CHAPTER THREE

RESEARCH METHODOLOGY AND DESIGN

3.1 Introduction

Chapter 2 discussed the philosophical underpinnings of IS research. These will be used to guide the research in picking an appropriate research methodology and in Chapter 4 they will guide the researcher in motivating for a correct theoretical conceptual framework that guide the investigation of the phenomenon under study.

"…adequacy of a theory … cannot be divorced from the process by which it is generated."

Barney G. Glaser and Anselm L. Strauss, 1967.

Every research process, whether deductive or inductive, has to use some theory. Glaser and Strauss (1967) emphasized the need to chose, plan, execute carefully and document comprehensively all the processes that are undertaken during research if the research goal is to generate theory. This task contributes immensely to the acceptance and final use of the theory in practice.

When researching phenomena that do not fall into the functionalist and positivistic paradigms, researchers find it more compelling to spend some time in choosing the most appropriate research methods. Most importantly, if the research is qualitative and interpretive in nature, more emphasis should be placed on the research design process in an attempt to ensure that two factors, quality and rigour, are satisfied. This chapter discusses the methodological facets needed to come up with good research whose output can be relied upon.

Firstly, the philosophical nature of a research problem dictates the research approach and methodology that will be followed. To borrow Glaser's dictum (1992), a methodology can be described as a theory or study of methods. A single research project may use one or several methods. It is, therefore, essential to order and describe these methods in a coherent way. We begin this chapter by discussing the philosophical assumptions made about the research problem. We then discuss the research approach. A brief discussion on qualitative and interpretive research then follows. In order to familiarize the reader with various qualitative research methods, a very brief discussion of these methods is given in this chapter.

In Sections 3.3 to 3.6, the GTM, the research method used in this study, is discussed in detail. This discussion is in conjunction with the discussion on research design and, lastly, the

quality requirements of an interpretive research are outlined. The chapter concludes with an analysis of the criteria for ensuring quality and rigour in qualitative information systems research as used in this research.

3.2 Research and Methodological Approach

This section is devoted to the discussion of the research and of methodological approach used in this study. It highlights the relationship between sound theory generation and the processes involved in its development. It is of the utmost importance to explicitly explain the meanings given to research approach, methodology and method, as opposed to the use of these terms in the software development field.

3.2.1 Research Approach

In a research approach we look at the pragmatic question of how the step-by-step execution of a research project is carried out. An approach may be defined as an overall idea of how the project will be undertaken. Depending on the degree of complexity of the problem, a single project may require one or a triangulation of techniques from both the qualitative and quantitative research paradigms. It may also require the use of both the inductive and deductive techniques as expounded by Bryman (2004). Some researches move from inductive reasoning to theory generation and then to deductive testing of the theory for validity, using some empirical methods. Others may just require the empirical testing of a theory, that is, the deductive process only. This research is an inductive type of study and does not require the testing of the generated theory. This study, however, calls upon the use of research techniques from the qualitative paradigm only.

3.2.2 Methodological Approach

The methodological approach consists of the research methods, research design, data-acquisition methods, modes of data analysis employed in the research and the justifications for employing all these techniques. In this regard, research methodologies are viewed as translation languages that map the principles of a paradigm to actionable steps to be followed in a research project, that is, the methods. This research assumes the definition of a methodology, the science of methods, to be a set of research principles that are related very closely to a unique paradigm. The methodology as a translation language provides "guidelines on acceptable research practices" (Sarantakos, 1997:34). This section discusses each of these methodological components in general and then in relation to how they have

been applied to this study.

3.2.2.1 Qualitative Research Methods

A research method may be seen as a "general way of thinking about conducting qualitative research" (Trochim, n.d). These methods require the purpose of the research, the part played by the investigator and the research phases (including the data-gathering and data-analysis techniques) to be described either "explicitly or implicitly". Research methods are more prescriptive and are dictated by the research methodology chosen. Different methods can be used in different methodologies but the reverse is not always true. Sarantakos (1997:34) sums it up by saying "methods are a-theoretical and a-methodological". The choice of research method influences the way in which the researcher collects and analyses data.

We will start by discussing some of the methods used in qualitative research. Finally, we will discuss the method used in this study. The discussion, however, is not exhaustive but only serves to give the reader an appreciation of why the researcher used GTM in this study. For a more comprehensive understanding of some of these different research methods in information systems and qualitative research, the reader is referred to Goede (2005:31-37) and Alexander (2002:30-38) who took the most trouble to discuss the pros and cons of a variety of these methods in their theses. Also, Myers (2003) has dedicated a website hosted by MIS Quarterly and the University of Auckland, to the discussion of most of these methods.

Ethnography

This method originated as a derivative of two Greek words namely, *ethnos*, which refers to people or ethnicity and *graphein*, which refers to the art of writing (Wikipedia, n.d.) or to a geographic location (Trochim, n.d.). Its philosophy is based on the assumption that, when one is studying culture, one needs to immerse oneself in the society whose culture is the subject of the study. In short, ethnography is the study of a social entity or practice in its geographical location.

The study of culture can only be done in conjunction with the people or society in which the culture resides. They cannot be separated. In modern day research, one cannot separate the culture of an organization from the organization itself. When applied to information systems, one cannot separate the system under study from the organizational context or from the people who will eventually use the system.

In such a case, the developer needs to be part of the system under study and also be able to capture the context, the culture and the political aspects inherent in the organization. The researcher assumes the role of an active participant in addition to being an observer of the other actors in the system.

Hunter (2003:297) qualifies this study as an exploratory type of study that has to be done over an "extended period of time".

Phenomenology

This method looks at the subjective experiences and interpretations of people who are the subjects of the research. The way others view the world is the focus of the study. As described in SEP (2008), it is "the study of structures of consciousness as experienced from the first-person point of view." In other words, it is a study of how people experience the presence of artefacts around them.

Field Research

This method can double as both a qualitative research method and a data-gathering technique (Trochim, n.d.; Hunter, 2003). As a method it grew out of its frequent and general use as a data-gathering technique. Researchers could not separate it from a method; hence its inception and cooption as a method in its own right.

Using this method, the researcher goes into the field and collects as much field data as is possible about the study area. Data may be collected by means of interviews or questionnaires. These are later coded and analyzed.

Field studies can be used in both positivist and interpretive researches. In the interpretivist tradition, the researcher does not treat data collected as objective facts but as products of individual respondents' interpretations of the situation.

Action Research

The purpose of action research is to test a theory or a hypothesis. In this particular context the researcher is an active participant who engages with other participants (respondents) working in the area under study. The idea is to allow the researcher to be a learner as well as an inquirer in his/her extended relationship with the problem (Hunter, 2003:295).

The action researcher participates in identifying the problem, finding the solution and implementing the solution if needed, in the organization in which the research is carried out. The action researcher goes through a continuous, cyclic process of arriving at a solution,

getting feedback on the appropriateness of the intervention and fine-tuning the solution through a process of further data collection and analysis until the problem is solved.

Narrative Inquiry

Narrative inquiry is a research method in which participants are allowed to relate stories about events that have occurred. The researcher's task is to evaluate and rate the stories as being as correct as is possible. Through the participants' accounts of the events that occurred, the relationships between data in the area of study can be revealed (Hunter 2003:299).

Case Study

Myers (2003) notes that a case study can serve both as a unit of analysis as well as a research method. This partly supports Trochim (n.d.) who does not include it in his discussion on methods but regards it as a data-gathering technique. In contrast to this view, Hunter (2003) and Myers (2003) classify it as a research method. As a research method, a case study can be used in both the quantitative and qualitative paradigms. The main purpose is not to generate general laws but to understand phenomena in their context. The methods discussed here can all be used in conducting qualitative–interpretive research studies. However, this study used GTM which is discussed in the following section.

