12)

GUIDELINE	DESCRIPTION
Design an artefact	Research must produce a viable artefact
Problem relevance	Objective is to develop a technology-based solution to a relevant business problem
Design evaluation	Use well-executed evaluation methods to test utility, quality and efficacy of an artefact
Research contributions	Effective DSR must provide clear and verifiable contributions in the areas of design artefact, design foundations, and/or design methodologies
Research rigour	DSR relies upon the application of rigorous methods in both the construction and evaluation of the design artefact
Design as a search process	Utilise available means in the search for an effective artefact and solution to a problem
Communication of research	Effective presentation of DSR to both technology- and management-oriented audiences

March and Smith (1995:255) see artefacts as research outputs while Hevner and Chatterjee (2010:6) define artefacts as *end-goals of design science research projects*. Outputs of the research also known as artefacts can be broadly categorised as:

- Instantiations: An instantiation may for example be a realisation of an artefact in IT. Other examples of instantiations are when systems are implemented or prototype systems are developed.
- Methods: A method is a series of steps explaining *how to* achieve something. Algorithms and practices are examples of methods.
- Models: Models are statements or propositions describing a set of constructs to solve a problem. Abstractions and representations are examples of models.
- Constructs: Concepts, syntax or language (vocabulary and symbols) used in a specified context to describe a problem and find a solution are examples of constructs.
- Better design theories.

According to March and Smith (1995:253), designing, creating and evaluation of artefacts are typical research activities exercised in IT and computer science research and it is possible to extend these activities to include the research activities of theory building and justification used in natural science research. Theories must explain how and why IT systems work within their operating environments and research should attempt to justify the theories (March *et al.*, 1995:255). This view is shared by Walls (1992:43), who claims that researchers use, modify, test or extend theories underlying the creation of IS artefacts. According to Hevner *et al*. (2004:77), design and creation of artefacts not only extend human and organisational problem-solving capabilities but also allow for theory development regarding impact, implementation and use of artefacts.

Examples of research where behaviour in existing systems was examined and whose results led to improved or new systems can be found in various studies (Markus, 1983:430; Nunamaker *et al.*, 1990-91:89; Orlikowski, 1993:309; Orlikowski *et al.*, 1997; Orlikowski *et al.*, 1997).

The philosophical assumption of a DSR paradigm implies a problem-solving- and engineering research methodology. Simon (1996:4) and Peffers *et al*. (2006:83; 2008:47) emphasise the problem-solving and engineering basis of DSR. According to Peffers *et al*. (2008:49), DSR methodology comprises three elements: conceptual principles defining the research methodology, practice rules and a research process.

4.5 RESEARCH STRATEGY

According to Oates (2006:156, 299), it is possible to use different research strategies linked to a philosophical paradigm. For example, case study research is mostly linked to interpretive research but can also be found in critical and positivist research. Strategies used often in DSR are an *action research* or *design research* approach. The philosophical stance for this research was highlighted in Table 4.2.

When new things such as new IS or IT is introduced in organisations, *action research* is conducted to explore and explain the socio-technical effect on users or organisational management and operations. Where research is concerned with change caused by intervention or the effect of implementation of an artefact in a socio-technical environment is studied, action research is used. Action research as a research strategy has been used in IS research associated with the underlying critical social or critical constructivist paradigm (Checkland, 1999:245, 247; Oates, 2006:156). The definition of Rapoport (1970:499) that *action research aims to contribute both to the practical concerns of people in an immediate problematic situation and to the goals of social science by joint collaboration within a mutually acceptable ethical framework* is a widely accepted and used definition (Myers, 1997:241).

The underlying principles of action research listed by Iivari and Venable (2009:4) are the researcher-collaborator agreement, theory, a cyclical model, change through action or intervention and learning through reflection.

In contrast, design research as a strategy is concerned with design or improvement of artefacts, constructing in context, knowing or learning through making and invention or improvement.

The research process does not only include a demonstration of technology skills and knowledge, but artefacts also have to be analysed, explained, justified, and evaluated (Oates, 2006:109). For my research a design research approach was appropriate since the focus of the research was on the construction of an artefact and not on intervention.

In design research three research cycles are distinguished as shown in Figure 4.3: the relevance cycle, the design cycle and the rigour cycle (Hevner *et al.*, 2010:16). In the relevance cycle the research problem or the need for the research and the research environment is explained. The rigour cycle uses existing knowledge bases such as theories, methods, design products, design processes, artefacts, experiments and expertise to provide a basis for rigorous design research. The design cycle constitutes the research activities and actions. Thorough evaluation or testing is done where requirements or problem statements are revisited and improved. Total redo may be required to ensure that the artefact meets requirements and expectations.

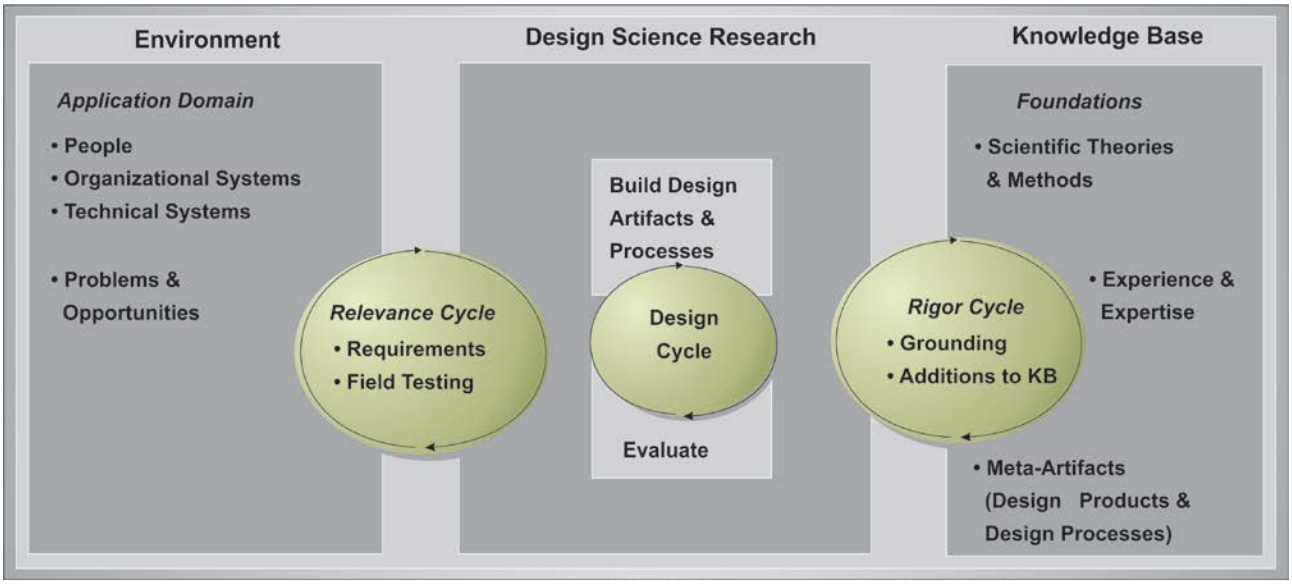

Figure 4.3: Design research cycles and research relevance and rigour (Hevner *et al.*, 2010:16)

For the purpose of my research the design research method as proposed by Vaishnavi and Kuechler (2013) and illustrated in Figure 4.4 was selected as the method to construct the framework artefact.

Vaishnavi and Kuechler (2008:489; 2013) describe five steps in the design research process:

1. Awareness of problem. In a first step the researcher becomes aware of a problem. The awareness phase is characterised by identification of a problem, a need or an idea where design and creation of an artefact, model, construct, method, theory or framework can lead to possible solutions. The outcome of this phase is a research proposal.

2. Suggestion. A solution is suggested in a second step by drawing on relevant existing knowledge or theories. In the suggestion phase, a possible design or solution is suggested.

3. Development. An artefact is developed in the development phase.

4. Evaluation. In the evaluation phase, the artefact is evaluated and tested. Quantitative or qualitative evaluation techniques are implemented to measure the performance of an artefact.

5. Conclusion. In a final step or conclusion, results of the design research make a useful contribution to the body of knowledge in the form of an acknowledged, approved, accredited artefact.

During the development, implementation and evaluation phases, new information can trigger awareness, which can lead to a repetition of the process. Several iterations of the process, called the "circumscription process", are possible before the design is finished and the design process concludes.

