

**UNIVERSITY OF KWAZULU-NATAL**

**THE RELATIONSHIP BETWEEN USER INVOLVEMENT IN INFORMATION SYSTEM  
DEVELOPMENT AND USER ACCEPTANCE OF THE INFORMATION SYSTEM: A CASE  
STUDY AT SASOL**

**By  
Vedantha Kundalram  
993216160**

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Master of Commerce**

**School of Management, IT and Governance  
College of Law and Management Studies**

**Supervisor: Mr Sanjay Ranjeeth**

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## **Abstract**

A critical component of software development is the process whereby the software requirements of users and stakeholders are established. This process is referred to as the Requirement Elicitation (RE) process of software development. The high rate of failed, cancelled or unsuccessful projects due to not meeting user requirements may be attributed to insufficient focus on the RE process. This case study investigates the relationship between the type of RE technique used and the success of an information system at a global petrochemical company based in South Africa. The end user involvement during the software development life cycle (SDLC) and the acceptance of the resultant information system was also examined.

Three information systems (IS) projects that employed different RE techniques were selected for the purpose of this study. An electronic questionnaire was disseminated to a randomly selected representative sample from the user community for each system in order to obtain feedback with regards to the success of the system from the user's perspective. The study adopted the strategy of focusing on end user acceptance of each information system as a pivotal contributory factor to information system success. In this regard, the Technology Acceptance Model (TAM) model was used to operationalize user acceptance of each information system that formed the focus of the study.

For each IS project, the quantitative dimension was extended to include a qualitative aspect that entailed structured interviews with the business analyst (BA) and project manager (PM), with the primary purpose of ascertaining the RE strategy used for the development of each system. The interviews also served the purpose of providing the researcher with an opportunity to obtain a deeper insight into the logistics of system development.

The results of the study indicated that planned, user intensive RE techniques resulted in greater system acceptance by the end users of the respective systems. A significant outcome of the study is that there is a strong correlation between the amount of end user involvement in the SDLC process and the success of the information system. A converse of this trend was also noted. When users have systems imposed on them, this results in lower satisfaction levels as a consequence of poor system usability and a lack of confidence in the value that the system provides for the end users.

This case study contributes in providing empirical evidence attesting to the theoretical and anecdotal assertion that well planned, user intensive RE strategies are critical for information system success. It is envisaged that this study will contribute to entrenching a culture of structured/planned systems analysis and design that prioritises the RE aspect of software development and the importance of the end user in the SDLC.

## List of abbreviations and acronyms

Acronyms	Description
ACRE	Acquisition of Requirements
ANOVA	Analysis of Variance
BA	Business Analyst
BABOK	Business Analysis Book of Knowledge
BI	Behavioural Intention to Use
BRS	Business Requirement Statement
CFF	Critical failure factors
CTL	Coal to Liquids
CMM	Capability Maturity Model
DSDM	Dynamic Software Development Methods
GTL	Gas to Liquids
HFOS	Hotel Front Office System
JAD	Joint Application Development
IIBA	International Institute of Business Analysis
IM	Information Management
IQ	Information Quality
IS	Information System
ISSM	Information Systems Success Model
IT	Information Technology
ITMS	Integrated Talent Management System
PM	Project Manager
PEOU	Perceived Ease of Use
PMBOK	Project Management Book of Knowledge
PU	Perceived Usefulness
RAD	Rapid Application Development
RE	Requirement Elicitation
RPM	Resource and Portfolio Management
SASOL	South African Synthetic Oil Limited

SCS	Service Catalogue System
SDLC	Software Development Life Cycle
SE	Software Engineering
SME	Subject Matter Expert
SPSS	Statistical Package for the Social Sciences
SQ	System Quality
SRD	System Requirements Determination
TAM	Technology Acceptance Model

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# Chapter 1: Introduction to the study

## 1.1 Introduction

The onset of digital computing, global business operations, internet services and information and communications technology has created a focus on Information Technology (IT) and the associated Information Systems (IS) used to deliver on services and processes. An important component to IT operations and services is Information Systems (IS), which Satzinger *et al.* (2007) defines as a group of interconnected components designed to gather, process, store and convert that data into meaningful output and information required to complete any task, activity or business requirement. Information Systems (IS) encompass the networks, hardware components, infrastructure and software used to perform required tasks, activities and processes, adding value to operations and decision making.