3.3 Research Method Used in this Study

This research followed a GTM study approach. There are many varied ways of conducting research using GTM, all grounded on either one of the two basic GTM strands, the Glaserian or the Straussian strand. These strands however, always leave researchers wondering which one of the two is better than the other and also looking for their similarities and differences in practice (Van Niekerk & Roode, 2009). However, there is a great difference in how these two strands are used in research as noted by Matavire and Brown (2008). Although some of these are very prescriptive (Strauss & Corbin, 1990), others give the researcher scope to direct the research in a way that suits the research environment. The proponents of GTM (Glaser & Strauss, 1967) and also supported by Charmaz (2006:9), however, urge researchers to use the method flexibly. Charmaz (2006) thus refuses to accept any prescriptive way of using this method. Instead she regards the method as a guiding framework that is as, "a set of principles and practices" that any researcher can fine-tune to suit the context of the particular research project (Charmaz, 2006:9). This argument was adopted in this study, where most of the original dicta have been modified to suit the dictates of the research environment and the phenomenon under study.

3.3.1 GTM

GTM is a research method that seeks to develop theory that is grounded in data. The main idea of GTM is supported by Hacking (2002:15), who, in his discussion of on the "Creation of Phenomena", asked the question "What comes first, theory or experiment?" Hall, the discoverer of the Hall Effect in magnetism, however, insisted that experimentation should be the beginning of a theory and that, for anything to exist, it should be created.

Trochim (n.d.) regards GTM as a generative method whose purpose is to generate or produce theory. Although GTM can produce new knowledge, research findings require a constant and sustained process of "explaining a multitude of factors" that also raise a need for further elaboration (Trim & Lee, 2004:478). The grounded theory approach can be used to produce developing theory, that is, new theory that has not fully reached saturation point. This theory may not necessarily equate to the substantive theory as described by Glaser and Strauss (1967) and others. Glaser and Strauss (1967) urge grounded theorists not to start with a problem statement or research questions, saying that merely an interest in the field will suffice. This argument was, however, refuted in later studies as discussed in Strauss and Corbin (1990), Charmaz (2006) and Leedy and Ormrod (2000). However, adherence to this requirement influences the way the grounded theory researcher plans and executes the research study, as will be described below.

3.3.2 The Research Design

Trochim (n.d.) regards research design as a process or phase that binds the project components together. Each research activity is positioned and described according to its contribution to the overall goal of the research. It is a process of moving from methodological abstractions to descriptions of the practical steps that are proposed and later followed during the execution of the research. Since our chosen research method is GTM, the research design should fit the requirements needed for its use in this research. This section is dedicated to the discussion of this research design and its suitability for the interpretive type of research.

3.3.2.1 Requirements for Sound Application of GTM

In a grounded theory research project, a researcher with an interest in a specific area of study should first identify its substantive area. It is in this area that the developed theory should be applicable and used. In some instances, the area of interest may straddle several disciplines, leaving the researcher with the problem of explicitly defining the substantive area of research.

An example of a research study that straddles two substantive areas is given by Goede (2005). Her research focused on the use of data-warehousing in decision-support systems and system-thinking methodologies. Analysis of this research may mistakenly lead one to identify either system-thinking methodologies or data-warehousing as the substantive area in the decision-support system (Goede, 2005:59-66). This could completely change the research strategy of the study. In other circumstances, both may be selected as substantive areas of research. A critical look at this research, as explained by Goede (2008), reveals that she:

> *"… wanted to study one area from the viewpoint of the other area. I wanted to look at Data Warehousing (DW) from a Soft System Thinking (SST) perspective and not from an objective perspective - I did not want DW answers, I wanted DW from a SST perspective answers".*

In other words, the substantive area was an integral collection of data-warehousing practices viewed from SST as a lens and not separately.

It requires a very critical mind to successfully identify the focus point for literature study and substantive area. Such a multiplicity of disciplines which need to be consulted in the same research at one point or other may start to flout many of the basic dicta of GTM as proposed by Glaser and Strauss (1967).

In this research, there are also two fundamental disciplines that need to be consulted by the researcher. These are the fields of software development and ontology as used in information systems discipline. This dialectical debate emanates from the researcher's interest in using ontology to improve the development methods of information systems. This alone forces the researcher to shift his interest into the way these information systems are developed and, later, into the software products that are used to implement these systems.

The substantive area debate

This study recognizes that the title of the research project, "Towards an ontology-driven software development approach: An unended quest" is multifaceted. It is, therefore, very important that we highlight here that the substantive area is neither software development nor the study of ontology in information systems, but is an integration of both of these. Put more simply, it is the study and use of ontology in the development of software products.

As such, the study does not need to separate software development and the ontology discipline and later choose either one of them as its substantive area. It, therefore, treats the

two fields as substantive areas and any dictum applying to the sound use of GTM principles will be applied with respect to this resolution.

3.3.2.2 Problem Statement and Use of Research Questions

As part of the research design, Glaser and Strauss (1967) and Glaser (1992) call on grounded theory researchers not to conceive a research question or hypothesis as a statement that focuses on and identifies the unit under study. Many research methodologies call for a research hypothesis into the problem area that guides the method of data collection and identifies the unit of analysis. In contrast, using GTM, the research focus becomes clear during open coding, collection of data by theoretical sampling and analysis of the data through the constant comparison method. Since the researcher does not start with a problem statement but with an interest in the field, he cannot derive these research questions (Glaser & Strauss, 1967; Glaser, 1992).

In contrast to the suggestion made by Glaser and Strauss (1967) and Glaser (1992), Strauss and Corbin (1990:37) advise researchers to start with a preliminary theory, research question or hypothesis. This theory is intended to guide the researcher and define the scope of the study. They argue that, without such a research question, the researcher will be faced with too many aspects to consider in a single research study. However, in choosing such a research question, the researcher should structure this in such a way that it leaves flexibility and freedom for an in- depth exploration. It should not limit the investigator but should only be a guide (Strauss & Corbin, 1990:37). As the research progresses, the research question is narrowed and focused using concepts and relationships to concepts that are inductively arrived at after analysis of the initial data samples.

Strauss and Corbin's (1990) suggestion did not go down well with Glaser (1992), who accused them of encouraging researchers to limit the free generation of theory by introducing preconceived ideas. However, in her book, "Constructing Grounded Theory", Charmaz (2006) concurs with Strauss and Corbin, as she also advocates the use of a preliminary theory.

Despite this academic debate, in practice researchers have to navigate through all of these requirements and come up with a research design that is practical. The present author would like to negate Glaser's (1992) inflexible and strict adherence to the non-use of preliminary theory. After all, study of literature has shown that he does not allow people to criticise his

dicta. This is supported by some of the arguments reflected in his writings such as Glaser (1992), Glaser (1993) and Glaser (2002), addressing his discomfort with Charmaz's (2000) monograph, which suggested that grounded theory be viewed as a constructivist method.

In this research, the author took the risk of provoking Glaser's wrath by proposing preliminary propositions as well as research questions (*Chapter 1, Sections 1.4 and 1.5*). These, however, were strictly preliminary, as advocated by Strauss and Corbin (1990), Gasson (2003) and Charmaz (2006). This is also supported with a study done by Matavire and Brown (2008:145), where 11% of the articles that followed the so-called Straussian strand had a priori theory. In contrast, those that followed the Glaserian GTM strand avoided a priori theory altogether.

3.3.2.3 Use of Literature

"There is a need not to review any of the literature in the substantive area under study."

Barney Glaser, 1992:31

When doing quantitative studies, literature can be used to find relevant previous research in the area, to discover gaps in the knowledge and to find theoretical or conceptual frameworks that are used to guide the research process. When doing qualitative studies, in particular when using GTM, researchers are strongly advised to defer the literature study until such time as they have collected and analyzed the first batch of the research data (Glaser & Strauss, 1967; Glaser 1992 &1993; Suddaby, 2006).

In using GTM, the intention is to discover concepts and hypotheses and not to test or duplicate them. At the beginning of the study, the researcher is advised not to study any literature in the field of study. This, Glaser warns, will introduce researcher bias by having a set of preconceived concepts, categories and properties from other researchers' work. Starting with a literature study will constrain the free discovery of theory and hence defeat the main dictum of grounded theory approach (Glaser & Strauss, 1967; Strauss & Corbin, 1990; Glaser, 1992; Charmaz, 2006; Gasson, 2003). This notion is supported by Hunter (2000:33), who argues that approaching a research problem without preconceptions leads to emergence of a theoretical framework from the data. It is important to mention that Strauss and Corbin (1990) do not completely dissuade people from reading literature in the substantive area before they start gathering data. However, they believe that some understanding of the

research area through literature study increases the theoretical sensitivity of the researcher when generating theory from the first data samples.