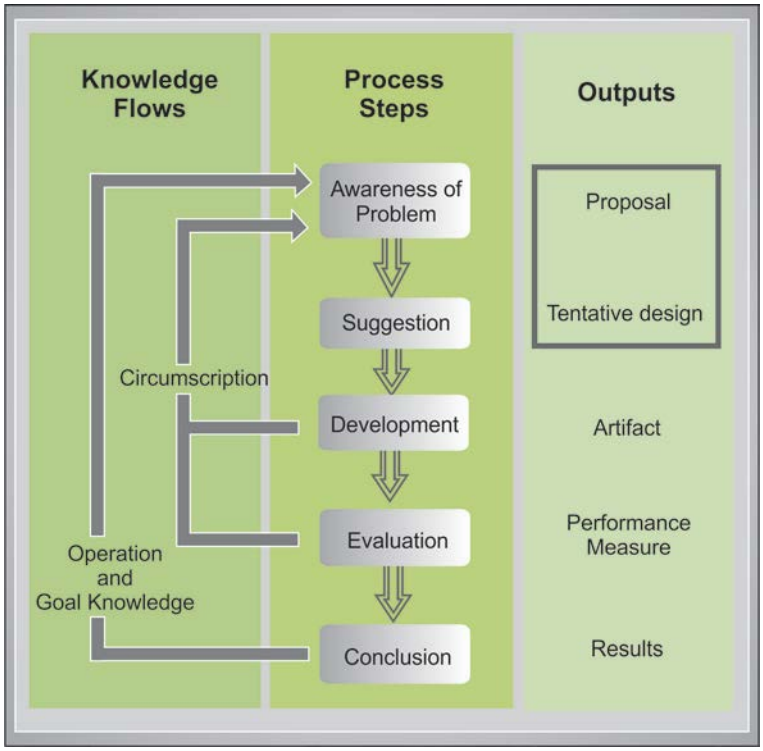

Figure 4.4: General methodology of design research of Vaishnavi and Kuechler (Kuechler *et al.*, 2008:489; 2013)

Vaishnavi and Kuechler (2013) explains the cognitive processes involved in the DSR process steps (Figure 4.5):

- During the suggestion phase, solutions to identified problems are abducted from existing knowledge and/or theory of the problem domain.
- During the development and evaluation phases existing knowledge and suggestions are used in a circumscription process attempt to solve a problem. Deduction refers to the "understanding that could be gained from the specific act of construction" and evaluation of artefacts (Vaishnavi *et al.*, 2013).
- In a conclusive phase, reflection and abstraction are used to make a knowledge contribution of new or updated design- and operational principles and theories.

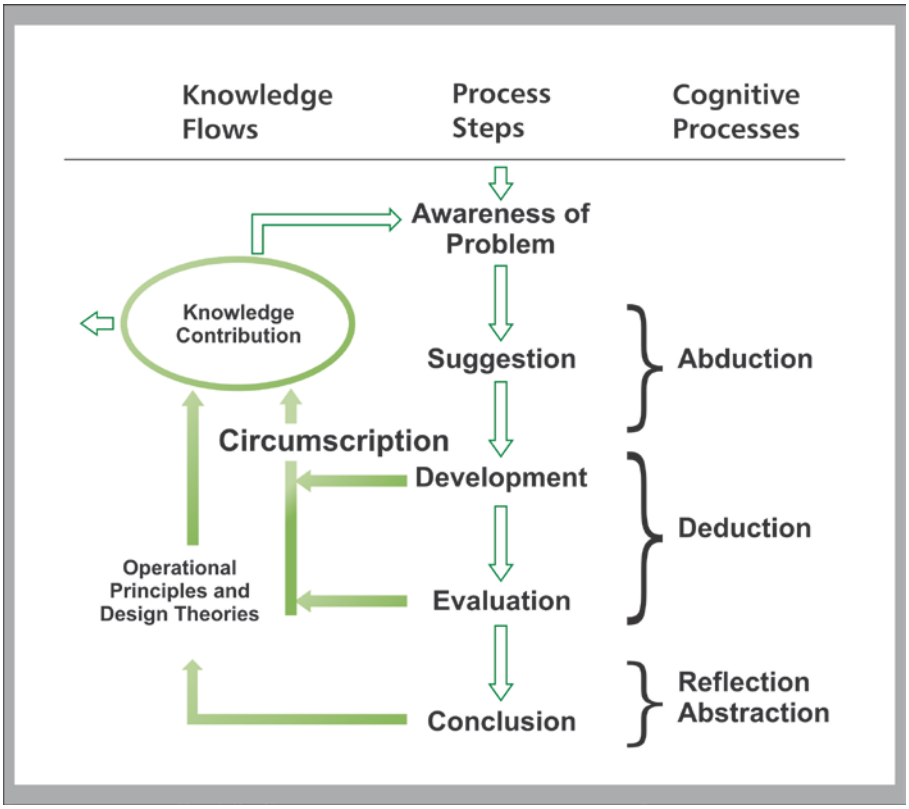

Figure 4.5: Cognition in the Design Science Research Cycle (Vaishnavi *et al.*, 2013)

4.6 DATA COLLECTION

Data collection is an integral part of any research effort. Just as important as it is to decide on a research design and strategy, is the choice of specific data-collection methods in conducting the research (Maxwell, 2005:79). For data collection to be successful the goal of the data-collection operation needs to be established. Once the purpose of the data gathering is known and understood, it will be an indication of the format of the data-gathering operation and how the data should be analysed. In design research, often classified as a problem-solving strategy, the first task is to set clear goals of what aspects of artefacts are investigated. Either the technical characteristics of an artefact are researched or the usefulness and impact of an artefact is the topic of the research. Depending on the goal, artefact and the research questions under investigation, appropriate data-collecting strategies and methods are selected and used.

Maxwell (2005:23) distinguishes between quantitative and qualitative research and lists “intellectual” and “practical” goals for qualitative research. Intellectually the researcher should understand the total meaning, context and process of the study, identify unforeseeable events and use these events to generate new ideas and explain conclusions. Practically, researchers can share results, experiences, collaborate and help to improve existing practices.

Quantitative data is data in the form of numbers or data that can be translated into numbers and is numerically or statistically evaluated. According to Rule and John (2011:60), the purpose of quantitative research is to seek statements of objective fact, prediction, law-like findings and generalisation in a

controlled environment such as a laboratory. Quantitative research is more established and often used in the natural sciences. Findings, theories and outcomes are often named laws. Quantitative research is used to study general trends across a population and uses numerical methods to ascertain magnitude, amount or size (Myers, 2009:260; Rogers *et al.*, 2011:271). Survey-based research and experiments lend themselves to quantitative data collection and statistical analysis where the focus is on what can be counted and measured (Oates, 2006:105, 131).

According to Maxwell (2005:22), *qualitative data* is data conveyed through words and text. The focus of qualitative data is not numerical but relates to text and meaning (Rogers *et al.*, 2011:270). Data collection is focused on people in situations and is inductive, interactive and flexible. Qualitative research is used to study social and cultural phenomena in depth (Myers, 2009:260). Goals, research questions, the conceptual framework of the researcher, research methods used and validity of the research are components of a qualitative study that researchers attend to interactively throughout the research. Terreblance *et al.* (2006:586) state that the focus of qualitative research is to study people in their natural environments and to report on feelings, social situations and experiences in real-world settings through the analysis of people's words, actions and motivations.

It is possible in design research to exploit both quantitative and qualitative data depending on the goal and purpose of the research. The research methods used in a study are dependent on: what the study entails, the specific context of the study and also other components of the research design (Maxwell, 2005:79). According to Hevner and Chatterjee (2010:320), experiments, simulation and testing can be performed to study structural and performance artefact issues such as usability. Quantitative surveys, qualitative interviews, observational case studies or field studies are possible strategies to apply when socio-technical aspects such as usefulness are investigated. Often, it is required to employ more than one strategy as the research progresses. The reason for this may be a direct consequence of using the circumscriptive design research model or to prove the rigour of the research.

Maxwell (2005:80) distinguishes between structured and unstructured data-collection approaches and states that structured approaches focus on comparability between people, settings, time and researchers and unstructured approaches focus on the phenomenon being studied. Generalisation and comparability in structured approaches are replaced by validity and understanding in unstructured approaches. In my research, the focus was first to understand the context of the data-collection environment and second to identify human factors. According to Maxwell's description, my research would be categorised as having used an unstructured approach.

According to Zikmund *et al.* (2013:63), it might be necessary to conduct a pilot study before embarking on a larger study or data-collection campaign. These authors describe a pilot study as a pretest or a small-scale research project where data is collected from participants similar to those the researcher aims to use in the full study. The results of this pretest are preliminary results and serve only to assist in the design of the intended study or data collection campaigne. Zikmund *et al.* (2013:63) state that *pilot studies are critical in refining survey questions and reducing the risk that the full study will be fatally flawed.*

A distinction is made between primary data sources and secondary data sources, especially in the social sciences. Hofstee (2006:51) distinguishes between primary and secondary data sources. Primary data is new

data that has not been analysed or interpreted before, for example, original data collected from participants during interviews. Secondary data is data retrieved from existing sources - data that has been analysed and interpreted before (Section 4.6). Primary data collection serves the purpose of *added value and credibility* to the research (Hofstee, 2006:29; Myers, 2009:122).

The data-collection methods applicable to my research – interviews, focus groups, questionnaires and appreciative inquiry – are discussed in sections 4.6.1 to 4.6.4. Participant selection is discussed in Section 4.6.5.

4.6.1 Interviews

Interviews are suitable data-collection methods for:

- gathering detailed information;
- flexible and complex situations when questions have to be adapted to suit different people;
- exploring feelings, beliefs, emotions and experiences of people; and
- investigating sensitive social issues (Oates, 2006).

