Chapter 2. Research methodology

2.1 INTRODUCTION

Chapter 1 introduced the theoretical background and research questions of the study. This chapter provides a *research methodology* to answer the research questions.

According to Creswell & Plano Clark (2006), one requires a distinction between a research methodology, paradigm, design and methods for conducting a study. According to Figure 8, a *methodology* aggregates the paradigmatic framework and entire process of research in a study. Research *design* refers to the plan of action that links paradigmatic assumptions to specific *methods*. *Methods* relate to techniques for data collection and analysis.

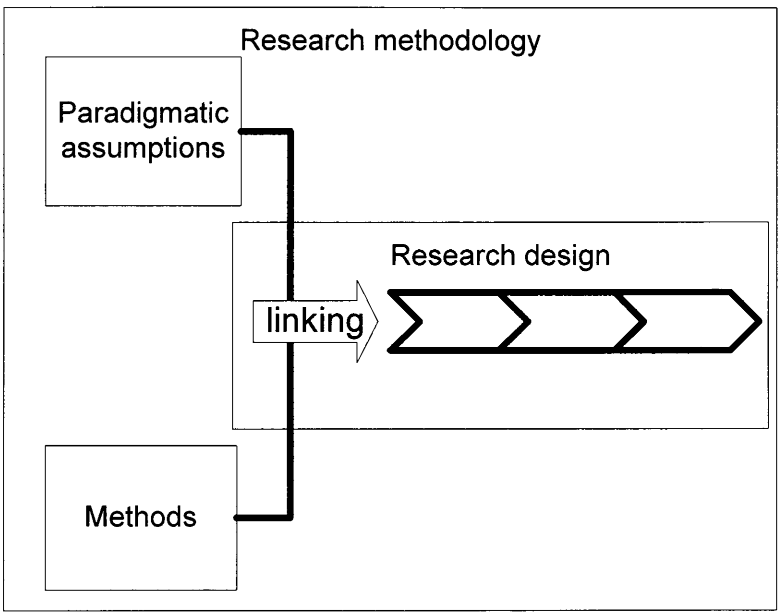


Figure 8: Research methodology concepts, based on Creswell & Plano Clark (2006)

This chapter starts with a presentation of research *methodology theory*, followed by an *application of theory* in devising a thesis research methodology. Section 2.2 provides a paradigmatic framework for discussing research assumptions. Section 2.3 discusses mixed methods design, design research, and exploratory design, whereas section 2.4 relates to theory on a sub-set of data collection methods. Sections 2.5 and 2.6 apply the theoretical concepts portrayed in sections 2.2, 2.3 and 2.4 to the specific paradigm, research design (mixed methods) and data collection methods used in this study. Section 2.7 refers to ethical procedures that were followed and the chapter concludes in section 2.8.

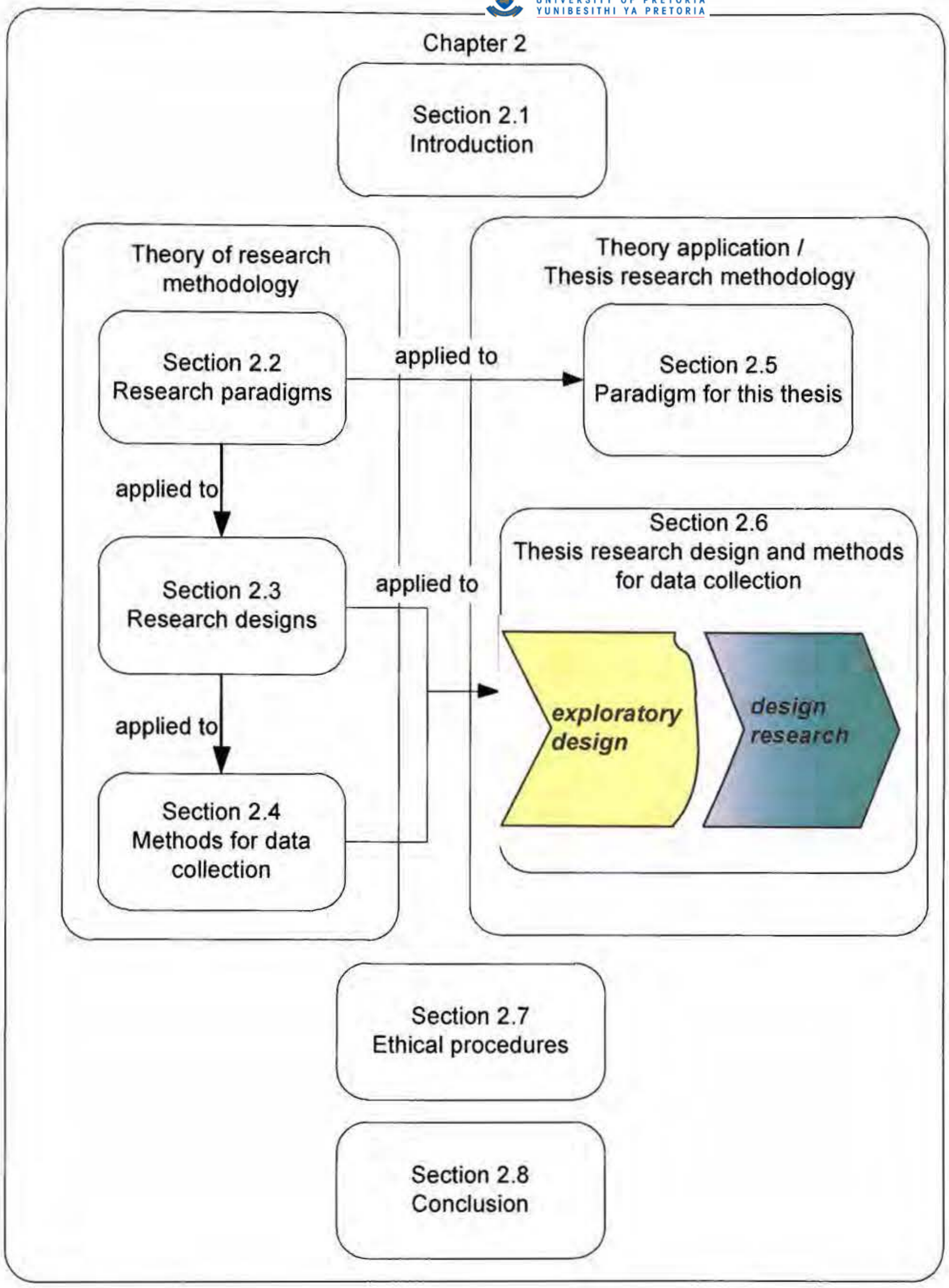


Figure 9: Chapter map for Chapter 2

2.2 RESEARCH PARADIGMS

Research philosophy and paradigms refer to the different "ways of knowing" (Vaishnavi & Kuechler, 2004/5). This section defines a single *paradigmatic framework* for discussing the paradigmatic assumptions embedded in the standard research designs covered in section 2.3 and the paradigmatic assumptions that may apply to this study (later in section 2.5).

This study applies a paradigmatic framework taken from three sources: (1) paradigmatic differentiators provided by Burrell & Morgan (1979) on sociological paradigms, (2) the paradigmatic framework provided by Iivari (1991) on the paradigmatic analysis of information systems development and (3) differentiators on research philosophy provided by Trochim (2006). The paradigmatic framework includes *ontology*, *epistemology*, *methodology, ethics* and *reasoning*. The various positions related to the paradigmatic framework is summarised in Table 1 and discussed subsequently.

Table 1: Paradigmatic framework

Framework differentiators	**Positions**		
Ontology	Realism	Nominalism	Constructivist
Epistemology	Positivism	Anti-positivism	
Methodology	Nomothetic	Ideographic	Constructive
Ethics	Means-ends	Interpretive	Critical
Reasoning	Inductive	Deductive	

Three positions exist in the case of *ontology*: *realism, nominalism* and *constructivist*. *Realism* suggests that the social world is external to individual cognition, consisting of hard, tangible and relatively immutable structures. The realist believes that the social world exists independently of an individual's appreciation of it and has an existence that is as hard and concrete as the natural world (Burrel & Morgan, 1979). *Nominalism*, in contrast, assumes that the social world external to the individuals appreciation, is made of names, concepts and labels which are used to structure reality (Burrel & Morgan, 1979). Searle (1995) adds a third ontological position, the position of the *constructivist*. Constructivism resides between the extremes of realism and nominalism. Constructivists agree with the nominalist that there is no absolute objective reality, but rather a semiobjective reality, called intersubjective reality, built and adapted via social consensus among subjects. The nominalist and constructivist agree that we cannot say how the world is, only how people see it (Gibbs, 2007).