Glaser, however, argues that, only after the collection and coding of the first set of data, and after generating a preliminary theory in the substantive area, can one use data from a literature study of the substantive area to support the emerging theory (Glaser, 1992:31). In their book, Strauss and Corbin (1990:39) talk of preliminary theory being generated from initial data samples, which seems to agree with Glaser's idea. They ask researchers to use a theoretical framework that is generated from the initial data gathered as a starting point in their theory-building process. They stress, however, that the framework should not be derived from the literature study.

Strauss and Corbin (1990:55) also encourage the study of non-technical literature. They list non-technical literature as comprising of letters, reports, diaries, biographies, videotapes and various other materials. Non-technical literature can be used as sources of primary data, supplementing the data collected through interviews and observation. Glaser (1992), however, says that non-related literature can be used to sensitize the researcher theoretically and to improve writing style and presentation techniques, but strictly forbids any literature study in the substantive area of study, whether technical or non-technical. Possibly the debate is on their interpretations of what constitutes technical, non-technical, related and unrelated literature. Glaser (1992:35) summarizes the argument by noting that reading unrelated literature:

"…maximizes the avoidance of pre-empting, preconceived concepts which may easily detract from the full freedom to generate concepts that fit and are relevant when initially coding and analyzing the data as it is collected".

The next section discusses how the present researcher used this debate on the use of literature in this study.

Use of Literature in this Research

Sociological researchers such as Glaser and Strauss (1965) often have the privilege of carrying out investigations in areas whose disciplines could be very new to them. An example of this is their study on the dying of patients in their paper, "Awareness of Dying" (Glaser & Strauss, 1965).

It is quite possible that they did not have prior knowledge of the literature in that particular discipline. However, this is not the case with many researchers, who investigate issues in their fields of expertise. As Campbell, (2009) noted, very few people, if any, begin their research without some prior knowledge. Prior knowledge and prior reading of the field under study is a given. He goes further to tell researchers to concentrate on reducing the impact of this prior knowledge on the process of theory generation. In such cases, it is difficult to heed the dictum not to read literature in the substantive area. This is the case in this research study. The author is a lecturer in Information Systems and is familiar with literature on software development and ontologies. It is apparent that the biggest challenge then is to observe and adhere to the requirements of the dictum laid down by Glaser and Strauss (1967).

The researcher instead allowed his prior knowledge to encroach into the research. This, if we use Glaser's argument on what constitutes data (Glaser, 2002), should not have an effect on the answers that the respondents gave during the interviews. The data should come from the field and the researcher limited as much as possible any discussion on software development and ontologies with the respondents before the interview. In cases where the interviewees wanted to know about the study, these discussions only took place after completion of the interview.

It was only after the analysis of the preliminary data samples that the researcher started consulting the literature in the fields of software development and ontologies. The researcher felt free to do this using the argument that GTM proposed by Glaser and Strauss is not a prescriptive method but should be viewed as a guiding principle.

3.3.3 Data Acquisition Methods

Interpretive research can employ both quantitative and qualitative data. The choice of the data to be gathered is guided in most cases by the philosophical underpinnings of the research problem. This section will briefly discuss the qualitative data gathering method only.

3.3.3.1 Qualitative Data Acquisition

The data gathering methods employed in this research are qualitative. There are four basic tenets of qualitative research: contextualism, process, flexible use of theories and, lastly, the acceptance and focus on the participants' and researcher's perspectives (Struwig & Stead, 2004). These aspects have to be considered whenever a researcher collects data. Qualitative data are usually unstructured, unbounded and textual in form. The data are a reflection of

how the respondent views his/her contextual settings and of how he/she interprets and presents the organizational view. The richness of these data may be lost when researchers attempt to aggregate or summarize them.

Qualitative research data collection can "capture complex and subtle social and behavioural data" (Cornford & Smithson, 1996:125). Using qualitative research, data are acquired by means of techniques such as interviews, questionnaires and observations. Characteristically, qualitative data are "narrative, impressionistic, opinionative and textual"(p.125). It is widely believed that qualitative research data collection methods are holistic in that they capture the most representative set of a study area.

3.3.3.2 Data Acquisition Methods for this Study

According to Olivier (2004:11), a research project should have primary and secondary goals. These can be deduced from the research objectives and the research questions for each project. Depending on the type of goal to be reached, either primary or secondary, different methods can be used to achieve it. For the sake of semantic uniformity these methods are classified as primary and secondary data-acquisition methods.

Prerequisites for GTM Data Gathering

"How you collect data affects which phenomena you will see, how, where, and when you will view them, and what sense you will make of them."

Charmaz, 2006: 15

Data collection is a very delicate process that needs to be managed. The quality of the research results is directly dependent on the data-collection process used. Several data-collection techniques are available for qualitative research, but, for GTM purposes, it is important to give more weight to field notes, interviewing, document and report sampling. GTM requires all interviews and field notes that are collected at the beginning of the research to be transcribed for coding and analysis.

Charmaz motivates for a data-gathering method that would allow researchers to view the researched phenomena in the same way as the participants in the research area see it (Charmaz, 2006:13). The data-gathering techniques can be changed during the research process to suit events occurring in the field. In fact, the data-collection methods should be chosen so that one gets appropriate data that soundly answer the research questions. Later, the researcher may chose to transcribe code and analyze specific portions of the data, a

process called theoretical sampling. Theoretical sampling is done in an attempt to reach theoretical saturation and density in the generated theory (Glaser, 1992).

3.3.3.3 Primary Data Acquisition and Sampling

In this study, the primary goal was to find the empirical evidence that supports the claim that ontologies can capture the human elements inherent in organizations. The survey method of interviewing was used to gather data from system development practitioners. The only problem encountered is that the interviewees had no knowledge of IS ontologies.

However, a vast range of people could have been used as respondents: end users, system analysts, programmers and IT academics would all have met the criteria. However the present researcher decided to start the data-gathering process with three IT academics who also have varying levels of industry experience.

The reason for doing this was based on the need to fine-tune the interviewing process as well as the interview questions. Academics are naturally expected to have a wide general knowledge of software development, including the concepts and practices that are used in the development process. This is discussed in greater detail in Section 6.1.

The three IT academics have different backgrounds, including system development methodologies, the philosophy of information technology, soft systems development methodologies, systems thinking, traditional and agile methodologies, programming and system and business analysis. The choice of academics allowed the researcher to elicit as exhaustively as possible a good number of codes and categories of incidents during the open coding process.

After the initial interviews, the door was opened for other practitioners, amongst whom were project managers, systems and software developers, system and business analysts and system test analysts.

Interviewing Techniques

With or without a specific research question, Glaser (1992:25) advises researchers not to ask direct questions during interviews. This dictum is used in a bid to guard against the preconception of emergence of data. He also proposes three fundamental formal ways of approaching the interviewing process if researchers use GTM. The first requirement is for the researcher to probe people working in the substantive area in an attempt to find their concerns. As they work in the substantive area, these people will have different ways of

arriving at a solution. The researcher is then tasked with finding reasons for the differences in their approaches to a problem.

The second requirement is to find categories of incidents as they show themselves in the substantive area. As Glaser (1992) stipulated, the fundamental rule for GTM is that theory must be based on emergent relevance of categories.

For sound GTM practice, Gasson (2003) identifies two elements that support Glaser's proposition. In the first, he advises that patterns inherent in the observed empirical data should form the basis of theory. Unlike hypothesis testing, he adds that inferences and prejudices or the association of ideas should not be entertained when conducting grounded theory research. Suddaby (2006) supports this by advising researchers that, when GTM is employed, one cannot make truth statements about reality, instead, grounded theory is about insights and explanations about social relationships and how they can be used to construct reality. Hence, it is more appropriate to deal with propositions and not hypotheses.