Interviews are subjective and classified into four main types: open-ended or unstructured, semi-structured, structured, and group interviews.

Unstructured interviews tend to generate a lot of rich exploratory data when participants are allowed to talk without much intervention from the researcher (Rogers *et al.*, 2011:585).

In *semi-structured interviews* the researcher prepares open-ended and closed-ended theme questions but allows participants to share information, feelings, experiences and emotions in conversation. Exploratory data is gathered (Oates, 2006; Rogers *et al.*, 2011:585).

Structured interviews consist of pre-determined, fixed, identical questions for every participant, usually with pre-coded answers. The goals of the interview session should be clear and well understood by participants (Oates, 2006:187; Rogers *et al.*, 2011:299).

Meyers and Newman (2007:2) describe the qualitative interview in IS as an art and in their model (Figure 4.6) provide the following guidelines to direct a qualitative interview:

- Researcher situation – for validity reasons, the researcher should set his/her role and position before the interview.
- Minimise social dissonance – the researcher should be aware of social and cultural barriers, which may include, for example, corporate position of participants or dress code.
- Ensure good representation – people differ and, therefore, it is wise to interview a variety of people.
- Everyone interprets – participants also interpret their world and therefore there is more than one interpretation of the same interview.
- Mirroring – focus on the participant's world and gather more information than words only through use of communication skills such as listening, building on participants' stories, creative but sensitive prompting, encouraging and directing of conversation.

- Flexibility – semi-structured and unstructured interviews require the researcher to explore, listen carefully, improvise and be open to acknowledge differences in participants such as shyness or fatigue.
- Confidentiality – get permission from participants, treat everybody with respect, keep all information in a safe and secure place, check facts with participants again if necessary and keep commitments to participants and organisations (Myers *et al.*, 2007:16).

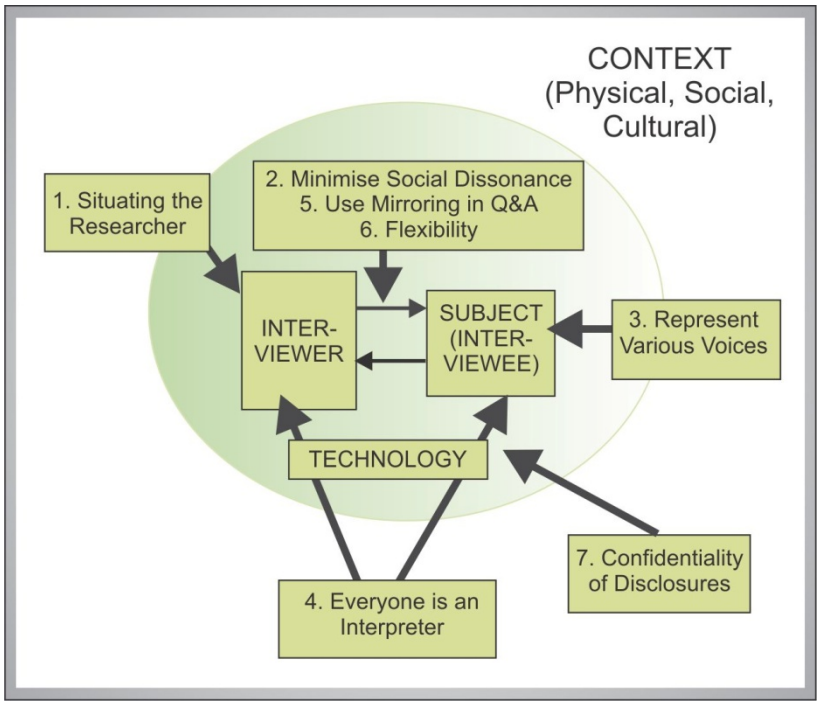

Figure 4.6: Guidelines for the qualitative research interview (Myers *et al.*, 2007:16)

Potential problems with interviews may include:

- time constraints;
- strangers in conversation;
- lack of trust;
- difficulties in understanding each other's language or context of reference; and
- the Hawthorne effect – the presence of the interviewer having an effect on participant behaviour (Myers, 2009:127; Oates, 2006:204)

Twice in the course of my research, semi-structured interviews were used as a data-collection method. First, in an exploratory study conducted at one organisation, the organisational context where EA was implemented as a new strategy was determined and human factors impacting on EA acceptance were identified. Later in my research, semi-structured interviews were used to verify the WoLAF for EA framework.

4.6.2 Focus Groups

Group interviews or *focus groups* normally involve three to ten participants. According to Rogers *et al*. (2011:302), the group represents a sample of a target population. This method is used to get a collective view within a social context through interactive thought and discussion of a topic introduced by the researcher (Myers, 2009:125). A question raised or a comment made by the researcher joining a group of people triggers a conversation or brainstorming exercise regarding a specific topic. More than one viewpoint is raised, which may result in a discussion and it possible for the researcher to gather more data and gain more insight. According to Hevner and Chatterjee (2010:123), the reasons focus groups are appropriate for design research include: flexibility for handling design topics and domains; direct interaction with participants and conversation about design issues; large amounts of rich data not only pertaining to the design itself but also to the situational use of an artefact in context; and building on other participants' comments.

In a study by Gal and Berente (2008:133) a social-mind-frame-representation approach as opposed to a technological-mind-frame approach is proposed for researching social and cognitive processes during the implementation of IS. Whereas technological mind-frames conceptualise meanings of organisational members about the technology they use, social representations describe the way people familiarise themselves with unknown phenomena or objects. Unknown objects become social objects when they are described (anchored) and used (objectified) by groups. Moscovici (2001) defines social representations as *a system of values, ideas and practises* where people first orientate themselves in a material and social world and second use communication as a means of information exchange about their individual world and information exchange about the group they represent. Gal and Berente (2008:136) explain that when new phenomena, events or directions are introduced to groups there may be a lack of understanding and groups of people need to create a social reality through representations and make connections by *means of familiar conceptual devices* to familiarise themselves with these objects and use them in language and actions.

Gal and Berente (2008:142) suggest using focus groups and group interviews as research methods to find reasons, for example, for low adoption of a new data-interchange system. These authors propose categorising and investigating vocabulary, imagery and knowledge of groups of people and also group dynamics such as interactions, practices, concerns and traditions. The theory of social representations is implicated for research conducted in times of social change and its effect on human behaviour, understanding, and communication. The theory is also suitable for researching natural groups in longitudinal studies. Gal and Berente (2008:142), however, show that the theory can be used in research concerned with information and communication in organisations. Social representations are ways in which people constitute their 'worlds' or environment.

A focus group interview was used by the researcher to understand the context in which EA was introduced. Participants in the focus group elaborated on procedures, actions and human factors that led to acceptance of EA in one sub-organisation.

4.6.3 Questionnaires

According to Rogers *et al*. (2011:238), questionnaires are a well-established technique for collecting demographic data and users' opinions. Questions in questionnaires should be unambiguous and set out to collect facts or information from human respondents as honestly as possible. Short, easy-to-answer questionnaires have a better chance of being answered. Questionnaires have closed and open questions and two of the advantages of using questionnaires are: reaching large numbers of respondents simultaneously and being more economic than interviews and observation. Disadvantages for researchers are not being in total control of the data-exchange process and not being able to probe particular responses (Rule *et al*., 2011:66).

With a questionnaire the inter-personal experience of face-to-face interaction and collection of data regarding feelings and emotions are not as easy to capture as with interviews. Myers (2009:156) states that questionnaires may be used to elicit information and opinions.

Open-ended questions allow respondents to express their views using their own sentences and descriptions. Closed questions can be posed in many different formats to measure human characteristics. Questions should be relevant, brief, specific and objective (Oates, 2006:222). Zikmund *et al.* (2013:289) define measurement as the *process of describing some property of a phenomenon of interest, usually by assigning numbers in a reliable and valid way*. The numbers then convey information about the property being measured.

Olivier (2004:82) and Oates (2006:247) list types of measurements used in questionnaires:

- Nominal or categorical measures – a value is assigned to an object for identification or classification purposes only. Respondents select answers from a list of alternatives. No quantities are measured and therefore this scale is a qualitative scale.
- Ordinal measures – respondents use numbers to arrange alternatives in order of preference or applicability (for example, objects are ranked on the basis of preference).
- Ratio measures – a unit of measurement is provided and used by respondents and a meaningful absolute zero is included.
- Interval measures – same as ratio but no zero point is included and they capture information about differences in quantities of a concept from one observation to the next. For example, in temperature differences of 30^{o}F and 60^{o}F the only meaning attached is that the first one is colder than the second and not that is was twice as cold – which is not true.

According to Zikmund *et al.* (2013:298), discrete measures are those that take on only one of a finite number of values. Nominal and ordinal scales are discrete measures.