Two *epistemological* positions exist: *positivism* vs. *anti-positivism. Positivism* aims at explaining and predicting what happens in the social world by searching for regularities and causal relationships between its constituent elements (Burrel & Morgan, 1979). *Anti-positivism* holds that only individuals who are directly involved in the activities which are studied, could provide a true understanding of the social world. The anti-positivist rejects the standpoint of the 'observer', which characterises positivist epistemology, as a valid vantage point for understanding human activities. Anti-positivists maintain that one can only 'comprehend' by taking the frame of reference of the participant in action; understanding from the inside rather than the outside (Burrel & Morgan, 1979).

Three categories of *methodology* are identified: *idiographic* methods, *nomothetic* methods and *constructive* methods. Burrell and Morgan (1979) identified the two categories idiographic and nomothetic. *Idiographic* methods highlight the unique elements of an individual phenomenon (G. Marshall, 1998). *Nomothetic* methods aim at providing more general law-like statements about social life, by imitating the logic and methodology of the natural sciences (G. Marshall, 1998). Iivari (1991) provides an additional method (*constructive*), which complements the idiographic and nomothetic methods, but creates a future rather than an existing reality. Focusing on IS development, Iivari's *constructive* methods (1991) could be used in either conceptual or technical developments. Whereas conceptual development refers to the development of various models and frameworks for creating a new reality, which does not necessarily have a physical realisation (e.g. an IS development methodology), technical development produces physical artefacts as output (e.g. executable software, such as a CASE environment).

Three *ethical* positions are distinguished: *means-ends*, *interpretive*, and *critical* (Iivari, 1991). The *means-ends* position provides means knowledge to achieve certain ends (goals), without questioning the legitimacy of the ends. The *interpretive* stance tries to provide and understanding of action, i.e. the goal-statements follow upon action. *Critical* research tries to remove domination and ideological practice by providing a critical analysis of goals (ends) (Iivari & Venable, 2009).

Trochim (2006) defines two ways of *reasoning* when conducting research: *inductive* versus *deductive* reasoning (see Figure 10). According to Charmaz (2006), *inductive reasoning* begins with the study of a range of individual cases and extrapolates patterns from them to form a conceptual category. This type of reasoning requires one to work back and forth between the themes and the data until one establishes a comprehensive set of themes (Creswell, 2007; Trochim, 2006). The tentative hypothesis (about theoretical themes) is transformed into general theory (Trochim, 2006). In contrast, *deductive reasoning* stipulates analytic categories beforehand according to an existing framework. Deductive reasoning works from the existing theoretical framework to define more specific hypotheses, collecting observations that leads to a confirmation (or not) of the original theory (Patton, 2002; Trochim, 2006).

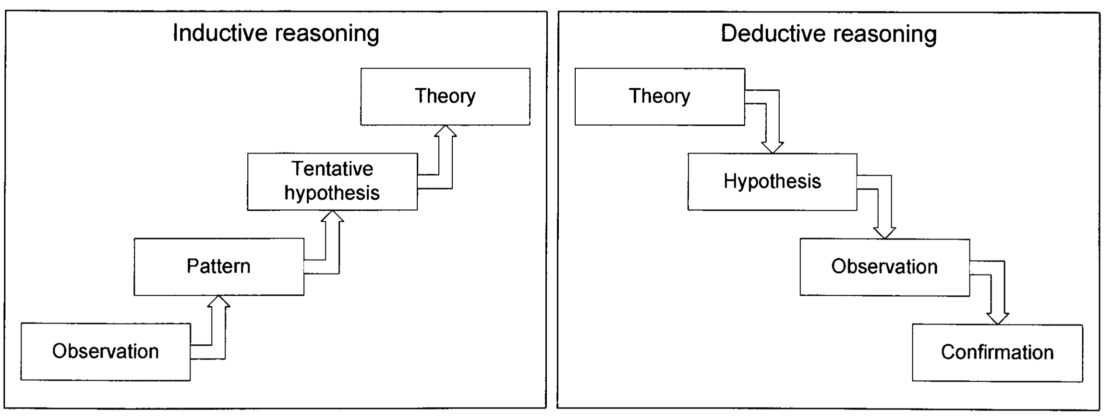


Figure 10: Inductive versus deductive reasoning (Trochim, 2006)

Inductive reasoning is by nature more open-ended and exploratory, while deductive reasoning is concerned with testing or confirming of hypotheses and thus narrower in nature (Trochim, 2006).

This section defined a paradigmatic framework consisting of five differentiators to frame the paradigmatic assumptions of a study: ontology, epistemology, methodology, ethics and reasoning. The paradigmatic framework is used to discuss the paradigmatic assumptions that apply to this study (later in section 2.5).

2.3 RESEARCH DESIGNS

According to the definition used by Creswell & Plano Clark (2006) the research design refers to the plan of action that links *philosophical assumptions* to specific *methods*. A research design may incorporate both quantitative and qualitative information to address the concerns of the main research question. Mouton (2001) states that *quantitative information* and methods are usually associated with the physical sciences, where time, density, costs and other measures may be meaningfully expressed as numbers and manipulated mathematically. In contrast, *qualitative information* and methods are usually associated with people orientated research, emphasising words, feelings, the quality of an event or experience.

This section provides theory about mixed methods designs (section 2.3.1) and the possible combination of two separate research designs in one study. Sections 2.3.3 and 2.3.2 cover two separate research designs, design research and exploratory design respectively.

2.3.1 Mixed method designs

According to Morse (2010) there is no real consensus regarding the definition of mixed method design. Whereas some authors define mixed methods as the combined use of qualitative and quantitative methods (e.g. Creswell & Plano Clark (2006)), others consider mixed methods to be of use when completing two separate research projects within the same study (Leech, 2010). Depending on the mixed methods design, mixed methods research could assume several worldviews / research paradigms (Creswell & Plano Clark, 2006).

Morse (2010) suggests that a mixed methods design consists of a complete design method (i.e. the *core component*), plus one (or more) incomplete design methods(s) (i.e., the *supplementary component*(s)) that cannot be published alone, within a single study. Another criterion for using a mixed method (*core component* plus *supplementary component(s)*) is that the "gap between the core method and supplemental project is too wide for any blending of the data of the core and supplemental project to be possible. Analyses must always be conducted separately" (Morse, 2010, p. 486).

The *supplementary component* usually provides *explanation or insight* within the context of the core component and consists of an incomplete research design, such as a particular style of interview. The *supplementary component* cannot be interpreted or utilised alone, due to an inadequate sample or lack of saturation. In addition, the supplementary component only continues until the researcher is certain enough that the sub-question (related to the supplementary component) is answered (Morse, 2010). See Figure 11 for a graphical representation of the *supplementary* and *core* component.

According to Morse & Niehaus (2009, p. 14), a mixed method design is a strong design, "as the supplementary component enhances validity of the project per se by enriching or expanding our understanding".

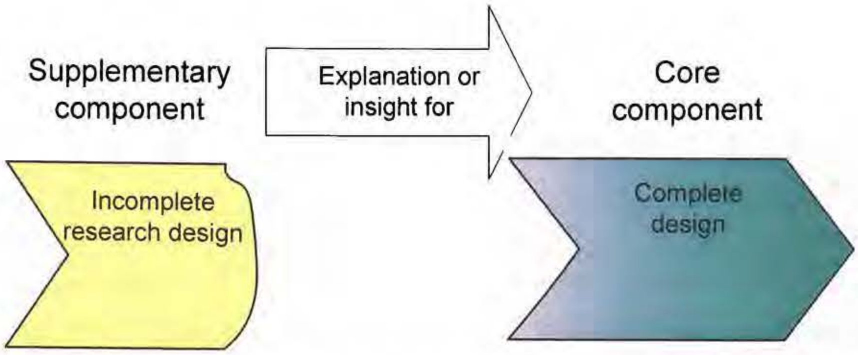
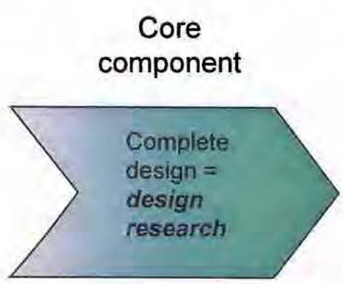


Figure 11: Supplementary and core component of mixed methods research, based on Morse (2010) (duplicate of Figure 6)

Mixed methods design allows for the simultaneous or sequential development of the *supplementary component*, depending on the research question and the strategy that would best enable the research question to be answered. Morse (2010) allows for the combined use of *two distinct qualitative designs* within one study (e.g. using grounded theory as the core component design and an interview as the supplementary component design). Likewise, this thesis demonstrates the combined use of design research (*qualitative*) as the *core component* and exploratory design (*qualitative*) as the *supplementary component* within a single study (see section 2.6).