In the third, he notes that the use of the Constant Comparison Method allows the emergence of theory. This theory, the codes and constructs (or categories and their properties) are constantly weighed against new data. Such constant comparison confirms that theoretical constraints are a by-product of – and are embedded in – the data. The primary data consisted of seven interview data samples which were collected using unstructured open interviews. The total number of interview questions was twenty six (26) and focused on different aspects of software development and implicitly on ontologies, as shown in Table 6.1.

3.3.3.4 Secondary Data Acquisition Methods

The researcher used a literature study in both software development and ontologies as a secondary source of data. This literature consisted of journal papers, conference papers, textbooks as well as email discussions. Although ontological research and the use of ontologies in software development are still in their infancy in South Africa, a number of research papers and proposed differential ontology models have already been published.

The secondary goal also consisted of building theoretical constructs that were finally used in the development of an ontology framework. The secondary goal supported the primary goal by providing a solid reference ground and the necessary theoretical sensitivity needed in generating the constructs from interview data. More so, it provided the necessary ontology information needed to fill up the gap in software development methodologies. As part of the

literature study, previous work done on system and software development and on ontology development was consulted. These are reflected in Chapters 4 and 5 respectively.

3.3.4 The Research Goals

Every research process should have research goals. These research goals can be classified as technical, social or philosophical in nature. Technical issues deal with the implementation of systems (Olivier, 2004). With respect to this research, technical goals might deal with the implementation of the ontology framework in software development. This is the task of a design science project as explained in Hevner *et al.* (2004). As this was not the purpose of the research, this was deferred for future research.

Social issues deal with the humanistic nature of any system or with its investigation (Olivier, 2004). Social goals require scrutiny of the social construction nature of software products and of how the ontology framework can capture these social aspects. These social issues form most of this research study. Most of the discussions on Chapters 4 and 5 addressed this research requirement.

Philosophical aspects of the study delve into the hidden assumptions made about the research under study. The fundamental questions are:

- What are we investigating?
- Is it objective or subjective?
- Is it a given or a product of the human or societal construction in which it is found?
- What constitutes the research?
- What actually are the problems bedevilling software product development and what do developers do about them?

These philosophical goals dealt with the basic paradigmatic tenets proposed here of moving from a mechanistic to a romantic software development approach. These tenets are used to justify the important role played by ontologies in software development. The mechanistic characteristics of software products are discussed in Chapters 4 and 6. These were elicited from technical literature as well as from the respondents. Chapter 5 provides information on the descriptions of ontologies, their social nature and some of the areas in which they can be applied.

The data-gathering methods indicated in Table 3.1 fall into one of the following categories: empirical, creative or tautological (Olivier, 2003). An empirical study was carried out in order to get primary data. This empirical study was based largely on interviews. The idea was to use this empirical method to generate and explore theory. The empirical evidence gathered was not used for testing theory but for the generation of theory.

Table 3.1 summarizes the data-gathering methods used in this research and the specific data-gathering goals of the project.

Table 3.1: Research Goals and Data Gathering Methods

Research Goals and Data Gathering Methods (*Adapted from Olivier, 2004*)				
Goal Type	**Data Gathering Method**	**Goal Category**		
		Technical	**Social**	**Philosophical**
Primary	Survey (Interviews)		Yes	
Secondary	Literature Study	Yes	Yes	Yes
	Model	Yes		
	Framework		Yes	Yes
	Arguments		Yes	Yes

Secondary data were used in this research to extend the theory, to fill the gaps in empirical evidence and also to increase the theoretical sensitivity of the researcher. The literature study provided much of the secondary data. This is a tautological type of evidence-gathering. Tautological methods are good at transforming inputs to reveal hidden characteristics that would otherwise not be obvious in the inputs prior to their transformation (Olivier, 2004). This is the purpose of Chapters 4 and 5 as reflected in Chapter 6.

In addition to the literature study, arguments and theoretical frameworks were used to develop new abstractions or theories. This creative type of method was employed to build the ontology framework and later, the ontology-driven software development approach that is described in Chapter 6 of this study. Although the process of model formation is included in Table 3.1, this aspect was not used in this research since it did not fall within the scope of this

research project. A model is more prescriptive and usually is a product of design science research project. The development of domain or process ontologies can be likened to this type of research goal.

3.3.5 Data Analysis in GTM

The generation of theory is a process of converting raw data into information. In this study, interview transcripts were coded, interpreted and subjected to several cycles of analysis to come up with the substantive theory. It is very important to note that many of the respondents were not familiar with the discipline of ontology as applied to software development. However, they were quite familiar with the information systems discipline that included the software development process. The issues they revealed as requirements for romantic systems development needed to be mapped onto the ontological concepts that formed the framework. This process was heavily based on a review of the literature in software development and in the field of ontology, as discussed in Chapters 4, 5 and 6.

3.3.5.1 GTM Coding

Grounded theory recognizes two types of codes: substantive and theoretical codes. The conceptual meanings that are given by generating categories and their properties comprise their substantive codes. These substantive codes are made up of the data patterns that are revealed in the substantive incidents during field data-gathering. On the other hand, theoretical codes comprise conceptual models of relationships that theoretically relate substantive codes to one another.

The ability to generate these codes is of the utmost importance during the generation of grounded theory. To achieve this, three basic types of coding are used: open coding, axial coding and selective coding (Glaser & Strauss, 1967; Glaser, 1992; Strauss & Corbin, 1990; Charmaz, 2006). These three types of coding are discussed below. It should be noted that a qualitative analysis piece of software called Atlas.Ti 5.2 was used in this study.

Open Coding

Open coding is a process tasked with the discovery of categories and their properties and which classifies them into themes or categories, at the same time looking for trends in the data (Gasson, 2003; Glaser, 1992; Glaser & Strauss, 1967). During this process, Gasson (2003) advises researchers to look for commonalities, associations and implied causality in

the elicited categories. The basic premise for open coding is that the research starts with no concepts at all. In the end, open coding has to establish core categories.

Open coding breaks the data down into incidents. These are further examined and analyzed to check for similarities or differences in the incidents thus generated. Glaser (1992:39) urges researchers to constantly check the "category or property of a category" indicated by the incident. The process of eliciting categories or their properties should be based on sound, unbiased judgments and on an unbiased view of the data.

Gasson (2003) and Strauss and Corbin (1990) argue that good open coding is informed by literature.

The Constant Comparative Method

This is an analysis process in which the researcher constantly compares incident with incident and then incident with concept. The properties of categories are generated during this process. The next step is to find the categories or the properties of the categories to which the incident belongs. Suddaby (2006:636) noted that the constant comparative method is tasked with translating the raw observations to a higher level, to "more abstract theoretical categories." This necessitates a continuous interplay between data analysis and collection. As Suddaby (2006:636) affirms, the most important and challenging part of employing GTM is the failure of researchers to "lift data to a conceptual level" resulting in mere reportages of data.

When generating categories, the grounded theory (GT) analyst looks for patterns and a conceptual name (i.e. a category) is given to a pattern of many similar incidents. The compared incidents can be used as indicators of the same concept. Saturation point is reached when many interchangeable incidents are found and coded. Categories are generated from similar occurrences of a pattern and not from isolated single occurrences that cannot be generalised. Then, theories should be allowed to emerge freely from the data. Patterns of data should be allowed to show themselves at a grand level of incidents and sift down through to the properties of incidents.

Lastly, when doing open coding, one can consider line-by-line analyses of sentences, paragraphs or entire documents. The most important thing is to allow the piece of data under analysis to form a comprehensible pattern or incident that can be used at the conceptualization stage to generate, discover or develop a category.

When researchers use the constant comparative method during GTM open coding, there are four basic questions, as expounded by Glaser and Strauss (1967), Glaser (1992) and Charmaz (2006), which should be used as lenses to direct the elicitation of categories as well as their properties. These questions are:

- Of what are these data a study?
- What category or what property of category does this incident indicate?
- What is actually happening in the data? And lastly,
- What are the basic social psychological processes or social structural processes in the main problem that make life viable in the action scene?