The measuring of attitudes is described by Zikmund *et al.* (2013:313) as important in situations where managers believe that strategies for changing the attitudes of employees towards their organisation, organisational goals or organisational products need to be implemented. Zikmund *et al.* (2013:313) list techniques for measurement of attitudes: ranking, rating, sorting and choice. Examples of simple rating scales of choice are "yes/no" or "agree/disagree". The category scale where more choices than only two are provided, leads to more information being collected from respondents. It is important to choose the correct words for the points of the measurement scale. For example, if you plan to measure importance or truth use

the correct words to describe the scaling points: “not at all important”, “not so important”, “neutral”, “fairly important”, “very important” or “not at all true”, “not very true”, “somewhat true”, “very true” or “definitely no”, “probably no”, “probably yes”, “definitely yes”.

The Likert scale is a well-known measure of attitudes where respondents indicate how strongly they agree or disagree with carefully constructed statements (Oates, 2006:223; Olivier, 2004:83; Zikmund *et al.*, 2013:316). The Likert scale attitude-measurement technique, where respondents choose between two or more alternatives, was used in my research for most of the questions in the questionnaire.

4.6.4 Appreciative Inquiry

According to Olivier (2004:114), many IT and IS research projects focus on problem solving in a working environment. The purpose of an appreciative inquiry is to start a research project by initially determining the positive and well-working existing procedures in an organisation. In a follow-up discovery phase the researcher focuses on establishing what ‘dreams’ or wishes for improvement exist. Participants are given the opportunity to express their vision and strategy for improvement or reaching their objectives or ‘dreams’.

In an initial exploratory study the aim of appreciative inquiry was to determine the context of the socio-technical environment and to identify human factors impacting on EA acceptance. Participants explained the well-working procedures in one sub-organisation where EA had been adopted as a new strategy. Participants also shared their vision of what human and work-role-related factors were needed to extend and improve the acceptance of EA as an enterprise-wide strategy.

Often when researchers decide to use interviews as a data-collection method, there is a need for the researchers to familiarise themselves with the data-collection environment. Zikmund *et al*. (2013:112) describe situation analysis of researchers and managers as the gathering of background information in exploratory research. It is proposed that the documented information lends itself to an appreciation of the problem-definition space and process.

4.6.5 Participant Selection

Purposive sampling is a technique used by researchers where participants are *deliberately chosen because of their suitability in advancing the purpose of the research* (Rule *et al.*, 2011:64).

Snowball sampling and chain referral sampling are methods used in qualitative research where one or more participants refer(s) the researcher to other suitable participants who possess knowledge of or interest in the research (Biernacki *et al.*, 1981:141; Penrod *et al.*, 2003:100; Zikmund *et al.*, 2013). Snowball sampling and chain referral sampling are similar techniques but snowball sampling usually involves only one social group whereas chain referral sampling could involve multiple social networks (Penrod *et al.*, 2003:102). These techniques are, for example, used to find and involve participants from small populations or participants that are difficult to locate. Goodman (2011:348) explains that snowball sampling was originally defined as a sampling method used in not hard-to-reach populations and later introduced as a sampling method most suitable for reaching participants in difficult, hard-to-reach or hidden populations. Heckathorn (2011:357)

describes the emergence of respondent-driven sampling (a series of methods to prove that chain-referral sampling is not a method of convenience) to confirm the trustworthiness of chain-referral sampling. Biernacki and Waldorf (1981:143) discuss the example of locating a drug user sample and Zikmund *et al*. (2013:395) state that extremely large samples would be needed to locate for example 100 participants when one is researching a rare phenomenon and that it would be easier to locate a few participants and then get referrals from them. One of the disadvantages of this method is that referred participants may be similar to the first person or so different from that person that the results are distorted. When sensitive issues, where ethics may be problematic, are researched, snowball-, chain referral- or respondent-driven sampling are useful and reliable methods to locate suitable participants (Penrod *et al.*, 2003:101).

A few participants in the exploratory study of the research were purposively selected at the beginning of the research and interviewed. Other participants were suggested by the selected participants and randomly approached by the researcher according to their availability and willingness to participate in the study. The method of snowball sampling in not hard-to-reach populations was a suitable choice in my research and in line with what Goodman (2011:348) explains when he states that in contrast to populations in ordinary samples existing of individuals, here one has to consider two populations: one of individuals and one of the relations among individuals. When a pilot questionnaire had to be distributed to test for ambiguity and clarity in questions compiled for a questionnaire, purposive sampling was again used. The revised questionnaire was sent to five people in different environments with a request to distribute the questionnaire.

4.7 DATA ANALYSIS

Sometimes during, but mostly after, completion of data collection results need to be analysed and interpreted in order for them to be useful and to contribute to any research conclusion. There are many ways to analyse and interpret data. Data analysis is dependent on data-collection techniques.

Zikmund *et al*. (2013:459) explain the stages of data analysis of raw data as editing, coding and creating an electronic data file. Editing refers to the checking of data with the purpose of adjusting data for correctness, consistency and legibility. Coding is used to represent the meaning of data. Codes can be used to simplify the analysis process. Symbols are assigned to raw data, especially when computer data files are used in analysis or for classifying and interpreting data. Depending on the goal and the way the data will be analysed, data analysis in research is known to be qualitative or quantitative in nature.

Quantitative analysis focuses on the use of numerical methods such as mathematical or statistical procedures to ascertain magnitude, amount or size while qualitative analysis focuses on the nature of a phenomenon and is represented by patterns, themes and stories (Rogers *et al.*, 2011:271). Saunders *et al*. (2009:482) distinguish between quantitative and qualitative data analysis:

- Quantitative data is based on numbers or meaning is derived from numbers and qualitative data is based on words or meanings expressed through words.
- Quantitative data collected is standardised and in numerical format and qualitative data is not standardised and is classified into categories.

- In quantitative data analysis, diagrams and statistical outcomes are used and in qualitative data analysis conceptual methods.

According to Oates (2006:267), qualitative data analysis means that themes and patterns need to be abstracted from verbally, visually and aurally collected data. Numbers are seldom used to code qualitative data. Words and phrases usually represent the patterns and themes identified in qualitative data (Zikmund *et al.*, 2013:465). Lazar *et al*. (2010:282) describe three stages of qualitative analysis of a data set. In the first stage data is analysed with the prospective aim of finding information about the major research idea and its components. In a second stage, the nature, properties and dimensions of each component are analysed. The third stage occurs when the information gained is used to better understand the research, make inferences or derivations about the research substances

The data analysis methods for interviews and questionnaires applicable to my research are discussed in sections 4.7.1 and 4.7.2.

4.7.1 Interview Data Analysis

Interview data analysis is the process of using raw interview data and transforming it into evidence-based interpretations that form the foundation for published material (Rubin *et al.*, 2005:201). Raw data in the form of researcher notes and audio- or video recordings are transcribed into a usable text format.

Examples of quantitative interview data are age, organisational job description, responses to closed questions. Before being numerically or statistically analysed, quantitative data usually needs to be ordered into data sets or spread sheet format. Two simple quantitative analyses techniques used are averages and percentages. Three different types of averages used are mean, median and mode. Mean describes the general used average where all the different numbers are added and divided by the total numbers at stake. Median represents the middle value of all the numbers when ranked and mode refers to the number occurring the most (Rogers *et al.*, 2011:273).

Data fields, records and files can be defined and used to store qualitative data. Zikmund *et al*. (2013:465) describe the purpose of coding qualitative responses as classifying comments and explain two basic rules: a coding category should exist for all possible responses and the coding categories should be mutually exclusive.

Oates (2006:268) provides information on how to analyse qualitative data. Qualitative data are usually searched for categories or patterns of response. Examples of qualitative interview data are responses to open questions and participants' responses to them (Rogers *et al.*, 2011:272). According to Rubin and Rubin (2005:201), actions performed on qualitative data collected by researchers are classifying, comparing, weighing and combining material from participants. The purpose of the actions is to extract meaning and patterns that may lead to "description of events into a coherent narrative". In unstructured responses, word counts can also be used to extract a code or category of interest to the research (Zikmund *et al.*, 2013:465).

Oates (2006:267) distinguishes between the analyses of textual- and non-textual qualitative data. Using a deductive approach, existing theories or own developed theories can be used to categorise data. An inductive

approach is used when the researcher observes and identifies segments or categories from collected data. Refinement into sub-categories or connections of themes is possible.

4.7.2 Data Analysis – Questionnaires

Results or raw data from questionnaires can be in the format of text or database entries. Data need to be analysed and cleaned up; for example, one ignores answers to clearly misunderstood questions. It is possible to create categories of responses and analyse subsets of the data for more specific results (Rogers *et al.*, 2011:273).

Data analysis of quantitative or numerical data can be performed by applying a wide range of statistical techniques and methods. Some simple methods include tables, charts and graphs to see patterns or detect trends in data. The researcher's interpretation of the data, however, plays a central role in the way the data analysis is performed and in the graphical methods chosen to present the data for better and easier understanding. More advanced descriptive and complex statistical techniques are used to analyse; for example, instrumental readings or data to prove the truth of certain occurrences or patterns (Oates, 2006:246). Oates (2006:254) states that statistical techniques "offer more universal means and criteria for evaluating key points and making generalized conclusions based on evidence" and provides examples of statistical measures: mean, median, mode, range, fractiles, standard deviation, correlation coefficients, chi-square test, null-hypothesis and tests of significance and T-tests.