2.3.2 Design research

Since design research will be used as the core component, within the mixed methods design of this thesis, this section provides more theory on design research as a research approach, followed by a philosophical discussion related to the paradigmatic framework defined in section 2.2.



Design science, as a problem-solving research approach, has its roots in engineering and the sciences of the artificial (Simon, 1996). Simon (Simon, 1996, p. 55) differentiated design science from other paradigms: "Whereas natural sciences and social sciences try to understand reality, design science attempts to create things that serve human purposes". Design science reflects on *design as a topic* of investigation to explore almost any design related subject, whereas *design research* uses *design as a method* for investigation (Kuechler & Vaishnavi, 2008), aiming to create "solutions to specific classes of relevant problems by using a rigorous construction and evaluation process" (Winter, 2008, p. 471). Although design research (especially IT-based design) received attention and development within the IS discipline, some also reason that design research may contribute to organisational theory development and improvement of professional practice (Romme, 2003; Van Aken, 2005). Keuchler & Vaishnavi (2008) are also in favour of a broader scope for design science research than its current focus on creating low level artefacts (IT mechanisms).

The following sections provide some background on design research as a research approach, followed by a philosophical discussion related to the paradigmatic framework defined in section 2.2.

2.3.2.1 Design research methodology and outputs

Although Vaishnavi & Kuechler (2004/5, p. 78) acknowledge the required alignment between business and information technology, they restrict their discussion of design science to the "activities of building the IS infrastructure within the business organisation". Highlighting the applicable use of design-science based research within the context of business-IT alignment, this thesis uses design-science based research to solve one of the research questions (see application of design research theory in section 2.6.2).

The fundamental principle of design-science based research (in short, design research) is that "knowledge and understanding of a design problem and its solution are acquired in the building and application of an artefact" (Henver, March, Park, & Ram, 2004, p. 82). Knowledge and action form a cycle, in which knowledge is used to create works, and works are evaluated to build knowledge (Owen, 1997).

Figure 12 demonstrates the reasoning in the design cycle. A design begins with *awareness of a problem*, followed by *suggestions* drawn from the existing knowledge/theory base for the problem area. An artefact may be implemented according to the suggested solution during the *development* process step. Implementations (partially or fully) are then *evaluated* (according to the requirements depicted in the *suggestion* description). Development and evaluation may lead to re-visitation of the problem (circumscription arrow in Figure 12) and further suggestion. Several iterations may be required before a design project reaches the *conclusion* step. Circumscription is an important process in design research as it creates an understanding that could only be gained from the construction-act. When the design process gets interrupted, valuable constraint knowledge is derived to gain a better understanding of the incomplete theories that initiated the original research problem (Vaishnavi & Kuechler, 2004/5).

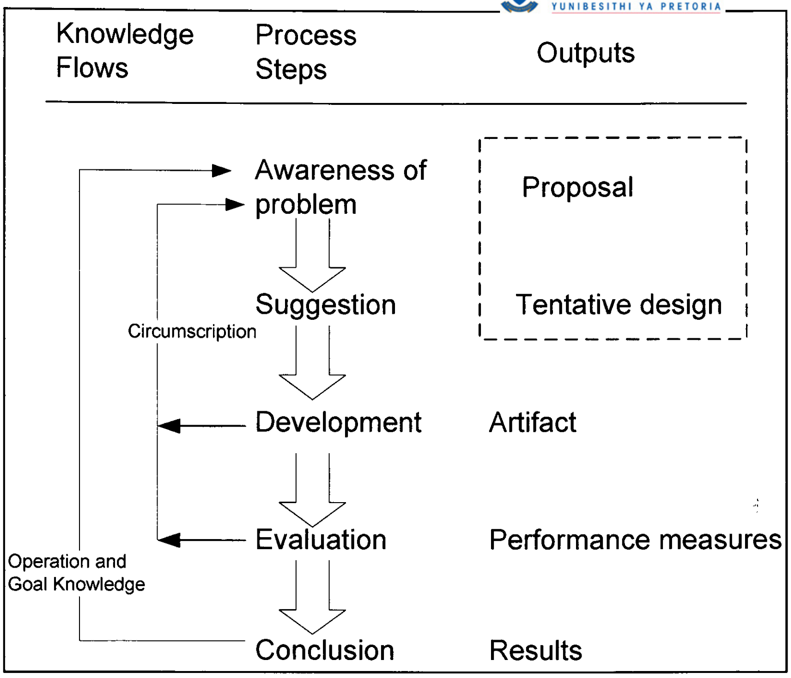


Figure 12: Reasoning in the design cycle, based on Vaishnavi & Kuechler (2004/5)

March & Smith (1995) identify four design artefacts/outputs produced by IS-related design-science research, including *constructs*, *models*, *methods*, and *instantiations*. *Constructs* offer a language for defining problems and situations. *Models* make use of constructs to depict a real world situation, frequently representing the connection between the problem and solution components. *Methods* define processes or guidance on how to solve problems, ranging from mathematical algorithms to informal, textual descriptions of "best practice". *Instantiations* are actual working/implemented systems, based on constructs, models, or methods. Instantiations enable researchers to evaluate the artefacts within a real-world environment (Henver et al., 2004). A fifth output, *better theories*, is added by Rossi & Sein (2003) and Purao (2002). Design research can contribute to *better theories* in two ways: (1) providing proof of a method (a methodological construction of an artefact is an object of theorising) or (2) exposing relationships between artefact elements and thereby elaborating previously theorised relationships. Table 2 provides a summary of the main outputs.

Table 2: The outputs of design research, based on Vaishnavi & Kuechler (2004/5)

	Output	**Description**
1	Constructs	The conceptual vocabulary of a domain
2	Models	A set of propositions or statements expressing relationships between constructs
3	Methods	A set of steps used to perform a task – how-to knowledge
4	Instantiations	The operationalisation of constructs, models and methods
5	Better theories	Artefact construction as analogous to experimental natural science

Since this study includes both a *model* (the BIAM), and *better theories (*by providing proof for the PRIF *method* and its associated mechanism and practices), the seven guidelines provided by Henver et al. (2004) (see Table 3) for constructing design-research outputs, were also useful. According to Henver et al. (2004), the guidelines, may be helpful to identify the *appropriate approach* for a research project, but should not be used in a mechanistic way.

Table 3: Design-science research guidelines, based on Henver et al. (2004)

Guideline	Description
Guideline 1: Design as an artefact	Design-science research must produce viable artefacts in the form of a construct, a model, a method, or an instantiation.
Guideline 2: Problem relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.
Guideline 3: Design evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.
Guideline 4: Research contributions	Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.
Guideline 5: Research rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.
Guideline 6: Design as a search process	The search for an effective artefact requires utilising available means to reach desired ends while satisfying laws in the problem environment.
Guideline 7: Communication of research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.

The seven guidelines of Henver et al. (2004) (see Table 3) provide guidance on viable artefacts, problem relevance, *design evaluation*, the research contribution, research rigor, the search process within the problem environment, and communication of research results. In terms of *design evaluation*, Henver et al. (2004) propose design evaluation methods that may be applicable in evaluating an artefact. One of the proposed design evaluation methods, a controlled experiment, is used to study an artefact in a controlled environment for qualities, such as usability (Henver et al., 2004). Data collection methods that could be used in combination with a controlled experiment to obtain artefact evaluation results include questionnaires (discussed in section 2.4.1) and interviews (discussed in 2.4.3).

2.3.2.2 Paradigmatic assumptions of design research

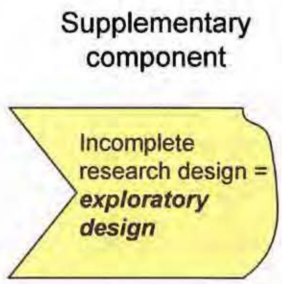
Design research complements both positivistic and interpretivistic perspectives (Niehaves, 2007; Vaishnavi & Kuechler, 2004/5). A study performed by Niehaves (2007) used the seven guidelines (see Table 3 in the previous section) for design-science research compiled by Henver et al. (2004) to reflect on how an intepretivist could still adhere to the guidelines by applying Klein and Meyer's (1999) set of principles of interpretive field studies. The possible pluralism in philosophical stance is due to the socio-technologist type of problems that are addressed and the constructional/developmental method that goes hand-in-hand with design research (Gregg, Kulkarni, & Vinze, 2001). Although Vaishnavi & Kuechler (2004/5) define design research as a third paradigmatic perspective, Iivari & Venable (2009, p. 7) disagrees, stating that design research "may be based on more or less" 'positivistic' or 'anti-postivistic' assumptions.