The questions should be asked repeatedly until such time as enough data, coding and analysis has occurred for the researcher to embark on "theoretical sampling and selective coding" (Glaser, 1992:51).

Unit of Analysis

Coding is a process of analyzing data. As such, the researcher is faced with the problem of choosing the correct unit of analysis. In open coding, this may be "*a sentence, a line from a transcript, a physical action … or a combination of*" such elements. In data analysis it is important to differentiate between the terms used by the respondents and the technical terms that the researcher associates with the phenomena. Gasson (2003:82) claims that this will reduce the bias that could be introduced in the analysis by the researcher's own preconceptions.

Axial Coding

Gasson (2003) describes axial coding as a constant search for relationships that exist among coded elements. Categories, sub-categories and their properties, as elicited during open coding should be scrutinized to check for similarities and dissimilarities in their associations. It is an attempt to relate structure to the process.

Theoretical Sensitivity

Glaser (1992) refers to theoretical sensitivity as the researcher's knowledge, comprehension and expertise that enables the generation of categories and their properties. Strauss and Corbin (1990:31) regard this theoretical sensitivity as more of a personal trait. These qualities

enhance the researcher's ability to relate the categories and properties to hypotheses and later to integrate them into hypotheses according to the emergent theoretical codes (Glaser, 1992). The main task of theoretical sensitivity is to generate concepts from the data and to establish their relationships using normal models of theory. It is a case of finding meaning, relationships and concepts in the data collected.

The ability to undertake theoretical sensitivity marks the difference between an informed and knowledgeable researcher and a theoretically competent grounded researcher. Unlike the former, the latter has the ability to generate hypotheses and convert them into theory. Strauss and Corbin (1990) attribute this ability to the researcher's intelligence, research, academic and professional background, as well as to the researcher's understanding of the area under study.

Besides undertaking sociology classes on theoretical coding and conceptualization, Glaser urges the grounded theory researcher to constantly study "substantive and formal theory" in any discipline other than that under study. He urges researchers to "Study theory constantly", (Glaser, 1992:28). By knitting the theoretical codes together the researcher will be able to see the research, the research data and the concepts that emerge from the data in a novel way. These can then be used for the generation of theory.

Researchers should always bear in mind that GTM is not a verification type of methodology. Hence, the hypothesis so generated "need not be verified, validated, or more reliable" (Glaser, 1992: 31-32). He, however, stresses the importance of the "rigor of systematic generation of theory".

Theoretical Memos

While doing coding, the researcher is intermittently struck by emergent theories, theoretical formulation and ideas about data. These revelations should be documented and are referred to as theoretical memos. By documenting these emerging materials, the researcher can obtain an insight into the type of questions and data that still require exploration.

Selective Coding

The purpose of selective coding is to factor in data that implicitly and explicitly support the categories already identified and their properties. The researcher should step back and look at the research questions to find what the research data need to generate. At this juncture, the

researcher chooses data that support the intended theory and should realize that not all data are worth analyzing (Gasson, 2003; Glaser, 1992).

3.4 The Double Mapping Principle

The double-mapping principle is a concept that is put into practice when researchers are faced with a study in which two disciplines are both considered as substantive areas in a GTM study. As Goede (2005) found out, in areas where a research straddles two fields, for example, in data-warehousing and systems-thinking, the chances are that the respondents may not be familiar with one or other of these fields. Two options are thus possible: to collect data separately from people in both fields and match them during analysis or to interview a sample of people in one of these fields, depending on the substantive area of study and then do a theoretical mapping.

It is very important to note that, in this study, many of the respondents were not familiar with the discipline of ontology as applied to software development. However, they were quite familiar with the software development discipline. Although both fields of software development and ontologies are considered as substantive areas in this particular context, the researcher could not get responses that were ontology-related.

The respondents gave descriptions of software development issues using their domain language. To match the categories of incidents to the ontology concepts, a double transformation (mapping) had to be done, as illustrated in Figure 3.1. However this mapping required the findings from the ontology literature study, as reflected and documented in Chapter 5, to be used as a primary document. As a primary document in Atlas.Ti, the findings in Chapter 5 generated ontological categories that were later mapped to the software development categories as generated from analyses of the interview data and literature study in Chapter 4.

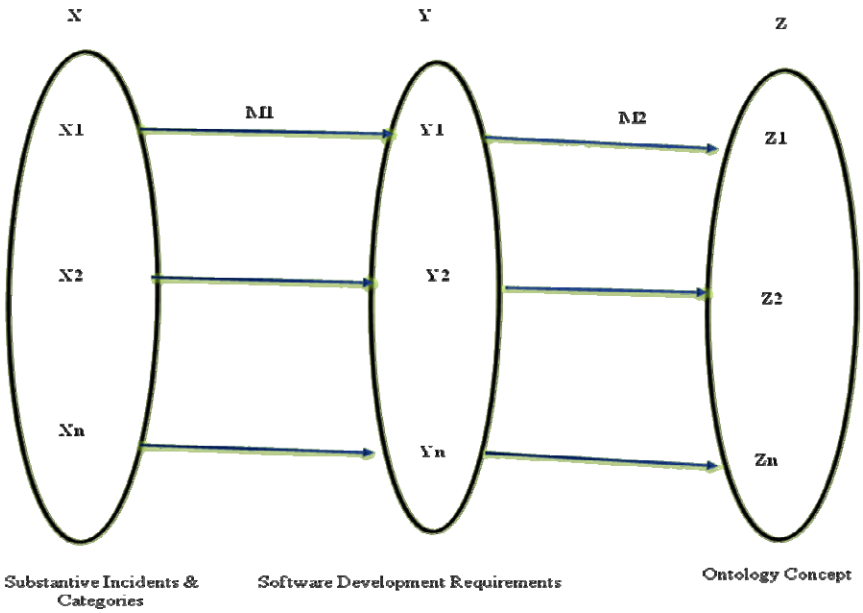

Figure 3.1: Three-Tier Incident and Concept Mappings

In Figure 3.1, X is a class of incidents and categories of incidents in the software development field. Y is a class of codes, requirements for software development process. M1 is the first mapping M(X) to M(Y). In a study consisting of a single substantive area, the relationship between categories in M(Y) could singly be used to generate theory.

However, in this study, a second mapping, M2, was required to map the software development categories to the ontological concepts to which they relate, that is, the transformation of M(Y) to M (Z). This second mapping became necessary because of the existence of the second substantive area and the research requirements of finding a framework of ontology aspects that could be used to improve the software development process. These ontology concepts do not directly have the same meanings as the concepts in use in current software development practices.

The implication of this double mapping is that the relationships between categories generated through mapping M1 could be distorted by the second mapping M2. This could have a serious implication on the final theory generated, as reflected at M(Z). To have a sound data analysis in a case like the one described here, researchers are urged to have a thorough knowledge of literature in the two areas under study. The knowledge of literature, in addition to increasing theoretical sensitivity, will also ensure a more appropriate mapping of concepts and their categories through mapping M1 and M2. In short, researchers are urged to conduct a thorough and continuous study of literature.

3.5 From Substantive to Formal Theory

It is important to note that the theory that is generated during any well planned grounded theory research should support the relationship of the data under study in the substantive area. It is claimed (Glaser & Strauss, 1967; Glaser, 1992; Strauss & Corbin, 1990; Gasson, 2003) that, if the theory fits the data, it is a more appropriate representation of the patterns inherent in data for that same area. This theory is defined as substantive theory. Strauss and Corbin (1990:173) describe substantive theory as one that is generated from *"the study of a phenomenon situated in one particular context"*. This theory, which is generated from a single research project, i.e., substantive theory, cannot be generalized and expected to apply snugly to many other areas with different contexts.

With time, substantive theory needs to be improved to form formal theory. Formal theory is the product of a cross-sectional study of many different contexts. This can only be done by asking researchers in the field to continuously conduct research in the same area and to add more knowledge to improve the representativeness of the theory in the substantive area, but in different scenarios. This process takes time and sometimes requires different types of researches and different researchers. When this is done, the theory can now be generalized at a more conceptual and abstract level. When done soundly, the theory can be referred to as formal theory (Gasson, 2003).