4.7.3 Literature Analysis

In a literature review the relevance of the research is explored and confirmed. Throughout the research, literature is reviewed and information is gathered to support ideas or claims (Oates, 2006:71). Different materials may be used and sources include books, articles, newspaper reports, journals, conference proceedings, radio- and television broadcasts, reports, multimedia sources and the Internet. According to Oates (2006:73), the literature review provides the foundation for one's research. Hofstee (2006:91) states that a literature review confirms the credentials of the researcher, the theory base of the research, and the context and significance of the research. Hevner and Chatterjee (2010:18) explain that in DSR, it is necessary to not only ground the research by use of scientific foundations such as theories, methods and frameworks but also to explore existing design products, processes, others' experiences and expertise.

Gregor and Hevner (2013:343) distinguish between *descriptive knowledge* (natural phenomena and the laws and regularities governing these phenomena) and *prescriptive knowledge* (knowledge of human-created artefacts) and argue that DSR needs to comprise both types of knowledge. Through an extensive literature review, books, journals, conference proceedings, dissertations, theses, reports and electronic sources were used to investigate information that had bearing on my research. Descriptive knowledge from theories and models were, for example, used to provide the basis for and relationships between existing knowledge and my research (Section 3.2 and Section 3.7). The Zachman Framework for Enterprise Architecture (Figure 2.2), used as a reference framework for the purpose of the research reported on in this thesis is an example of prescriptive knowledge used.

An extensive literature study was conducted for the purpose of the research. Studies from the literature were analysed and useful data extracted.

In all of the abovementioned methods of data analysis for qualitative data, it is possible to transcribe and categorise data. Methods of interest used for literature analysis are analytic induction, coding/tagging, mapping, content analysis and content- and thematic analysis.

Analytic induction allows the researcher to define a phenomenon and propose an explanation. A case is usually examined to find out if the explanation fits. An example of analytic induction data analysis is given in a study performed by Markus (1983:430).

Coding/tagging is a method used with interview-, questionnaire- and text-based data in general. Codes or tags are labels used to group data according to themes or patterns. The research objectives motivate the formulation of themes or patterns (Rogers *et al.*, 2011:286). Rule and John (2011:77) state:

> *Good qualitative research would allow some codes to be brought to the data (deductive analysis) but ensure that ample room is created for the data to 'speak' and 'name' additional codes (inductive analysis).*

Mapping as a data analysis method is a means of describing superordinate categories and grouping related items into described categories to show their position.

The purpose of *content analysis* is to discover meaning from textual documents or other sources such as video or film (Hofstee, 2006:124).

Content- and thematic analysis happens after coding and involves identification of themes or patterns, grouping data into logical categories and naming of categories. Working from codes to themes is a common method used in exploratory-study data collection and according to Rule and John (2011:78) the discussion of the themes and the relationships between them is central to the understanding and the interpretation of the case.

4.7.4 Validity and Verification

Hevner and Chatterjee (2010:17) graphically explain a design research relevance and rigor cycle spanning the environment of IS research. IS research normally addresses organisational business needs and contributes to solutions of business problems, which makes the research relevant. The research draws from the IS knowledge base and again make contributions to the IS knowledge base, which proves the rigor of the design research (Figure 4.7). The three cycles have to be present and identifiable in DSR (Hevner *et al.*, 2010:17).

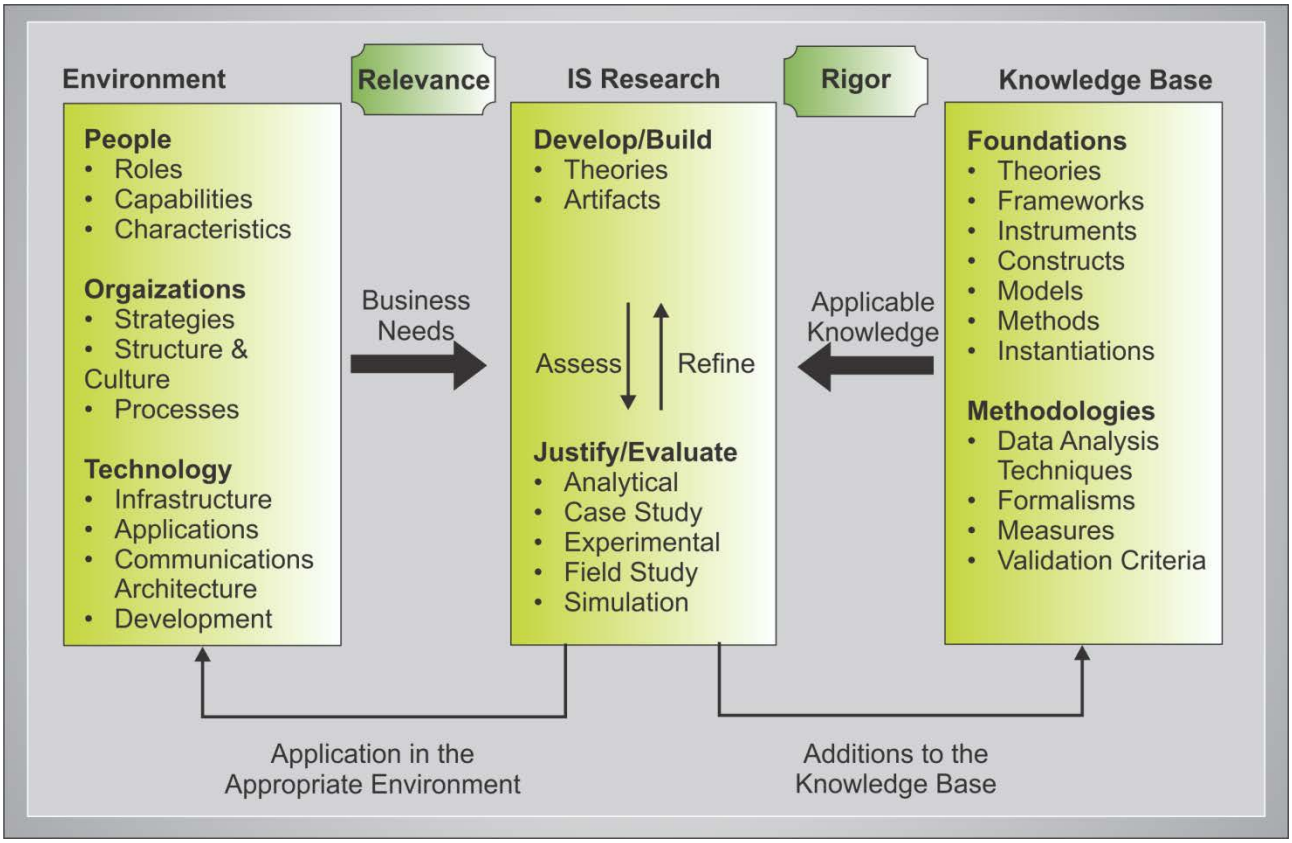

Figure 4.7: Information systems research framework (Hevner *et al.*, 2010:17)

Validity is a measure of whether research findings present a true and trusted view of research events. Unlike objective numerical and statistical measurements used for validity checks and verification of quantitative data, qualitative data validation and verification rely on subjective interpretation. According to Zikmund (2013:155), exploratory research and accompanying qualitative data collection should be followed by a confirmatory study to avoid decision making by people in organisations as a result of researchers' poor interpretations. A confirmatory study tests and then confirms or rejects the research idea. When the research, however, aims to develop an idea or a theory, qualitative research is preferable.

Zikmund *et al*. (2013:154) state that replication of results where the *same interpretation will be drawn if the study is repeated by different researchers with different respondents following the same methods* can be used as a validation method for qualitative research. In organisational DSR, the use of different contexts – in terms of business, culture, socio-technical environment and human work-role distribution and responsibility, and replication of results as mentioned above – is not a consistent way *of verification of research* results.

Threats to validity are listed by Saunders *et al*. (2009:157):

- History or time of data collection: Occurrence of organisational incidents might have a negative impact and affect the data collected from participants.
- Testing: When participants believe that responses or results might have a negative influence on their organisational position.

- Instrumentation: Acts and ways of participation can be influenced by knowledge of the research being in process.
- Mortality: Participants dropping out of studies may influence data and results.
- Maturation: Research over time may be influenced by organisational changes.
- Ambiguity about causal direction: Cause and effect are not always distinguishable in qualitative data collection.

According to Saunders *et al*. (2009:159), it is in the data-interpretation phase of the research where it is most likely for a researcher to *make logical leaps and false assumptions.* A hybrid approach entails using existing and established theoretical constructs to assist in sense making (Saunders *et al.*, 2009:159). The theoretical framework of DSR, theories and methods of organisations, EA, IS, and technology acceptance are referenced in my research.