Applying the paradigmatic framework defined in section 2.2, Iivari & Venable (2009) debates the philosophical pluralism inherent in design research. In terms of *ontology,* design research adopts *constructivism*, i.e. building social consensus about a specific part of reality (Vaishnavi & Kuechler, 2004/5). Although design research produces general solution concepts, typical of a positivistic *epistemology*, an anti-positivistic *epistemology* may be assumed during the evaluation of designed artefacts. Although both nomothetic and idiograpic *methods* are proposed (Henver et al., 2004), the third category of methods (constructive) is exemplary of design research. In terms of *ethics*, design research is mostly means-ends-oriented and may also take a critical position to challenge existing power structures through the development of new artefacts (Iivari & Venable, 2009). The type of *reasoning* as defined by Trochim (2006) may require either/both *inductive* and *deductive* reasoning depending on the type of artefact constructed.

This section motivated the possible philosophical pluralism inherent in design research, when the paradigmatic framework (defined in section 2.2) is applied to design research. Later in section 2.5, the philosophical stance of this study is motivated.

2.3.3 Exploratory design

Since exploratory design will be used as the supplementary component (not the core component), within the mixed methods design of this thesis, this section provides an introduction on exploratory design.



Mouton (2001, p. 22) states that exploratory research looks for ideas, patterns or themes to explore a current phenomenon/event/issue/problem. Exploratory studies are the first step in a research program designed "to develop a new theory or model that has broad applicability". Exploratory information that reveals patterns may be developed into a theory to explain how various elements contribute to patterns. Some research designs (e.g. case study research), may be explorative in nature, but may not be representative of all the characteristics of the concept required for generalisation.

The broad definition of exploratory design impairs classification according to the paradigmatic framework defined in section 2.2. However, in terms of reasoning, an exploratory design starts with an *inductive* reasoning to identify existing patterns or themes.

2.4 METHODS FOR DATA COLLECTION

According to Cresswell & Plano Clark (2006) *methods* relate to techniques of data collection and analysis. This section provides theory about three data collection methods used in this study: literature review (section 2.4.1), questionnaires (section 2.4.2) and interviews (section 2.4.3).

2.4.1 Literature review

According to Webster & Watson (2002) a *literature review* creates a firm foundation for advancing knowledge by facilitating theory development. Booth, Papaionnou, & Sutton (2012, p. 2) define a *literature review* as a method for "identifying, evaluating and synthesising the existing body of completed and recorded work produced by researchers, scholars, and practitioners". Booth et al. (2012) state that a literature review offers numerous opportunities to engage and interact with theory. They identified eleven different types of review; one is called the *qualitative systematic review* (QSR). The QSR integrates and compares findings from qualitative studies, with the objective to find themes or constructs in or across individual studies. The analysis process may include conceptual models (Booth et al., 2012). One of the examples presented by Booth et al. is a study performed by Damschroder et al. (2009) to combine constructs across published theories with different labels, removing redundancy and overlap. The result of the meta-model by Damschroder et al. was an overarching typology for implementation research.

Later, section 2.6.3 applies the *qualitative systematic review* as a data-gathering method for constructing the Business-IT Alignment Model (BIAM).

2.4.2 Questionnaires

Questionnaires are often based on the desire to collect information from a sample of respondents from a well-defined population. The questionnaire typically contains a series of questions for the respondents to answer (Czaja & Blair, 2005). Questionnaire information can be collected via various means (e.g. mails, web-based, telephone and interviews), using different formats (i.e. closed-ended and open-ended). Closed-ended questions provide a fixed list of alternative responses and ask the respondent to select according to the predefined alternatives. In contrast, the open-ended questions do not provide a pre-existing response, allowing the respondent more latitude in responding (Rea & Parker, 2005).

Whitten & Bentley (2007, p. 221) listed several advantages and disadvantages when a systems analyst uses a questionnaire for data-gathering (see Table 4). As evident in Table 4, questionnaires allow for relative inexpensive data-gathering from a large number of individuals. However, due to its inflexible nature, a questionnaire does not produce the same level of richness and opportunities for further expansion/explanation that is possible with an interview.

Table 4: Advantages and disadvantages of using questionnaires (Whitten & Bentley, 2007)

Advantages	**Disadvantages**
• Most questionnaires can be answered quickly. People can complete and return questionnaires at their convenience. • Questionnaires are a relatively inexpensive means of gathering data from a large number of individuals. • Questionnaires allow individuals to maintain anonymity. Therefore, individuals are more likely to provide real facts, rather than telling you what they think their boss would want them to. • Responses can be tabulated and analysed quickly.	• The number of respondents is often low. • There is no guarantee that an individual will answer or expand on all of the questions. • Questionnaires tend to be inflexible. There is no opportunity for the systems analyst to obtain voluntary information from individuals or reword questions that may have been misinterpreted. • It is not possible for the systems analyst to observe and analyse the respondent's body language. • There is no immediate opportunity to clarify a vague or incomplete answer to any question. • Good questionnaires are difficult to prepare.

The ultimate goal of the questionnaire-based research is to allow the researchers to generalise about a large population by studying only a sample of the population. Accurate generalisation requires orderly procedures for statistical analysis and also require identification of variables/parameters that require measurement. Depending on the type of variable/parameter, different measurement scales may be applicable, e.g. nominal scale (using labelled categories), *ordinal scale* (using ordering/ranking) and interval scale (exact measure in terms of a standard unit of value). An *ordinal scale* that is often used to measure the attitude of the respondent is called the Likert scale, which entails a five-, seven-, or nine-point rating scale (Rea & Parker, 2005). An example of a five-point scale is:

Value	**Description**
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

Once collected via the questionnaire, descriptive statistics are used to describe characteristics of the sample data (x) and thereby provide an indication of the characteristics of the larger population. Descriptive statistics usually measure the *central tendency* and *dispersion* of the data. Although various measures are used to measure *central tendency* (e.g. mode, median and average), the *average* (arithmetic mean) is most often used by the general public. The *average* is the mathematical centre of the data. Likewise, various measures are used to measure *dispersion* (e.g. range and standard deviation), but the *standard deviation* is most often used. The *standard deviation* represents the mean distance of each value in the sample from the *average*. The more dispersed the data are, the greater is the *standard deviation* (Rea & Parker, 2005).

The *average* and *standard deviation* formulas are given below:

(1) *Average*, $\bar{x} = \frac{\sum x}{n}$

(2) *Standard deviation*, $S = \sqrt{\frac{\sum(x-\bar{x})^2}{n}}$

Two prerequisites for generalisation, based on the statistical analysis of a sample, are an adequate *sample size* and selection of a *representative sample*, discussed in sections 2.4.2.1 and 2.4.2.2 respectively.

2.4.2.1 Sample size

The appropriate sample size is determined by the level of accuracy required to make inferences from the sample to the entire population. Using a sample, rather than the entire population, introduces the risk of making erroneous inferences about the population (Rea & Parker, 2005). This thesis does not aim to confirm or reject a hypothesis based on statistical results, but rather use descriptive statistics to highlight areas that require further research. Therefore, this section will not elaborate further on the requirements for an adequate sample size.

2.4.2.2 Representative sample

Sampling methods can be categorised into *probability sampling* and *nonprobability sampling* (Rea & Parker, 2005).

If a study has the objective to generalise findings scientifically, *probability* sampling is required. In *probability sampling*, every member of the working population should have an equal chance of being selected as part of the sample. Probability sampling requires knowledge of the composition and size of the population (Rea & Parker, 2005).

If a study does *not* aim to generalise findings scientifically (i.e. with a known degree of accuracy), *nonprobability sampling* would be adequate. In *nonprobability sampling*, every member of the working population does *not* have an equal chance of being selected as part of the sample. In addition, the research may not have knowledge about the composition and size of the population. One type of nonprobability sampling is *convenience sampling*. According to Hesse-Biber & Leavy, (2011) a *convenience sample* is a sample of informants that are available, who have some specialised knowledge of the setting, and are willing to serve in a specific role.

This study applied questionnaires as part of a qualitative analysis, retrieving experience-based knowledge from the research participants. Section 2.6.2 elaborates on the use of questionnaires in this study. Questionnaires tend to be inflexible in nature, disallowing opportunities for further expansion/explanation. Interviews are more flexible and may be used as a complementary data-gathering tool.

2.4.3 Interviews

The research interview is an "*interview* where knowledge is constructed in the *interaction* between the interviewer and the interviewee" (Kvale, 2007, p. 1). Hesse-Biber & Leavy (2011) define various different types of interviews, i.e. in-depth interviews, semistructured interviews and structured interviews. The *in-depth interview* is used when the interviewer seeks knowledge from the interviewee's point of view. The interview questions are open-ended and the degree of structure to the interview depends on the extent to which interviewers have a specific agenda. The *semistructured interview* contains specific research questions, selected by the interviewer to guide the interview, but used based on discretion. The *structured interview* starts with a pre-defined set of questions posed to every interviewee. If the participant strays away from the topic at hand, the interviewer will guide the conversation back to the interview questions.