The Software Development Life-Cycle (SDLC) is a process followed in the information technology environment for software development. A vital component of the SDLC is the requirement elicitation (RE) phase. The RE phase aims to establish the needs of the end users and key stakeholders through various methods of engagement and elicitation techniques. The success of the software development process is measured by the acceptance of the information system (IS) by the end users. This claim is corroborated by prominent researchers in the field of requirements engineering as well as software engineering (Pressman, 2009; Sommerville, 2009; Cheng and Atlee, 2007). User acceptance of an information system depends on whether the system implemented is easy to use and meets the user needs, amongst a range of other factors cited in the literature (Hofmann and Lehner, 2010; Thomas and Fernandez, 2008; Legris *et al.*, 2003).

According to Connor *et al.* (2009), RE is recognised as a critical activity of software development, and a lack of rigour in the process of eliciting user requirements increases the likelihood that the final project will be deemed a failure or the quality of the information system will be compromised. This observation has been the catalyst for the “spawning” of academic disciplines such as software engineering (SE), where a large focus is on RE. The global financial crisis has impacted organisations with decreasing revenue. This has resulted in organisations critically reviewing financial spending and implementing cost reductions in the areas of information technology (IT) budgets and salary increments. IT can assist in reducing operational costs by streamlining processes. However it does require a significant budget for software development, IT subject matter experts, hardware and infrastructure procurement and

management in terms of desktops, laptops, servers, networks, peripherals and back up facilities (Luftman and Ben-Zvi, 2009). SASOL, a global petrochemical company based in South Africa, has an IT budget estimated at one billion rand annually for the Financial Year 2012. With the current economic climate, companies cannot afford the high IT costs and high levels of failed IS projects (Emam and Koru, 2008).

SASOL is an international petrochemical company established in the early 1950's in Sasolburg in the Free State Province of South Africa. The company has expanded to include sites across South Africa, Africa and internationally. Employing at least 35 000 employees in more than 48 countries, SASOL is also a leading edge technology driven company. SASOL's competitive advantage is being one of the first companies to perfect the Fischer Tropsch process. The Fischer Tropsch process entails converting coal and gas into fuel. SASOL has expanded into developing fertilizers, explosives, chemical by-products, wax, synthetic fuel, plastics, and a host of other products from the by-products of the Fischer Tropsch Process. Information technology (IT) and information systems (IS) are critical to SASOL plant operations, processes, personnel productivity and communications. Projects implemented at SASOL range from document management solutions, to point-of-sales systems, to order and procure SASOL chemical products, to drilling campaigns in remote regions and collection of the geological data, to setting up reactors and new production plants. IT and IS is required to support and enable such projects and the associated systems. The Information Management (IM) department at SASOL plays a crucial role in supporting the projects and IT services at SASOL, with a range of technical specialists employed in the IM Department. Updating one's knowledge base and keeping abreast of policies, procedures and standards is critical in SASOL. The SASOL Information Management (IM) department is closely aligned with the principles of the business analysis book of knowledge (BABOK), project management book of knowledge (PMBOK) and international institute of business analysts (IIBA).

Three information systems (IS) projects that employed different RE techniques were selected for the purpose of this study. A questionnaire was disseminated to a randomly selected representative sample from the user community for each system in order to obtain feedback with regards to system acceptance. Structured interviews, with a pre-determined set of questions, were conducted with the business analyst (BA) and project manager (PM) of each IS Project in order to ascertain the RE strategy used. The structured interviews consisted of a set number of predetermined questions that were asked to each interviewee. The interviews were formal meetings scheduled with the interviewees. Unstructured interviews are less formal and consist of a range of questions which may be asked of the interviewee as opposed to scheduled set questions asked of all interviewees (Sekaran and Bougie, 2010).

The SE fraternity has proposed many RE strategies, where the explicit purpose is the common aim of assisting analysts in understanding the needs of the user community. Although some analysts believe that one methodology or technique is applicable to all situations, the academic community seems to suggest that such an approach cannot be sufficient for all conditions and environments (Wood and Silver, 1995; Maiden and Rugg, 1996; Leffingwell and Widrig, 2000; Browne and Rogich, 2001; Liebowitz, 2001; Davey and Cope, 2008; Pressman, 2009; Thomas and Fernandez, 2008).

This study aimed to establish a possible relationship between the level of end user involvement in the SDLC and the success of the information system from the user's perspective. This was achieved by investigating the RE techniques and in SASOL. The research approach was primarily quantitative with components of qualitative research techniques included. This study is a case study of the information systems implemented at SASOL, by the Information Management (IM) Department. RE techniques will be shown to be critical in the SDLC. The phenomenon for investigation is level of end user involvement in the SDLC and the success of the information systems implemented thereof.