Generation of this formal theory requires time, with different researchers making use of the same substantive theory and application of many conceptual reflections and abstractions before it can be accepted as such in the specific discipline. Also, some people use the variety of situations studied to distinguish between substantive and formal theory. The reflexive type of process that was followed during this study is discussed below.

3.6 The Reflexive Grounded Theory Process

The grounded theory process does not follow a linear set of steps in practice. It is a repetitive process that requires the researcher to consider the previous process as well as the next process. Depending on the results achieved, the steps followed can always be adjusted to improve on the process. This is termed the reflexive process.

The researcher, therefore, followed the reflexive approach discussed by Gasson (2003). The reflexive approach, as used in this research project, is shown in Figure 3.2 below. From project initiation down to the generation of substantive theory, the researcher needed to reflect and make explicit the influences of assumptions and actions taken at each stage of the

research process (Gasson, 2003). The research process is portrayed in a non-linear fashion, a characteristic of how the researcher accomplished the research study.

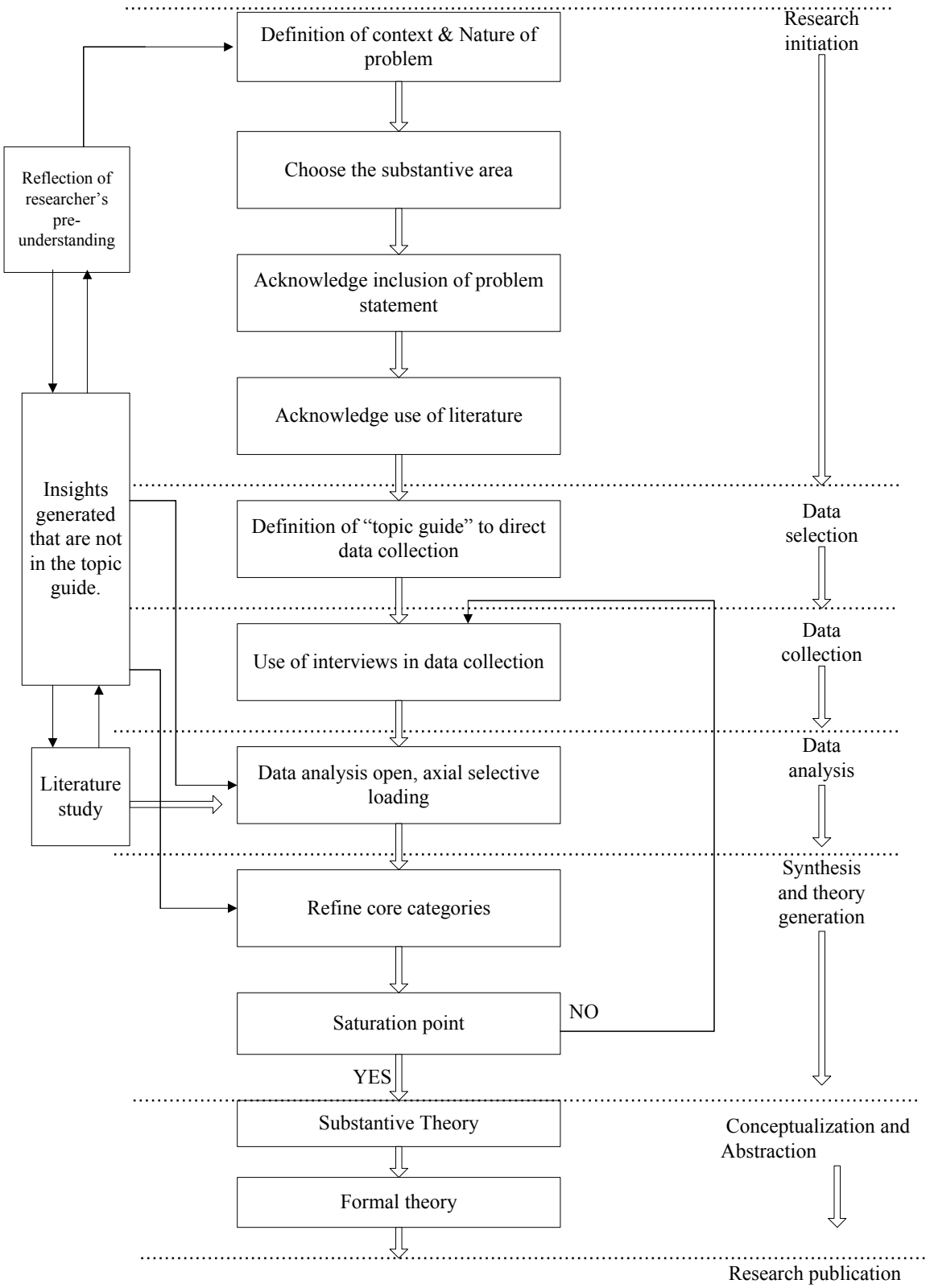

Figure 3.2: A Reflective Grounded Theory Process *(Adapted from Gasson, 2003)*

In brief, the researcher started by defining the problem context and its philosophical nature. The substantive area of research was identified at the same time. Propositions were included together with highly generalized research questions. In addition, the use of literature and of the researcher's pre-understandings was acknowledged.

The next phase included selection, collection and analysis of the data. These were not done in a linear fashion but in a cyclic way. At each phase of the research process, the researcher had to reflect on the steps used, compare these with the goals of the research and evaluate the impact of that phase on the rest of the study. The influence of individual phases on previous and subsequent phases also had to be analyzed. At the end the substantive theory was developed as "An Ontology-Driven Software Development Framework" that guided the development of the ontology-driven development approach and methodology in this study.

3.7 Judging the Fidelity of Generated Grounded Theory

Since quantitative and qualitative research strands are sometimes dichotomous, it would be unwise for researchers to use quantitative criteria for assessing the rigour and quality of qualitative research. Firstly, the assumptions made about the two types of research are very different and hence the perceptions of reality in these two paradigms also differ. When GTM is used in a qualitative research, the positivist notions of "falsification and hypothesis testing" are not accepted (Suddaby, 2006:634). Glaser (1992) adds that the hypothesis generated does not require further testing or validation. It should be borne in mind that this method is grounded in the idea that social theory must emerge organically, depending on the good fit of the observed data to the conceptual categories identified by the researcher during the coding process. This is supported by Hevner *et al.* (2004:87-8) who noted that research rigour is judged by the "adherence to appropriate data collection and analysis techniques". This is heavily encompassed in the systematic data- gathering process and in the analysis of these data using the constant comparative method. In short, the data should be able to explain and predict successive interpretations and, lastly, the relevance of categories to the core issues under observation. It is important to note that GTM is more interested on how "subjective experiences can be abstracted into theoretical statements about causal relations between actors" (Suddaby, 2006:635). It is, therefore, important to find criteria for judging qualitative research that fits the interpretive nature of such problems while, at the same time, keeping the appropriate measurement characteristics that allow rigour and quality to be judged in the same way as in the quantitative studies.

There are four dichotomous issues that usually confront researchers in their attempts to judge and qualify the fidelity of the research process. These issues, taken dichotomously as quantitative versus qualitative, are: objectivity *versus* confirmability, reliability *versus* dependability or auditability, internal validity *versus* internal consistency and, lastly, external validity *versus* transferability (Gasson, 2003). During a research study, these issues are closely related to the research design process and ultimately affect the quality of the research process, research results and their acceptance in a discipline as new contributions to a body of knowledge.

This section discusses the aspects that apply to qualitative interpretive research only and the way in which they were incorporated with respect to this research. Together with the factors discussed by Klein and Myers (1999) (*see Section 3.9*), these issues will be revisited in the concluding chapter of this research.

As shown in Table 3.2, four criteria are proposed by Gasson (2003) for use in checking and maintaining quality and rigour in a qualitative research study. These criteria: confirmability, dependability, internal consistency and transferability, together with their core issues are described below.