Whitten & Bentley (2007, p. 223) listed several advantages and disadvantages when a systems analyst uses an interview for data-gathering (see Table 5).

Table 5: Advantages and disadvantages of using interviews (Whitten & Bentley, 2007)

Advantages	**Disadvantages**
• Interviews give the analyst an opportunity to motivate the interviewee to respond freely and openly to questions. By establishing rapport, the systems analyst is able to give the interviewee a feeling of actively contributing to the systems project. • Interviews allow the systems analyst to probe for more feedback from the interviewee. • Interviews permit the systems analyst to adapt or reword questions for each individual. • Interviews give the analyst an opportunity to observe the interviewee's nonverbal communication. A good systems analyst may be able to obtain information by observing the interviewee's body movements and facial expressions as well as by listening to verbal replies to questions.	• Interviewing is a very time-consuming, and therefore a costly, fact-finding approach. • Success of interviews is highly dependent on the systems analyst's human relations skills. • Interviewing may be impractical due to the location of interviewees.

As can be seen from Table 5, interviews are very time-consuming, but allows for communicative interaction between the interviewer and the interviewee in obtaining a richer data set than with a questionnaire.

This section provided theory on different data collection methods that are applicable to this study. The section is also the concluding section as related to the theory of research methodology. The following two sections (sections 2.5 and 2.6) apply the theory of research methodology to the specific research methodology for this thesis. Section 2.5 delineates the paradigm of this thesis, whereas section 2.6 details the research design and data collection methods for this thesis.

2.5 PARADIGM FOR THIS THESIS

A mixed methods design is appropriate to answer the main research question of this thesis, namely:

What constructs are required for a process reuse identification framework to enhance the operating model concept within the context of business-IT alignment?

The mixed methods design, as defined by Morse (2010), requires two design components to answer the main research question. According to Morse (2010), the two design components (a *core component* and *supplementary component*) may be used sequentially or simultaneously. The *supplementary component* continues until the researcher is certain enough that the sub-question (pertaining to the *supplementary component*) is answered.

This study started with the *core component* (*design research*) in answering *Research Question 2*, namely:

What constructs are required for a process reuse identification framework to enhance the operating model concept, using the business-IT contextualisation model?

Since an appropriate business-IT contextualisation model could not be found, the study also initiated a *supplementary component* (*exploratory design*), to develop a business-IT contextualisation model, thus answering the *Research Question 1*, namely:

What model is required to contextualise different business-IT alignment approaches?

Thus, the *supplementary component* (*exploratory design*) was used *simultaneously* with the *core component* (*design research*) to answer the main research question. As suggested by Morse (2010), the *supplementary component* (*exploratory design*) only continued until the sub-question (*Research Question 1*) was answered.

Using a mixed methods design (see Figure 13), the core component (*design research*), developed the PRIF (Process Reuse Identification Framework), and a supplementary component (*exploratory design*), developed the BIAM (Business-IT Alignment Model). Even though Morse (2010) states the supplementary component may not be publishable within a single study, the result of the supplementary component (initially called the Business-IT

Alignment Framework (BIAF)) was published as a single study (De Vries, 2010). Yet, the result of the supplementary component (BIAM) was a prerequisite in providing *business-IT alignment insight* for the core component.

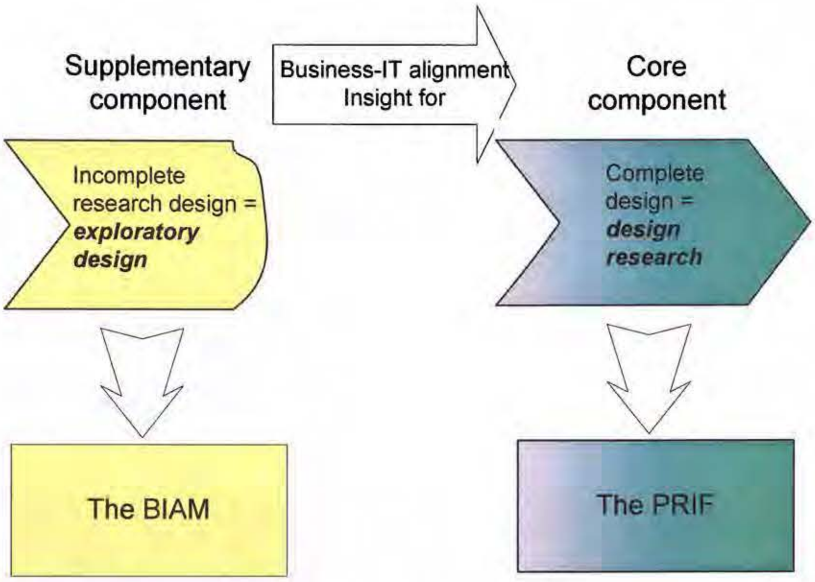


Figure 13: Components of a mixed methods design for this thesis

Referring back to section 2.2, the paradigmatic framework includes *ontology*, *epistemology*, *methodology, ethics* and *reasoning.* Table 6 presents the paradigmatic framework, as applied to this thesis (shaded cells on Table 6) and is discussed subsequently.

Table 6: Paradigmatic framework applied to this thesis

Framework differentiators	**Positions**		
Ontology	Realism	Nominalism	Constructivist
Epistemology	Positivism	Anti-positivism	
Methodology	Nomothetic	Ideographic	Constructive
Ethics	Means-ends	Interpretive	Critical
Reasoning	Inductive	Deductive	

My *ontological* belief is that of *constructivism*. Constructivists agree with the nominalist that there is no absolute objective reality, but rather a semiobjective reality, called intersubjective reality, built and adapted via social consensus among subjects. Although the construction of the PRIF (Process Reuse Identification Framework) applies positivist-related methods during the evaluation of the PRIF, an anti-positivistic stance is taken to construct an intangible artefact that is useful to a very specific community, i.e. enterprise architecture practitioners using the operating model (OM). The development/construction of the BIAM (Business-IT Alignment Model) follows *inductive reasoning* using exploratory design, which requires an *anti-positivist* *epistemological* stance. The inductive reasoning process gathers knowledge from different existing alignment approaches, each based on its own worldview.

Both nomothetic and constructive *methods* were used in this thesis. Nomothetic methods aim to generalise, which is the purpose of constructing both the BIAM and PRIF. Constructive methods are typical of design research (used to construct the PRIF), which assist in creating a new reality, rather than describing and existing reality. The *ethical* position is both means-ends and critical. The means-ends position relates to the development of the BIAM; the BIAM (means) could be used to contextualise an existing alignment approach in terms of business-IT alignment (ends). The means-ends position also relates to the PRIF (means) which could be used to identify process re-use opportunities at an enterprise (ends). The critical position relates to the fact that an application of the PRIF could lead to process standardisation implementation, which could challenge existing power structures.

Finally, in terms of reasoning, the BIAM and PRIF required both *deductive* and *inductive reasoning*. Both artefacts (BIAM and PRIF) required *inductive* reasoning during the development and construction of the artefacts and *deductive* reasoning during the application/evaluation of the artefacts.

2.6 THESIS RESEARCH DESIGN AND METHODS FOR DATA COLLECTION

This study applied a mixed methods design as delineated in section 2.3.1. The purpose of this section is to outline the specific design/research plan for this study, based on the theoretical concepts about research design (covered in section 2.3) and data collection methods (discussed in section 2.4).

Section 2.6.1 describes the mixed methods design and the constituent two components, *design research* and *exploratory design*. Sections 2.6.2 and 2.6.3 provide more detail about the two components and their associated data collection methods.

2.6.1 A mixed methods design

The mixed methods design (see Figure 14) consists of a core component (*design research*), which develops the PRIF (Process Reuse Identification Framework), and a supplementary component (*exploratory design*), which develops the BIAM (Business-IT Alignment Model). Figure 14 show that the *exploratory design* component produces the BIAM, which provides *business-IT alignment insight* (Figure 14, horizontal arrow) for the *design research* component and subsequent development of the PRIF. According to Morse (2010), the supplementary component (*exploratory design*) may consist of an incomplete design (e.g. using literature review alone as data collection instrument). The core component (*design research*), however, requires a complete design (e.g. adhering to the guidelines of Hevner et al. (2004) in doing design research, and using questionnaires and interviews as appropriate).