Presentation of an artefact and *verification* of the usefulness of an artefact can be executed in many ways. Trauth (1997:238) suggests using more than one perspective and data source and discusses an iterative way of obtaining feedback data from participants during collection and interpretive practices. Garcia and Quek (1997:456) argue that interaction between researcher and participants results in subjective reporting and therefore interpretation and verification of the results cannot be value free. In conjunction with the views of Trauth and Garcia and Quek, Rule and John (2011:107) list practical steps to assist researchers in ensuring that case study data collection is trustworthy:

- crafting thick description;
- verifying accounts with respondents;
- creating an audit trail; and
- using critical peer checks.

Descriptive evaluation is a valid evaluation method in DRS (Hevner *et al.*, 2004:86). Hevner *et al*. (2004:86) list two methods:

- Informed argument: Use information from the knowledge base (e.g. relevant research) to build a convincing argument for the artefact's utility.
- Scenarios: Construct detailed scenarios around the artefact to demonstrate its utility.

4.7.5 Triangulation and Crystallisation

Triangulation is a process of investigation in research whereby more than one data collection source or different data collection techniques are used to ensure that rigour, reliability, validity and good quality is achieved during data-collection procedures (Rogers *et al.*, 2011:225; Rule *et al.*, 2011:108). The practice of using multiple data-collection methods is explained by Oates (2006:37), who lists methods of data, strategy, time, space, investigator and theory as possible triangulation data-collection- and analysis methods. Rogers *et al*. (2011:225) describes four types of triangulation:

- Triangulation of data means data is collected from multiple sources at different times, places or from different people.

- Investigator triangulation refers to more than one researcher working together to collect data.
- Triangulation of theories occurs when findings are viewed based on different theoretical frameworks.
- Methodological triangulation happens when more than one data gathering technique is used.

While triangulation is used in quantitative and qualitative research to increase the trustworthiness of a study, *crystallisation* is a method more applicable to qualitative research. According to Henning *et al*. (2004:17) and Rule (2011:109), crystallisation ensures that more facets of the nature of reality are enclosed in the research through the use of additional sources and methods. Crystallisation, therefore, provides a wider picture rather than a more in-depth picture, as is the case with triangulation. Four commonly used analysis styles qualitative researchers follow are crystallisation, editing, template and quasi-statistical (Miller *et al.*, 1994:345). These styles are based on steps of developing an organising system, segmenting the data and making connections (Miller *et al.*, 1994:345). In crystallisation researchers are immersed over time in the research they perform and text they produce.

Qualitative researchers are advised to consider multiple and conflicting voices, and differing and interacting interpretations to facilitate triangulation and crystallisation (Hodder, 1994:400; Janesick, 1994:214)

4.8 DETAILED RESEARCH PLAN

The research plan used for this study is discussed in more detail in this section.

EA is a strategic and continuous description of how the business, information and technology of an enterprise is integrated, engineered and managed with the purpose of, first, understanding the complexity of this process and, second, to assist enterprises in change management. Enterprises span all entities of which organisations, systems, resources, people, and technologies are examples. Enterprises are also operational instances that use business plans, designs, processes, methods, theories and models. Successful enterprises depend on implementation of business goals supported by information management through the use of technology. Enterprises are human-driven entities. For enterprises to maintain a competitive advantage and sustain their business initiative but, even more important, improve their business, it is necessary for humans to understand the integration process of its business, IM and IT. EA is a strategy that can be used to assist enterprises in this endeavour.

The purpose of the study was to investigate the human factors impacting on EA acceptance in enterprises. The research was initiated by a research question:

> *What are the human factors that affect the acceptance of enterprise architecture (EA) and how can these factors be used in an organisation to manage enterprise architecture acceptance?*

A main objective divided into two main research objectives and three sub-objectives guided the research.

The main objective was:

> *To develop a framework of human factors (WoLAF for EA) to assist organisations in managing EA acceptance.*

The main research objectives are:

> *RO1: To design a model that will assist organisations in management of EA acceptance.*
>
> *SO1.1: To determine the human factors affecting EA acceptance.*
>
> *SO1.2: To determine the work levels applicable to EA.*
>
> *SO1.3: To categorise the human factors per work level into human concerns.*
>
> *RO2: To propose a method to use the model to assist organisations for management of EA acceptance.*

The purpose of the study was to identify, record, and classify human factors hindering EA acceptance in enterprises into a framework to be used in organisations to promote EA acceptance. The research paradigm of DSR adopted and the research strategy followed in the research are discussed in Section 4.8.1 followed by a description of how the data collection for the research was performed. Section 4.8.3 describes how data analysis was done. Section 4.8.4 provides a description of the verification of WoLAF for EA. The chapter concludes with a discussion of the ethical considerations of the research.

Table 4.5 lists the thesis sections where the research objectives have been reached.

Table 4.5: Research objectives reached as described in thesis

RESEARCH OBJECTIVE	SECTION ADDRESSED IN THESIS
RO1: To design a model that will assist organisations in management of EA acceptance.	Section 5.7
SO1.1: To determine the human factors affecting EA acceptance.	Section 5.2
SO1.2: To determine the work levels applicable to EA.	Section 5.4
SO1.3: To categorise the human factors per work level into human concerns.	Section 5.3.1.8
RO2: To propose a method to use the model to assist organisations for management of EA acceptance.	Section 6.2

4.8.1 Research Paradigm and Research Strategy

In developing a framework consisting of the human factors identified and an approach to manage EA acceptance, a DSR paradigm based on the philosophical assumptions highlighted in Table 4.2 was selected.

The strategy used for the research was design research with cycles of awareness, suggestion, development, evaluation and conclusion as described in Figure 4.4. The development cycle that was used comprised of one main design research (DR) cycle and four design research sub-cycles, developed to compose the framework. In Figure 4.8 the methodology followed is graphically depicted by a description of the main DR cycle and four sub-cycles.

4.8.1.1 Main Design Research Cycle

The first DR cycle is a main research cycle that describes the entire research process of the methodology followed.

Awareness	Awareness of the problem was established after the literature on EA acceptance in organisations had been reviewed and after several meetings were attended where speakers mentioned the problem of EA acceptance in organisations. A need for the development of a work-level acceptance framework for EA (WoLAF for EA) was established.
Suggestion	In a suggestion phase, the thesis statement was defined as 'it is possible to identify human factors impacting on EA acceptance and compose a framework of human factors to assist in promoting and managing of EA acceptance'.
Development	The main DR cycle comprised two development phases. In the first development phase main research objective 1 (RO1) was addressed as 'to design a model that will assist organisations in management of EA acceptance'. The second development phase comprised the development of a method addressing main research objective 2 (RO2) is 'to propose a method that assists organisations in management of EA acceptance'. The two development phases will be explained in more detail in sections 4.8.1.2 and 4.8.1.3.
Evaluation	In the main DR cycle's evaluation phase WoLAF for EA was presented and evaluated against principles for frameworks by interviewing several participants in the field of EA to establish WoLAF for EA's usefulness and appropriateness in the management of EA acceptance in enterprises. Results were analysed and WoLAF for EA was updated.
Conclusion	In a final DR phase and conclusion, WoLAF for EA was confirmed. All research outcomes were reported, possible implementations of WoLAF for EA were proposed and prospective future research suggested.