Table 3.2: Criteria for Judging Qualitative-Interpretive Research

Criteria for Judging Qualitative-Interpretive Research ***(Adapted from Gasson, 2003)***	
Criterion	**Core Issue**
Confirmability	Findings should represent, as far as is (humanly) possible, the situation being researched rather than the beliefs, pet theories or biases of the researcher.
Dependability/Auditability	The way in which a study is conducted should be consistent across time, researchers, and analysis techniques.
Internal Consistency	How we ensure rigour in the research process and how we communicate to others that we have done so.
Transferability	How far researchers may make claims for a general application of their theory.

3.7.1 Confirmability

This aspect requires the research findings to depend on the subjects and conditions of the study rather than on the researcher (Gasson, 2003). Confirmability can be achieved by having a thorough and complete description of the research and data-collection processes, analysis

and of the findings, according to the research context. In the research report, documentation and explanations of how the results were obtained and of what influenced specific decisions to pick on certain data patterns should be included.

In this study, in addition to the subjects, the researcher is also included as part of the research. Therefore, a collective assessment of both the subjects and the researcher's interpretations is needed.

3.7.2 Dependability/Auditability

This factor requires researchers to constantly visit and question the assumptions made about the research problem, from the start of the research through to the end of the research process. They need to document and justify all the decisions made about the research process. This process should enable an outsider, trained to think like the researcher at the time of the research (i.e. having the same context), to be able to arrive at the same conclusions using the same data from the field. In short, researchers should provide an audit trail to anybody interested in the research to check the steps followed in the process.

In this research, the accepted ways of using GTM in qualitative research were followed. In cases where adaptations were made to the requirements for sound grounded theory research, the assumptions and reasons for making such changes were documented.

3.7.3 Internal Consistency

This issue deals with the credibility of any qualitative research. It is important to have a reflexive process of data coding and analysis as depicted in Figure 3.2. A critical analysis of each stage was done and justified. The appropriateness of the data used to generate the substantive theory should be discussed relative to the theoretical findings (Gasson, 2003:95). The use of the constant comparative method in this research study is discussed in order to explain how the selective coding and theoretical sampling processes gave rise to the research findings. By the use of this method, the biases and distortions in the data analysis could, at least, be identified and minimized.

3.7.4 Transferability

This notion calls upon researchers to look for '*transferability and fit*' between those contexts in which the generated theory or results may be applicable. In this research, after generation of the substantive theory, a further step was taken to formalize the theory through a process

of abstract conceptualization such as that proposed by Strauss and Corbin (1990). In support of Gasson (2003)'s quality criteria as discussed here, the following section discusses other criteria for improving the quality and fidelity of qualitative research (Klein & Myers, 1999).

3.8 Evaluation of Qualitative Interpretive Research Study

As discussed in Chapter 2, the underlying epistemology of this research revealed it as an interpretive study. Working from this background, it is highly important to discuss Klein and Myers' seven principles (Klein & Myers, 1999), which they regarded as important in the evaluation of an interpretive research study. When discussing these principles, the present author accepts them as guiding principles only. He agrees with Klein and Myers that they should not be used and applied mechanistically. In any case, interpretive research can never have a "pre-determined set of criteria" that can be used in the research. The execution of the research is guided solely by the context of the study.

In addition to discussing these seven principles, the researcher also discusses the relevance and application of each principle to this study. Reference is also made to sections in the thesis where each principle is applied.

3.8.1 The Fundamental Principle of the Hermeneutic Cycle

This principle supports the idea that human understanding can only be achieved through repeated cycles of interpretation. Starting with one's fore-knowledge and prejudices, understanding of any situation involves an interdependent process of interpreting individual cases of the situation and knitting them together to provide a holistic understanding of the whole.

In this research, Chapters 2 to 6 were developed and reported using this principle. The research philosophy was discussed in Chapter 2. The research design is discussed in this chapter. Chapter 4 covers the investigation of literature in the field of software development. Different cycles of interpretation were done to come up with issues that characterize current mechanistic software products.

Chapter 5 contains a synthesis of literature on ontologies and their relevance to software development. In Chapter 6, based on the philosophical underpinnings of grounded theory, the researcher discusses the empirical data gathered from the respondents. This involved defining categories and their properties, employing the process of theoretical sensitivity and

axial coding to abstract relationships among the categories and their properties and, finally, using the constant comparative method, generating the inductive grounded theory.

This principle basically is fundamental, not only to the other six principles as discussed by Klein and Myers (1999), but also to the whole research study discussed in this thesis.

3.8.2 The Principle of Contextualization

Klein and Myers (1999) noted that the situatedness of a research study, based upon the respondents' and researcher's interpretation of the scenario, has an effect on the findings of the research. To properly understand the study, the context upon which the research is based should be discussed and elaborated. Context is built by reflecting on the social settings of the people involved in the research, as well as by taking their historical backgrounds into consideration.

This principle was applied in Chapters 2, 3 and 5. Of importance is the discussion of this chapter, which spells out the unique environmental, social and practical conditions that were considered in this study. Section 6.1 on research profiles can also be used as evidence of this principle.

The conditions are referred to as unique because they influence only the present research study and the results generated are highly dependent on this context. It is also important to note that the discussion of the research results and the conclusions based on the findings are grounded heavily on this research design and the researcher's theoretical sensitivity. Another researcher whose theoretical sensitivity is different from this researcher may reach a different conclusion.

3.8.3 The Principle of Interaction between the Researcher and the Subjects

Interpretive data are a product of the interaction between the researcher and the researched. The researched, in addition to software development phenomena, also includes the respondents interviewed during this study. It is important that the relationship between the researcher and researched be critically reflected upon and annotated.

In this regard, we reflect on the choice of the respondents, the data-gathering techniques used (in this case interviews) and on the conditions that existed during the interview process. In some cases, it is also prudent to reflect on individual interviews and on the reasons, if any, for tuning each interview relative to the type of respondent.

Klein and Myers (1999:73) urge researchers not to ignore the role played by respondents as "interpreters and analysts" of data. In this research, we acknowledge our choice of respondents, as discussed in Section 3.3.3.3, and also the fact that many of the respondents needed clarification of many of the concepts that were used by the researcher during the interviews.

As the respondents appropriated the new meanings of these concepts, they had to adjust their understanding of both the software development field and the research problem. As a result, they also assumed the position of analysts in this study.

3.8.4 The Principle of Abstraction and Generalisation

This principle makes use of the first two principles, the principle of the hermeneutic cycle and the principle of contextualisation. It calls upon researchers to relate the field study results to the theoretical concepts that describe the phenomena under study.

The philosophical grounding in GTM, as discussed in Section 3.4, also supports the application of this principle. In generating categories and the properties of these categories, the concepts used need to be mapped to ontological theory concepts so as to constitute the ontology framework for software development. This principle is used in Chapter 6 especially during the open, axial and the application of the double mapping principle. In addition, being theoretically sensitive, as discussed by Glaser and Strauss (1967), Section 3.4.5.1 calls upon the researcher's skills in abstraction and generalisation.

3.8.5 The Principle of Dialogical Reasoning

Interpretive research using GTM requires the research to meet specific methodological requirements as discussed in Section 3.4.1. These requirements relate to the use of literature, theoretical sampling and research questions.

In principle, the researcher is urged not to begin with a problem statement but only to have an interest in the chosen field of study. This obviates the need for research questions and minimizes the possibility of the introduction of researcher bias. The researcher is also urged not to read any of the literature in the substantive area of study.

During data collection, the researcher is directed to choose those respondents who are most likely to provide answers relevant to what is being researched. The interview questions can also be changed and adapted as the study progresses, focusing on the issues that need to be addressed, for example, by filling the gaps in the generated theory until saturation point is

reached. This process is termed theoretical sampling and works together with selective coding in a grounded theory research. This principle is addressed theoretically in this chapter and empirically in Chapter 6.