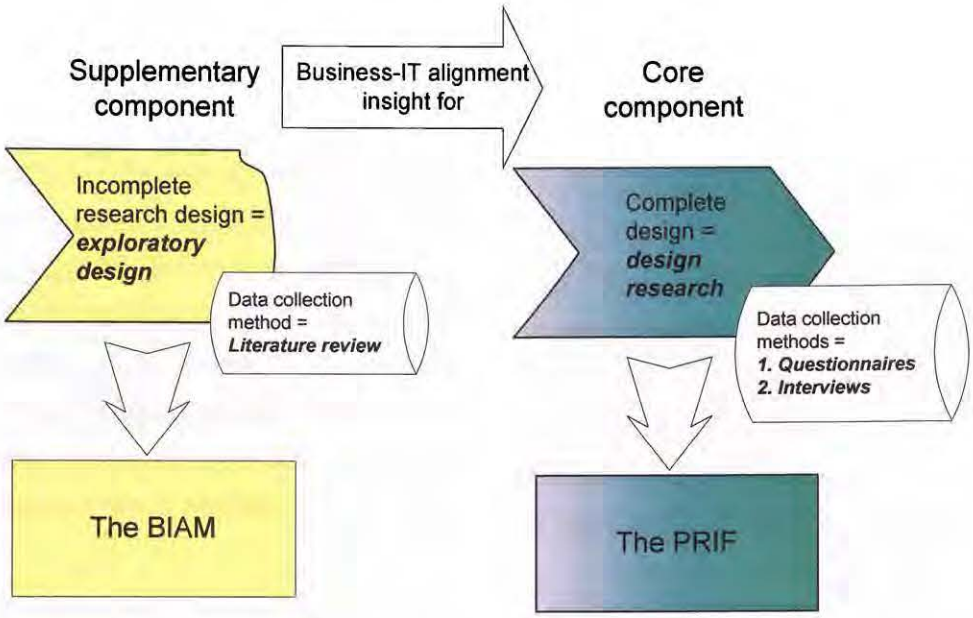


Figure 14: Components and data collection methods for this thesis

2.6.2 Design research and data collection for building the PRIF

This study applied design research as a complete research design (core component) to develop the PRIF (Process Reuse Identification Framework). The main design research cycle (Figure 15, column 1, *The main cycle*) consists of five steps to address *Research Question 2* of this thesis: (1) awareness of problem, (2) suggestion, (3) development, (4) evaluation and (5) conclusion. The *development* step of the main cycle contains three sub-cycles (Figure 15, column 2, *Sub-cycles*), each contributing systematically to the development of the whole PRIF:

- Sub-cycle 1 applies a BIAM contextualisation to the *foundation for execution approach* (Ross et al., 2006) to demarcate and derive requirements for the PRIF.
- Sub-cycle 2 applies the BIAM contextualisation to the *essence of operation approach* (Dietz, 2006) to ensure compatibility with the OM. In addition, Sub-cycle 2 evaluates the use of the interaction model (part of the *essence of operation approach*) as a suitable process representation language for the *method, mechanisms and practices* of PRIF.
- Finally, Sub-cycle 3 develops a *method, mechanisms and practices* that incorporates the interaction model (evaluated in Sub-cycle 2), and adhere to the requirements stipulated in Sub-cycle 1.

During the main cycle and Sub-cycles 1 and 2, the *problem awareness* steps require re-visitation of the extended knowledge base (Figure 15, yellow arrow, *EKB Re-visitation*). A re-visitation of knowledge leads to suggestions to incorporate existing knowledge within the context of developing the PRIF.

The design research components are colour-coded to map the components to Part C chapters of this thesis. In addition, the colour-coded sub-cycles (Figure 15, column 2, *Sub-cycles*) also map to the colour-coded parts of the PRIF (Figure 15, column 3, *The PRIF*).

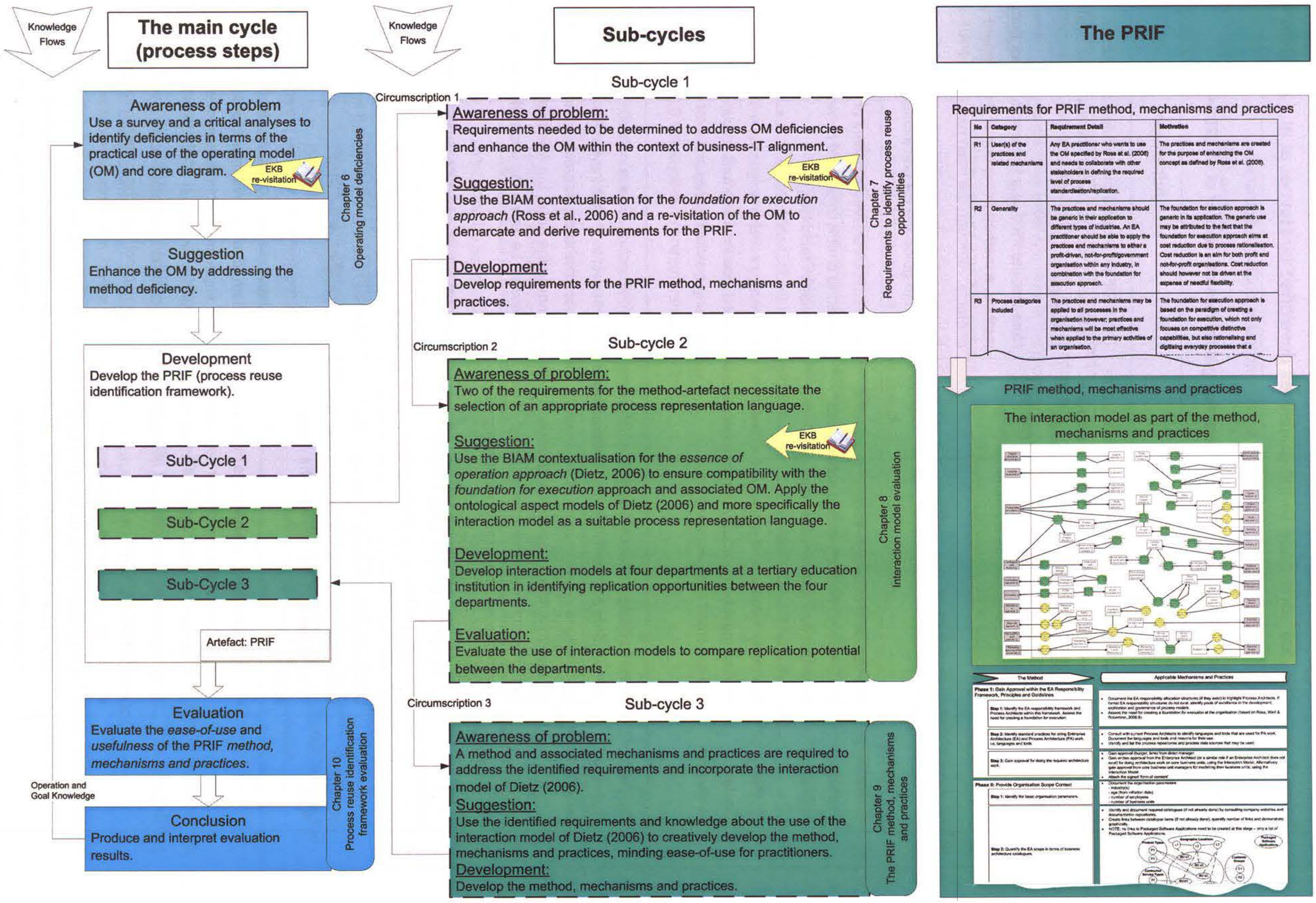


Figure 15: Design research for building and validating the PRIF

Table 7 demonstrates adherence to the guidelines developed by Hevner et al. (2004) on doing design research.

Table 7: Adherence to the design-science research guidelines of Hevner et al. (2004)

Guideline	Description	Adherence
Guideline 1: Design as an artefact	Design-science research must produce viable (innovative, purposeful) artefacts in the form of a construct, a model, a method, or an instantiation. The artefact must be described effectively, enabling its implementation and application in an appropriate domain.	The PRIF provides a purposeful contribution (enhancing the OM) within the domain of business-IT alignment. Note that the PRIF is a framework, rather than a method, a method being one of the standard artefacts. Although the main part of the PRIF is a method, additional mechanisms and practices were added to guide the EA practitioner.
Guideline 2: Problem relevance	The objective of design-science research is to develop technology-based solutions to important and relevant business problems.	The PRIF, as an enhancement of the OM concept, is used to enable *alignment between business and information technology*.
Guideline 3: Design evaluation	The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.	The study provides a rigorous evaluation of the method, mechanisms and practices of the PRIF, by applying questionnaires and interviews based on experimentation (see section 2.6.2).
Guideline 4: Research contributions	Effective design-science research must provide clear and verifiable (implementable) contributions in one or more of the areas of the *design artefact*, design foundations, and/or design methodologies. In terms of the *design artefact*, the artefact must enable the solution of unsolved problems. It may extend the knowledge base of apply existing knowledge in new an innovative ways.	The PRIF enhances a current model (i.e. the OM) with respect to identifying process re-use opportunities at an enterprise. The PRIF extends the knowledge base, but also applies existing knowledge, i.e. using the interaction model in new ways. Refer to chapter 11 for an in-depth discussion of research contributions.
Guideline 5: Research rigor	Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact. • Design-science researchers must assess the appropriateness of their performance metrics. The construction of effective metrics is an important part of design-science research. • Constructs, models, methods, and instantiations must be exercised within appropriate environments. Appropriate subject groups must be obtained for such studies. Issues include	Rigorous methods were applied in the construction and evaluation of the PRIF: • A requirements analysis provides effective objectives and constraints for the required *method, mechanisms and practices*. In addition, a suggested method-component (the interaction model) is evaluated prior to its inclusion as part of the *method, mechanisms and practices*. The construction process of the *method, mechanisms and practices* demonstrates adherence to the identified requirements. The *method, mechanisms and practices* apply metrics to evaluate ease-of-use and usefulness of the artefact.