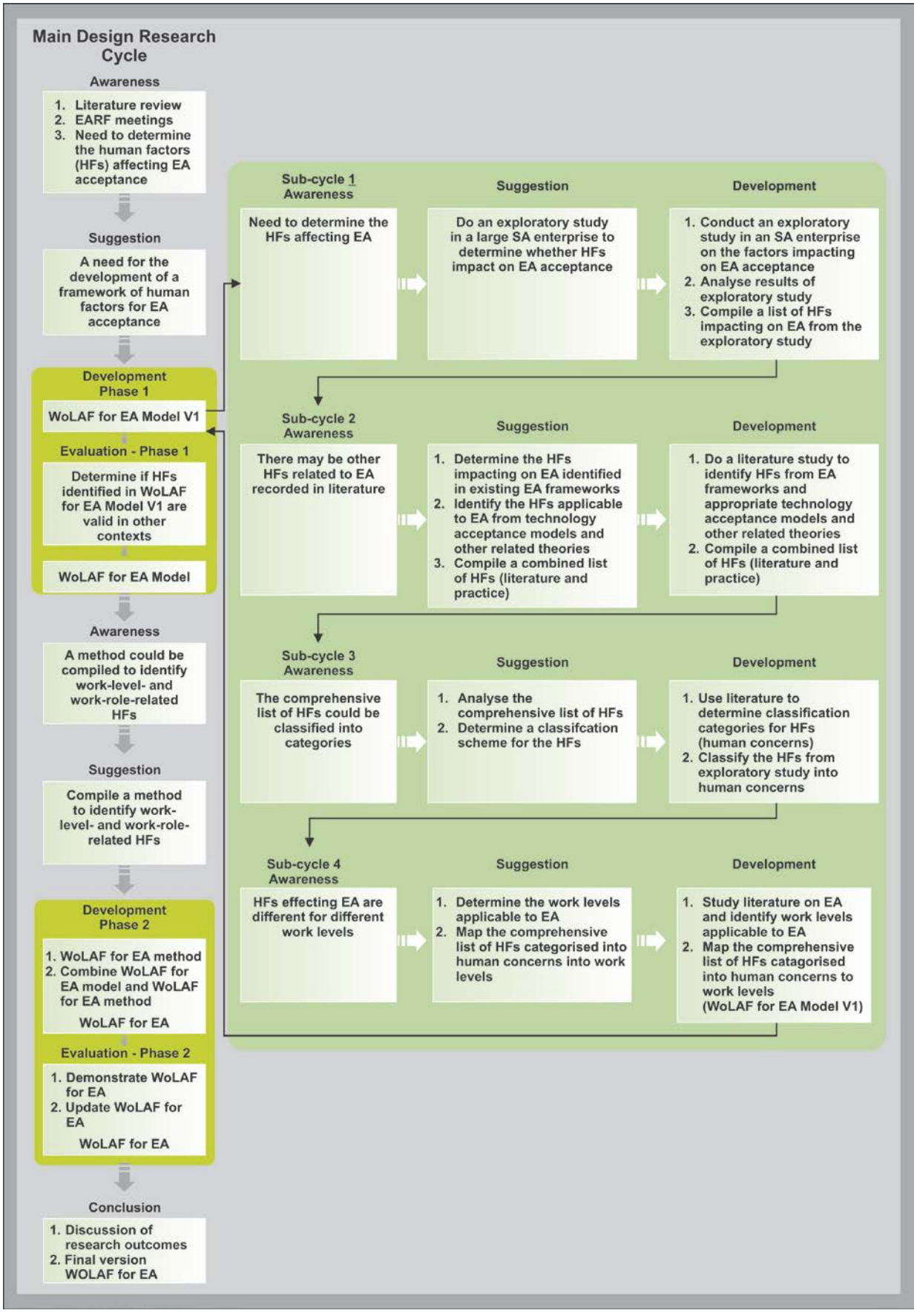

Figure 4.8: DR methodology cycles of the research

4.8.1.2 Development: WoLAF for EA Model

Four design research sub-cycles had to be completed in the development of the WoLAF for EA Model.

During completion of the four design research sub-cycles embedded into the main design research Development Phase 1, a preliminary version of the WoLAF for EA Model was compiled. In realisation of main research objective 1 (RO1 – To design a model that will assist organisations in management of EA acceptance), WoLAF for EA Model Version 1 (V1) comprised a comprehensive list of human factors categorised into six human concerns identified from the literature and mapped into work levels. After WoLAF for EA Model V1 had been evaluated in more contexts, the final WoLAF for EA Model was designed and established.

4.8.1.2.1 Sub-cycle 1 of Main Design Research Development Phase 1 (RO1):

In the awareness phase the question was how to determine human factors affecting EA acceptance? The first sub-objective of the study was established (SO1.1): To determine the human factors affecting EA acceptance.

The suggestion was to perform an exploratory study to identify human factors impacting on EA acceptance. Data-collection techniques used were interviews with different stakeholders and a focus group interview. Participants represented demographically distributed organisations of the same enterprise.

In a development phase, the exploratory study was conducted, data was collected and analysed and results were initially compiled into a list of human factors.

4.8.1.2.2 Sub-cycle 2 of Main Design Research Development Phase 1 (R01):

Awareness in this sub-cycle generated the question of human factors related to EA recorded in the literature on EA and literature on technology acceptance.

The suggestion was to use the literature on EA and EA frameworks to determine human factors listed as impacting on EA, as well as the literature on applicable technology-acceptance models to identify human factors shown to have impacted on technology acceptance. The next step suggested was to compile a combined list of human factors identified through the literature and practice and in a following step map the list of human factors into work levels.

In a development phase, the literature on EA and appropriate technology-acceptance models were reviewed to identify human factors. A combined and more comprehensive list (literature and practice) of human factors was compiled.

4.8.1.2.3 Sub-cycle 3 of Main Design Research Development Phase 1 (R01):

Awareness in Sub-cycle 3 came as a realisation that the human factors in the comprehensive list are classifiable into categories of human factors.

Through analysis of the comprehensive list of human factors a further suggestion was to determine a classification scheme for the human factors. Many human factors exist and have been described in the literature and possible categories of related human factors were suggested.

In the development phase of Sub-cycle 3 the literature was used to identify and choose suitable human factor categories (named "human concerns" for the purpose of the research). The comprehensive list of human factors was categorised into six human concerns (6EAHCs).

4.8.1.2.4 Sub-cycle 4 of Main Design Research Development Phase 1 (R01):

Awareness of the difference in human factors for different work levels was established in Sub-cycle 4 and addressed to determine the work levels applicable to EA (SO1.2).

The suggestion was to use the EA literature to determine work levels applicable to EA.

In a development phase, the EA literature was consulted and work levels applicable to EA were identified. Work levels identified were classified into suitable work levels useful for my research.

The comprehensive list of human factors, categorised into EAHCs were mapped into work levels (SO1.3). The outcome of this sub-cycle was named WoLAF for EA Model V1.

4.8.1.2.5 Evaluation of WoLAF for EA Model V1

The evaluation phase of WoLAF for EA V1 comprised three steps: First, the idea was to determine whether the comprehensive list of human factors that impact on EA acceptance and categorised into work levels is valid in more than one context (the exploratory study was executed in one organisation). The second step comprised compiling work-level-related questionnaires to determine the validity of the WoLAF for EA Model V1 in more organisations. In a last step results were analysed and changes made to confirm WoLAF for EA Model.

4.8.1.3 Development: WoLAF for EA Method

In a succeeding main design research Development Phase 2, main research objective 2 (RO2) was addressed and a method was proposed to assist organisations in the management of EA acceptance.

The final version of WoLAF for EA consisting of a model and proposed method of implementation was established.

4.8.2 Data Collection

A summary of the data-collection methods used for the research, which also indicates in which DR cycle and sub-cycle the main research objectives and sub-objectives have been addressed, is presented in Table 4.6. Research objectives addressed and methods used in design research cycles are shown, as well as the data-collection methods used in the research reported on in this thesis. The data-collection method of this research can be classified as one that uses multiple methods. The use of multiple methods means that a variety of

methods was used to match a variety of purposes (Saunders *et al.*, 2009:153). Interviews were carried out in one organisation to identify human factors. A pilot study and questionnaires were used to verify the human factors identified, in more and various organisational contexts.

Table 4.6: Data-collection methods used and objectives addressed in the DR cycles of the research

DESIGN RESEARCH CYCLE	INTERVIEWS	FOCUS GROUP	QUESTIONNAIRES	LITERATURE
Main Cycle	RO1, RO2			Main research question and objectives RO1,RO2
Sub-cycle 1	SO1.1	SO1.1		SO1.1
Sub-cycle 2				SO1.1
Sub-cycle 3				SO1.3
Sub-cycle 4				SO1.2
Main Cycle	Main research question RO1, RO2 Presentation and verification of WoLAF for EA		Validation of WoLAF for EA Model in more contexts	

In an exploratory study, semi-structured interviews and a focus group interview were used for the purpose of both understanding the context of my research by gaining insight into an organisational structure and assisting in the qualitative data collection required to answer the research question (Section 5.2.1). Data was gathered from employees in a specific organisation in a single exploratory study to gain an understanding of how and why human factors impact on EA acceptance and to determine the human factors impacting on EA acceptance. The focus in SO1.1 (to determine the human factors affecting EA acceptance) was on gathering information and opinions from humans in an organisation on their experience of EA.

Realisation and output from this exploratory phase of the research was the identification and expression of the need for a framework of human factors to assist in promoting acceptance of EA in organisations in a South African context.

The literature was used to find more human factors related to the research and a comprehensive list of human factors was compiled (Section 5.2.2).

In human-related research, data often needs to be collected from participants in a study. There was a need for data to be collected to confirm that the human factors identified in one organisation were valid in more organisational contexts. A pilot questionnaire was compiled (Section 5.6.1). A small group of the population was selected for testing questionnaire procedures and questions and for possible mistakes and misunderstandings (Olivier, 2004:12; Rogers *et al.*, 2011:225). In my research the pilot questionnaire was distributed for the sole purpose of investigating whether the questionnaire was easy to access via the Internet, readable and the intended questions compiled for use in a questionnaire were clear, unambiguous and easy

for participants to respond to. The data collected in the pilot questionnaire was used to confirm that questions in a work-level questionnaire were valid and correct.

Questionnaires were distributed to participants in more organisations (Section 5.6.2). The technique of snowball sampling was used (Section 4.6.5).

Later in the research, interviews were again used to present the WoLAF for EA framework and thereby evaluate and confirm the artefact (Section 7.3).

In the research reported on in this study primary data was collected from participants three times throughout the duration of the research: first, in the exploratory study; second, in more contexts to verify human factors; and, third, to evaluate the outcome of the research.