3.8.6 The Principle of Multiple Interpretations

This principle urges researchers to accept differences in how their respondents interpret the same phenomena. Based on their background knowledge, different people give different meanings to things, depending on their situatedness and contextual setting. These different interpretations should be annotated and described. The reasons for these discrepancies in interpretations have to be inferred from the context of the respondents.

These differences should not be construed as conflicts but as differences in viewpoints. They should be used by the researcher as instruments to aid his or her further understanding of the researched phenomena. The selection and use of interviewees from different software development specializations also ensured that different perspectives are gathered according to the different software development phases in which they are working. There are several of these multiple interpretations in this research, which were used to increase the researcher's theoretical sensitivity.

3.8.7 The Principle of Suspicion

In all data-gathering exercises random and systematic errors are evident. If undiscovered, these will affect the quality of the research findings. The principle of suspicion requires researchers to look for "possible biases and systematic distortions in the narratives collected from the participants" (Klein & Myers, 1999:72). It should be noted that these biases can also come from the researchers themselves during the interview and analysis stages. The principle of constant comparative analysis ensures that biases and distortions are reduced. Also, the researcher replayed all of the interview audio recordings during data analysis in order to increase his understanding of the data as well as checking the fidelity of the transcriptions.

3.9 Limitations of the Research Methodology

This section discusses some issues that may affect the findings from this research. The qualities of the various elements of the research are also discussed from the perspectives of Gasson (2003) and Klein and Myers (1999). Firstly, the quality of the data-gathering process was affected by the fact that the researcher considered too wide a spectrum of software practitioners. The researcher should have sampled at most one or two categories of software

practitioner types, such as developers, programmers, project managers, systems analysts and users. This, however, may be regarded as an advantage, since the varied types of practitioners brought a broader perspective to issues affecting software development.

Secondly, the research might have been improved if many of the respondents had prior knowledge of ontology as used in systems development. This lack of ontology knowledge added a second layer of analysis to the process in the researcher's attempt to match software development concepts to ontology concepts. In such a process, some of the rich information may have been lost. The plus side of this, however, is that lack of prior knowledge in ontology helped to reduce the bias and preconceptions of the respondents.

In terms of judging the quality of this research, the researcher discovered that some of the criteria proposed by Gasson (2003) and Klein and Myers (1999) could be used in conjunction with each other.

3.10 Evaluation Criteria for the Generated Theory

There are several evaluation criteria that are used worldwide in different institutions and various academic disciplines (Introna, 1992; University of Victoria, n.d.). However, it would be futile to try and include all such criteria in the evaluation of a single thesis. On that note, the following criteria were chosen as being more representative and form a very subjective selection:

a. Thesis integration and coherence – A thesis should be logical, and have a golden thread allowing continuous rational connections between the different subsections, sections and chapters of the document (University of Victoria, n.d.). It should not be a concatenated grouping of unrelated sections and chapters.
b. There should be sufficient study of relevant literature – A research study that culminates in a thesis should be grounded in a sound study of literature, emphasising recent developments in the substantive areas of study. Thorough knowledge of original literature sources, the fields under study and both the theoretical and methodological groundings to the study should be achieved and reflected in the thesis. While the research should not be penalised for not covering exhaustively all literature in the field, it should be borne in mind that "a critical, analytic approach" to literature study must be followed. In such a study, different academic discourses should be acknowledged and that possible contradictions in views, both theoretical and

methodologically should be noted. It should also take into consideration any possible sources of error in the interpretation and use of the literature in the study.

c. Statement of the research problem – Depending on the research approach adopted, the research problem statement may be developed from the study of literature. However, using GTM, the research interest, instead is considered. The problem can only be noted after the analysis of that first batch of data. The problem statement can then follow under any of the three categories, namely:
    - Proposing a novel theoretical or methodological slant on a topic area;
    - Development of a new area where a theory(method) can be applied; or
    - The problem statement can be presented as research questions or propositions.

d. Suitability of the methods of enquiry adopted – This covers the theoretical underpinnings and methodological underpinnings of the research. When considering theoretical groundings, the researcher is urged to look at the claims made about reality, the perception given to what is being researched. The ontological, epistemological and humanist stances taken about the nature of reality should be brought to the fore, clearly and succinctly. These underpinnings can be considered as a lens under which the research problem is observed. On the methodological grounding, the researcher should clearly document all the steps, giving reasons for data-gathering, analysis and presentation of the results. It is common to allow a slight diversion to discuss other research methods that could be possible candidates of the research enquiry. This allows the research to build enough ground to support the chosen research approach. Claims to a better methodological approach should be corroborated by explanations of why other methods were discarded. It is also important to have sound linkage of the methodological grounding to the theoretical grounding.

e. Analysis of data – The methods of analysis should be aligned and suitable to the research method chosen. In addition to documenting all the analysis steps chosen, in the analysis process particular attention should be paid to the assumptions made and to new revelations arising from the process. Lastly, only important summary data should be included in the main body of the research report, with primary and secondary data being relegated to the appendices (University of Victoria, n.d.)

f. Theory should unify various, previously unrelated problems or concepts (Introna, 1992).

g. The theory should produce a new perspective on existing problems. This should lead to new understanding of the persisting problems under investigation. (Introna, 1992).

h. The theory should produce unconventional ideas. These new ideas could be radical and challenge existing beliefs in the field of study (Introna, 1992). Stoke and Bird (2008) encourage researchers to use the *'minimal creativity'* as a yard stick. At the minimum, two conditions should be checked: novelty and agency. In their words, an idea**, F**, may be considered novel if, and only if**, F** has never occurred before and it is new to the history of ideas in the study discipline. In this case, we assume a historical novelty that is judged using "socio-technical facts, not behavioural ones" (Stokes and Bird, 2008:230). With agency, it can be stated that, "some behaviour, artefact or event **F** is the product of the agency **A** only if **F** would not have occurred had **A** not acted in some autonomous way" (Stokes and Bird, 2008:231). Creativity, therefore, at the very least requires "the right kind of agency and novelty" to come together in a research study (Stokes and Bird, 2008:232).

i. The theory must exhibit positive and negative heuristic power. Heuristic power relates to the ability of the theory to guide users in formulating new research problems as well as solving some other problems (Introna, 1992).

j. Contribution of theory to body of knowledge – Publishability of the theory is often used as a criterion for judging contribution to the body of knowledge. However, it is also important to check, compare and contrast the assertions that are made by the generated theory with those of other previous researchers in the same field (Introna, 1992). At least, the theory can improve on the precision of these assertions and the explanations thereof.

These evaluation criteria will be used in Chapter 7 together with the criteria used by Klein and Myers (1999) and Gasson (2003), as discussed above, in order to judge the contribution of this research study to knowledge, the practice of software development and to the information systems discipline in particular.

3.11 Summary

When going on a journey, travellers should always ensure that they have chosen the correct mode of transport and have the financial support and the appropriate accessories for use during their journey. Most importantly, they need to identify their destination correctly. This chapter acts a route planner for our research journey and includes a set of methods, techniques and tools needed for successful completion of this research journey.

The chapter started with a revisit to Chapter 2, in which we elicited the philosophical nature of the research problem. Then, the methodological requirements of the study, that is, the research method used, the design, the data-gathering and analysis techniques and tools were identified. The chapter concluded with a discussion on the quality considerations of the study. It is also noteworthy to discuss AtlasTi.5.2, the text analysis tool used in this project. However we deferred the complete discussion of the Atlas.Ti 5.2 modules to Chapter 6, which is dedicated to data analysis. The discussion has been very silent about how the research will finally reach theoretical saturation. According to Suddaby (2006), researchers should not focus on telling the reader about saturation point. He notes that theoretical saturation is not always obvious in most GTM researches. There are other basic tenets to GTM that should be followed and described in a research thesis, such as adherence to theoretical sampling, and constant comparison (Suddaby, 2006) that provides a cue to the quality of the theory generated. However, as noted in Brown (2008), the use of analytical software tools such as Atlas.Ti can hinder or distort such reportages. Most of this documentation is captured in the software repository leaving the author to document the results that lead to inductively generated theory. The next chapter is dedicated to discussion of software development practices.