Guideline	Description	Adherence
	comparability, subject selection, training, time and tasks.	• The selected subject group (research participants) received training on business-IT alignment theories and practices, as well as the BIAM and the proposed *method, mechanisms and practices* of PRIF.
Guideline 6: Design as a search process	The search for an effective artefact requires utilising available means to reach desired ends while satisfying laws in the problem environment. • If the case of a wicked problem (high complexity in the solution space), the design task involves construction of an artefact that 'works well' for the specified class of problems. A search process could then iteratively identify deficiencies and creatively develop better solutions. • The 'goodness' of solutions need to be demonstrated, e.g. comparing solutions with those constructed by expert human designers for the same problem situation.	The study demonstrates the identification of available means (available mechanisms and practices) that may address desired ends, posed by defining PRIF requirements. • The study applies one evaluation-iteration to the PRIF. Yet, additional iterations could lead to adaptations and additional solution improvement. • The study measures the solution (*method, mechanisms and practices*) against the identified PRIF requirements, rather than against other existing solutions.
Guideline 7: Communi-cation of research	Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences. • Technology-oriented audiences need sufficient detail to enable the described artefact to be constructed (implemented). • Management-oriented audiences need sufficient detail to determine if the enterprise resources should be committed to constructing and using the artefact within their specific enterprise context.	The PRIF is presented effectively: • The *method, mechanisms and practices* of PRIF present sufficient detail to EA practitioners, who had to use the *method, mechanisms and practices* in identifying process re-use opportunities at their enterprises. • The method-artefact includes components to plan the scope of method-application at an enterprise. Research participants had to facilitate discussions with business unit managers and the chief enterprise architect to define the scope of implementation.

As can be seen from Table 7, the research design for the development of the PRIF adheres to the guidelines proposed by Hevner et al. (2004). As proposed by Hevner et al., the guidelines assisted with the identification of an appropriate approach and evaluation methods.

The following sub-sections provide details on the data collection methods that were used as part of the design research process.

2.6.2.1 Data collection in defining the research problem

During the initiation of the study, (Figure 15, column 1, *Awareness of problem*) a *questionnaire* was used (discussed in section 2.4.2), based on experimentation, to evaluate the practicality of defining an OM and high-level representation of the EA (as depicted on a core diagram). This study takes the stance that EA practitioners will be primarily responsible (in consultation with the chief executive officer and business managers) to define a future OM, based on business architecture analyses. Questionnaires would thus be a suitable instrument to obtain feedback from EA practitioners on the practicality of defining the OM, based on guidelines provided by Ross et al. (2006). The questionnaires incorporate both closed-ended and open-ended questions (see Appendix A).

The research participants received training to ensure that they were knowledgeable on business-IT alignment, strategic decision-making, and the *foundation for execution* approach and associated artefacts as defined by Ross et al. (2006). A *convenience sample* (see definition in section 2.4.2.2) of *thirty* graduate participants was used, of which fifty-two percent (52%) of the participants had previously obtained an engineering degree, thirty-two percent (32%) a technical diploma, twelve percent (12%) a Bachelor of Science (BSc) degree, and four percent (4%) a Bachelor of Commerce (BCom) degree (De Vries & Van Rensburg, 2009).

2.6.2.2 Data collection to evaluate the use of the interaction model

The second sub-cycle (Figure 15, column 2, *Sub-cycle 2*) required evaluation of the interaction model as a component of the *method, mechanisms and practices* of PRIF. According to the set of requirements generated in sub-cycle 1 (Figure 15, column 2, *Sub-cycle 1*), the *method, mechanisms and practices* required a *process representation language* that would adhere to two of seven requirement categories.

This thesis argues the use of the ontological aspect models, and more specifically the interaction model, as a suitable *process representation language*, that could be incorporated as part of the PRIF *method, mechanisms and practices.* EA practitioners would ultimately use the interaction model; therefore, the study required EA practitioners to experiment with the interaction model. One of the two requirements stipulates that *business users* should be able to understand the process representation language that is used in rendering process reuse identification results. The study consequently required evaluation of the interaction model from two viewpoints: (1) the *EA practitioner's* viewpoint and (2) the *business user's* viewpoint.

The experimentation process followed a participative approach, where a sample of four research participants (industrial engineers) represented an *EA practitioner's* viewpoint. The participants received extensive training in the use of the interaction model and the underlying theory. Each participant was responsible for developing an interaction model for a different engineering department at a tertiary education institution, using the ABACUS tool. ABACUS (architecture based analysis of complex systems) is a repository-based modelling tool that supports over 30 public frameworks and notations (Avolution, 2012). ABACUS was selected as modelling tool due to several reasons:

- Availability of the ABACUS tool to the research participants.
- Support from the ABACUS-vendor, Avolution, to develop templates in modelling the ontological aspect models, based on the DEMO-3 specifications (Dietz, 2009).
- The ability to perform comparisons between different models, due to the repository of components and connections, and reporting tools of ABACUS.
- The ability to re-use components and connections within several graphical representations.

For the *business user* perspective, *four* heads of departments (HODs) were involved interactively to evaluate the contents of their departmental interaction model. An introductory presentation ensured that HODs received sufficient training in understanding the theory behind the interaction model (see Appendix B for introductory presentation slides). The HODs were also requested to provide feedback on the ease of understanding of the interaction model in the form of a *semistructured interview* (see definition in section 2.4.3).

2.6.2.3 Data collection to evaluate the PRIF method, mechanisms and practices

During the evaluation process of the main cycle, (Figure 15, column 1, *Evaluation*) a *questionnaire* was used (discussed in section 2.4.2). The questionnaire was based on experimentation, and evaluated the ease-of-use and usefulness of the *method, mechanisms and practices* from an *EA practitioner viewpoint*. The research participants (EA practitioners) also had to explain the use of the *method, mechanisms and practices* to their business unit managers to obtain feedback on its ease-of-understanding from a *business user* viewpoint. The questionnaires incorporated both closed-ended and open-ended questions (see Appendix A, *Task 1* and *Task 2*).

This study had to ensure that the group of research participants were knowledgeable on business-IT alignment, as well as the *foundation for execution* approach (Ross et al., 2006) and the *essence of operation* approach (Dietz, 2006). The participants also received training on the use of the *method, mechanisms and practices*, and the underlying theories (see Appendix B on training notes). A *convenience sample* (see definition in section 2.4.2.2) of *fourteen* post-graduate participants was used. However, two participants were excluded; one participants was absent from both training sessions on the interaction model and underlying theory, whereas the second participant applied a different method than stipulated by the PRIF *method, mechanisms and practices*. Although a small sample, if compared to a sample of 30 participants in the survey pertaining to the practicality of the OM and core diagram (discussed in section 2.6.2.1), training sessions were highly interactive due to the small group, consequently participants gained a thorough understanding of the underlying theories covered during the contact sessions.

The profiles of the *twelve sample* participants indicated that seventy-five percent (75%) of the participants previously obtained an industrial engineering degree, eight percent (8%) a mechanical engineering degree, eight percent (8%) a technical diploma and eight percent (8%) did not indicate the tertiary qualification.

2.6.3 Exploratory design and data collection for building the BIAM

This study applied an exploratory design as a research design to develop the BIAM (Business-IT Alignment Model), solving *Research Question 1*. According to Marshall & Rossman (2011) qualitative methodologists have described three major purposes for research: to *explore*, *explain* or *describe* a phenomenon. An *exploratory* study has one or more of the following objectives (C. Marshall & Rossman, 2011):

- To investigate little-understood phenomena.
- To identify or discover important categories of meaning.
- To generate hypotheses for further research.

In developing the BIAM, exploratory design aims to satisfy the second objective, i.e. to identify or discover important categories for current alignment approaches. A *literature review* (data collection method) *inductively* extrapolated themes from existing data. Figure 16 applies the concepts on inductive and deductive reasoning as described by Trochim (2006). Inductive reasoning required iteration back and forth between the themes and the data until a comprehensive set of themes were established (see Figure 16, *Iterate back and forth* arrow).