Qualitative data-collection methods were described and principles of methods were listed to account for choice of methods in the research (Section 4.6). In my research, I used interviews and questionnaires as data-collection methods and therefore ensured *methodological triangulation.* Also, the data used for the research were collected from different people and multiple sources including the literature. In this way the *triangulation of data* was endorsed. My research effort was also extended to include additional organisations to determine if human factors identified in one organisation were valid in more contexts. In this way a wider picture was provided and *crystallisation* was ensured.

4.8.3 Data Analysis

Qualitative data was gathered in an exploratory study and in a situational analysis classified into a list of human factors according to the contributions of the different participants. Participants in one enterprise responded to questions by explaining organisational and change-management operations, work-role- and task-related interaction and perceptions of human factors that influence EA acceptance. Oates (2006:268) discusses identification of three types of themes when qualitative data is analysed: general information of no immediate value to the research; information of significance in describing the context of the research environment; and valuable information regarding the research questions and methodology of the research. Categories can originate from using existing theories (deductive analysis) or derived from data collected and composed (inductive analysis).

The aim of analysing the interviews and focus group data initially gathered in my research was in line with the description of Lazar *et al*. (2010:282) (Section 4.7.1). Information about the major research idea and its components were gathered when participants were asked to elaborate on their experience of EA being adopted as an organisational strategy. Audio recordings were transcribed and content analysis of transcriptions and researcher notes was performed.

Data was interpreted to understand the research context, detect themes of interest or find categories of human factors (Section 4.7.1). Rogers *et al.* (2011:287) explain categorisation as dividing data into ‘elements’ and then categorising each ‘element’. Using inductive analysis in the research, ‘codes’ or ‘themes’ or ‘categories’ of human action and interaction were derived and identified as dynamic concerns impacting on organisational and EA management.

In an attempt to ensure that as many as possible of the human factors influencing EA acceptance were identified and listed, the literature on human factors related to EA (Section 3.7) and technology acceptance (Section 3.6) was reviewed (SO1.1 – to determine the human factors affecting EA acceptance). Human factors identified in the exploratory study were compared to human factors described in the literature and a combined list of human factors was compiled.

Analysis of the comprehensive list of human factors required that literature on general human factors be consulted to identify a classification scheme for the comprehensive list of human factors identified through my research. Six categories of human concerns were defined (Section 5.3). The comprehensive list of human factors impacting on EA acceptance was analysed, classified and categorised into human concerns (Section 5.3.1.8).

Noticing and realising the differences in human factors according to work levels during the interviews required the literature on EA to be investigated for an applicable work-level classification scheme (SO1.2 - to determine the work levels applicable to EA). The architecture perspectives of Zachman (Section 2.5.1) were used as a guideline to compose work levels identified in the exploratory study and useful to my research (Section 5.4). Human factors identified in the exploratory study and categorised into human concerns were mapped to EA audience work levels (SO1.3 - to categorise the human factors per work level into human concerns), which resulted in Work-level acceptance framework for enterprise architecture Model Version 1 (WoLAF for EA Model V1) (Section 5.5).

4.8.4 Verification of WoLAF for EA

According to Hevner and Chatterjee (2010:17), the environment of the research provides the researcher with the research problem and the opportunity to apply the design research idea in context to verify its relevance and usefulness (Section 4.5). Results from an evaluation phase may, for example, reveal the necessity for corrections of an artefact or revision of initial requirements for the artefact.

At three stages during my research, evaluation was performed for verification purposes. In an initial verification of the WoLAF for EA Model V1 questions designed for a questionnaire were evaluated for ambiguity and correctness. Then questionnaires were used to determine if the comprehensive list of human factors impacting on EA acceptance in one organisation was valid in more than one context. In a final evaluation, WoLAF for EA was presented in semi-structured interviews, verified and confirmed. In my research, human factors impacting on EA acceptance were identified and a framework artefact was proposed and evaluated to assist in the management of human factors that impact on EA acceptance. Informed argument as a type of descriptive evaluation was used in the research (Section 4.7.4).

In an evaluation phase of Development Phase 1 of the main design research cycle, the purpose was to determine if WoLAF for EA Model V1 was valid in other contexts. In a pilot questionnaire, human factors divided into different work levels were evaluated in multiple contexts. After results from the pilot questionnaire had been analysed and processed, ambiguous and open-ended questions were removed. An updated questionnaire was used to determine validity of the WoLAF for EA Model V1 in a variety of

contexts. Using simple quantitative analysis of tables and charts (Section 4.8.2), WoLAF for EA Model V1 was confirmed as valid in various contexts. The final WoLAF for EA Model was compiled.

The WoLAF for EA Method to assist organisations with management of EA acceptance was compiled and WoLAF for EA (WoLAF for EA Model and WoLAF for EA Method) was established. In a final evaluation phase of the main design research cycle, interviews were conducted to present and verify WoLAF for EA. WoLAF for EA was verified against principles for frameworks and its usefulness in organisations. The idea was to:

- Present and explain WoLAF for EA to EA stakeholders representing different contexts, organisations, work roles and EA interests in organisations.
- Establish whether they agree with the model and method of WoLAF for EA.
- Discuss the work-level human factors listed to once again verify if factors needed to be changed or updated.

The involvement and subjectivity of the researcher are acknowledged throughout the research process, as it is never possible for humans to completely dissociate themselves from interactive situations such as interviews.

4.9 ETHICAL CONSIDERATIONS

Research ethics is concerned with what is permissible and acceptable when one is conducting research. Research ethics has a dual meaning attached to it: It may be applicable to research involving humans, animals and the environment or it may concern the honesty and integrity of the researcher. Mouton (2001:276) states that researchers should act responsibly and be accountable to society when conducting research. In research involving people and design, a researcher should always consider human action and perceptions of the research from three sides: that of the researcher, that of the participants in the study and that of the people that will be using the design (Oates, 2006:54; Rule *et al.*, 2011:106).

Lee *et al*. (1997) describe individual human behaviour and humans in organisations by arguing that the same publicly observable behaviour can have different meanings in different organisational arrangements. According to Lee *et al*. (1997), *the meaning of an individual action and the meaning and the organisational setting as a whole are mutually dependent*. An interpretive researcher should understand both simultaneously.

Guba (1994:105) advocates trustworthiness of qualitative research and Rule and John (2011:106) agree that values of rigour, transparency and professional ethics promote trust and fidelity in a research effort. The following ethical research principles for qualitative research listed by Rule and John (2011:107) were considered in my research:

- Thick description – a detailed and true description of how actions and events happened during data collection.
- Verifying description with participants – allowing participants to review and confirm data contribution.
- Creating an audit trail – findings may be tracked back to original sources of data collection.

- Critical peer checking – allowing colleagues and fellow students to check data interpretations.
- Lazar *et al.* (2010:426) state that participants in research should be treated fairly and with respect. Researchers have to provide participants with information regarding the research and allow them to voluntarily decide to participate or not, or to withdraw their participation at any stage. Where human participants are involved in research, their signed consent should be obtained and anonymity and confidentiality should be ensured where desired. Most universities and research organisations have committees and procedures to assist researchers with ethical considerations (Oates, 2006; Olivier, 2004:147).

Participants were chosen involuntarily according only to their involvement, knowledge and expertise of organisational operations and EA. As described in sections 4.6.1 to 4.6.5 individuals as data-collection sources were used in a research design concerning individuals and a focus group in organisations. Subjectivity and involvement of the researcher is acknowledged throughout the study. Informed consent was obtained in all interaction with participants and participants could withdraw from the study at any time, should they have wished to. The researcher was aware of the "The Chatham House Rule" in conducting a focus group interview. This rule states that *participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any participant, may be revealed* (www.chathamhouse.org.uk) (Stanford, 2007:137).

Questionnaires were completed electronically via a website where participants were informed about the aims of the research and were given the choice of voluntary participation. Questionnaires were mostly completed anonymously, apart from those occasions where participants contacted me with requests of feedback when the study was completed. Institutional ethical codes were complied with throughout the duration of the research. The researcher acted with honesty, respect and integrity in interaction with the literature, the research community of IS and EA and all participants in the study.

Requests for outcomes of the research will be addressed and satisfied if possible.

4.10 SUMMARY

The focus of this chapter was on the research design and research methodology used in the research reported on in this thesis. A conceptual overview was provided of how the chapter layout of the thesis was positioned according to six aspects of importance to the research. The purpose of this chapter was to provide literature related to the research background of the research. In this way the underlying philosophical paradigm and assumptions of the research, approach, research design and methodology followed in the research were discussed.

The research approach and methodology of design research were used in the research. The title of the thesis indicates the involvement of humans in organisational operation and, therefore, design research in IS was selected. The main research question, two main research objectives and three sub-objectives initiated a main DR cycle and four sub-cycles of the circumscription process of design science. The research steps followed and described in the research cycles were awareness, suggestion, development, evaluation and conclusion or

parts thereof. Outcomes of the development in one sub-cycle initiated new awareness and the start of a following sub-cycle. A more detailed research plan was described.

A detailed description of the course of events of my research and the design research's main and sub-cycles will follow in chapters 5 and 6.