This study used *four main data sources* in constructing the BIAM:

1. Six current alignment approaches.
2. Theoretical foundations of the six alignment approaches.
3. The ISO/IEC/IEEE 42010 standards.
4. Lapalme's three schools of thought.

Although not part of the primary data source, this thesis also refers to *other alignment approaches* (discussed in section 3.4) as a *secondary data source*, to provide additional motivation and explanation for some of the BIAM constructs.

The use of BIAM was demonstrated by applying BIAM *deductively* to four diverse approaches:

1. The *Zachman* approach (Zachman, 2009a).
2. The *Open Group* approach (The Open Group, 2009).
3. The *foundation for execution* approach (Ross et al., 2006).
4. The *essence of operation* approach (Dietz, 2006).

The following four sections (sections 2.6.3.1 to 2.6.3.4) present the main data sources for developing the BIAM inductively.

2.6.3.1 Data source 1: Six current alignment approaches

The study analysed six current alignment approaches (Figure 16, *Data source 1*), later discussed in section 3.3, to highlight commonality in terms of business-IT alignment:

1. The *Zachman* approach (Zachman, 2009a).
2. The *Open Group* approach (The Open Group, 2009).
3. The OMB approach ((OMB, 2005, 2007a, 2007b).
4. The Gartner approach ((Bittler & Kreizman, 2005; Gartner, 2008a, 2008b; James, Hander, Lapkin, & Gall, 2005)
5. The *foundation for execution* approach (Ross et al., 2006).
6. The *essence of operation* approach (Dietz, 2006).

2.6.3.2 Data source 2: Theoretical foundations of the six alignment approaches

Since the six alignment approaches (used as data source 1) were also derived from existing theory, the exploratory study also analysed the main theoretical foundations of the six alignment approaches (Figure 16, *Data source 2*), which include systems theory (discussed in section 3.2.1), systems engineering and the basic system design process (discussed in section 3.2.2).

2.6.3.3 Data source 3: ISO/IEC/IEEE 42010 standard

The first version of the BIAM was published in 2010, then called the BIAF (De Vries, 2010), and did not conform to the ISO/IEC/IEEE 42010 standard (ISO/IEC JTC 1/SC 7 committee, 2011) on *architecture description* (see section 3.2.4). In this thesis, BIAM was updated to ensure compliance with the ISO/IEC/IEEE 420 standard on *architecture description.*

2.6.3.4 Data source 4: Lapalme's 3 schools of thought

Although not incorporated in the published version (De Vries, 2010), this study also extended the BIAM, by incorporating the three schools of thought of Lapalme (2011). The three schools of thought highlighted different levels of alignment scope and are further discussed in section 3.2.3.

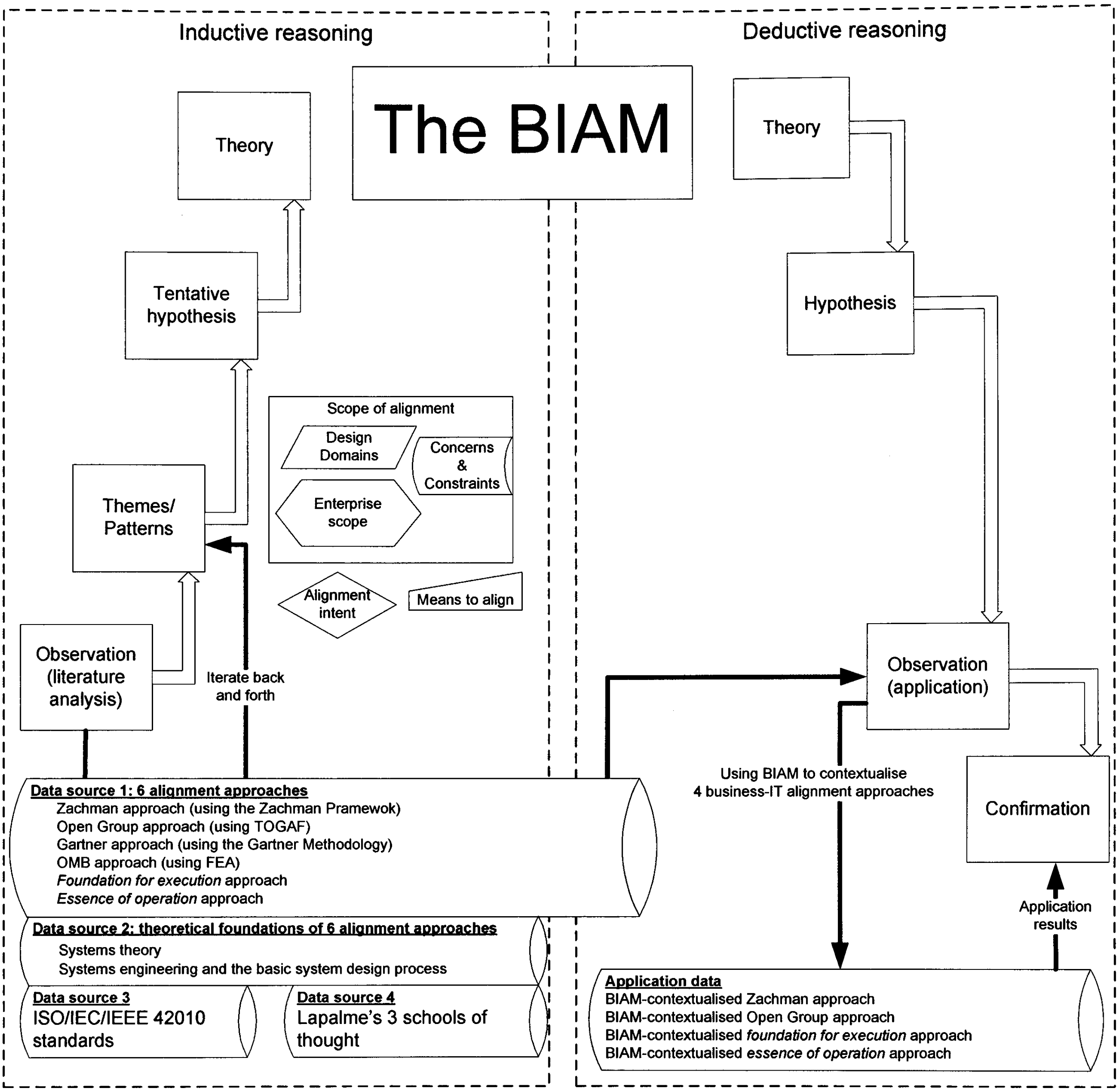


Figure 16: Exploratory design for building and applying the BIAM

Since the study involved humans during interviews and questionnaires, the next section demonstrates adherence to ethical principles and discipline-driven requirements.

2.7 ETHICAL PROCEDURES

The University of Pretoria employs a value system to ensure that researchers (1) should be true to the ethical principles of justice and credibility, and (2) shows research responsibility and duty when involving humans, animals or the environment as subjects of the research (University of Pretoria committee for research ethics and integrity, 2007). Since this study involved humans during interviews and questionnaires, the discipline-driven requirements were followed as stipulated by the Faculty of Engineering, Built Environment & IT. A proposal related to this study was submitted and approved by the ethics committee (see proposal and approval letter attached in Appendix C). The proposal addresses two main ethical concerns, (1) anonymity of participants, and (2) confidentiality of enterprise information.

In accordance with the proposal submitted to the ethics committee, a letter was submitted (headed *Letter of research participation consent)* to every research participant, stating that the questionnaire results would be treated anonymously and that enterprise information will be kept confidential (see Appendix C for signed letters). In addition, a letter was submitted to each research participant (headed *Providing consent for doing architecture work*) that required completion by the participant and his/her direct manager for doing architecture work and obtain information from the business management community (see Appendix C for signed letters).

2.8 CONCLUSION

This chapter provided the rationale for using a mixed methods design as an applicable research design for this study. The first sections incorporated *theory on research methodology* (research paradigms, research designs and methods for data collection), whereas the follow-up sections provided an *application of theory* to deliberate the paradigm that applied to the mixed methods design for this thesis.

According to the mixed methods design of this thesis, the main research question is addressed by using two research design components. The core component (*design research*) addresses *Research Question 2* by developing the PRIF (Process Reuse Identification Framework). The supplementary component (*exploratory design*) addresses *Research Question 1* by developing the BIAM (Business-IT Alignment Model). The chapter concluded with the ethical procedures that applied to this thesis.

Although *design research* is the core component of this thesis, the next part (Part B) starts with a discussion of the supplementary component in developing the BIAM. The reason for starting with the supplementary component is that its result, the BIAM, is used to provide business-IT alignment insight for the core component.