## **1.2 Background to the study**

After numerous instances of software development failures extensively elaborated on in Pressman (2009) and discussed further in Chapter 2, Section 2.7.2, the software engineering community has made strong recommendations with regard to the SDLC. These include adherence to proper information system management practices such as following a defined SDLC, obtaining sufficient user involvement at the analysis stage of the software development lifecycle, and the utilisation of structured RE strategies. All of these strategies have an over-riding framework that is dictated either completely or by a variant of the recognised software development process models, such as the Waterfall Model, Iterative and Incremental Model, Spiral Model or Agile Model. These software process models provide a foundation for stability, accountability and adherence to the process of software development. These software process models recommend a significant proportion of development time be devoted to the RE phase of the development lifecycle.

A consequence of the lack of focus on the RE phase of the SDLC is that many information systems fail in terms of functionality or fail to deliver on user expectations of the system (Hall *et al.*, 2002; Verner *et al.*, 2005; Thomas and Fernandez, 2008). An evaluation of these failed software projects often leads to the identification of an array of factors that may have contributed to the failure. Some of the common issues

that have contributed to software project failure are: resource constraints (financial and human resources), lack of management support, scope creep, lack of user involvement and ineffective project management (Pressman, 2009). However, the consequences of these factors are not as significant as the consequence of a poor RE process. Projects are systems or products designed and implemented to meet a stakeholder's need or requirement. In order to correctly address the system requirements that the final product will offer, it is imperative to clearly define the stakeholder requirements.

The elicitation of user requirements is a fundamental part of any product life cycle. Rexfelt and Rosenblad (2006) referred to the fulfilment of user requirements as being imperative for successful system development. It was further claimed by Rexfelt and Rosenblad (2006) that the elicitation of user requirements is critical in the software development lifecycle, but it is equally important to ensure that the development process enables the project team to fulfil these requirements. Based on the RE process, requirements engineering bridges the divide between the end user and the system developer. Without proper RE the entire SDLC can be adversely affected by unclear requirements, impacting on the software development and user satisfaction with the system (Hickey and Davis, 2002). The consequence of poor requirement capturing sessions is that the user's expectations of the system will not be met. According to Saiedian and Dale (2000), poor RE will result in an uninformed development team and a set of users who will be unsure of what system functionality to expect. There will also be a lack of detailed documentation regarding business requirements that can be used to compare the system developed and the initial user requirements.

As mentioned earlier in the chapter, this case study is based on SASOL, a global petrochemical company constantly striving for innovation and improvements to processes and technologies. A core component of SASOL is the Research and Development department which is based in Sasolburg and does significant work in the field of chemical technologies, technology innovation, engineering management and project management. SASOL is highly rated as a leading company to work for in the disciplines of science, engineering and research. SASOL drives a value oriented culture amongst its employees, offering expert technical, operational and administrative support for research projects. A significant number of the company's employees hold Masters, PhDs and post doctorate qualifications. SASOL encourages research studies and is therefore a suitable case study for this research project. Challenges of obtaining approvals to conduct research in corporate organisations, access to information and resources, and IT departments fearing disclosure of failed or unsuccessful projects, is not encountered at SASOL.

The Information Management (IM) department at SASOL are involved in a range of activities and business analysis on a daily basis. Project management, requirements engineering, SDLC and process mapping, as well as detailed analysis and design for information system (IS) projects within SASOL is performed daily. Implementation and maintenance of appropriate policies, processes and supporting both local and international users, is also undertaken. A key component of the IM department at SASOL is the testing and implementation of leading edge technology to enable business efficiency and effectiveness. Requirement capturing sessions and facilitation of workshops are conducted with business to identify analyse and develop new system requirements from an idea generation stage to a stage where viable systems can be implemented. The development of sound business plans for new systems and projects, and using information systems to translate business strategies into business ideas and plans is critical.

The Information Management (IM) department performs an important role at SASOL by delivering relevant information system solutions to enable business success and to leverage information management solutions to achieve business excellence. Advising business on information system solutions and cost options in order to effectively improve business effectiveness and efficiency (SASOL, 2011). The BA engages with the users to obtain the requirements and the requirement documents are issued to the system engineers or developers to proceed with the other phases of the SDLC. The case study conducted at SASOL determined that the systems engineers and developers do not actively engage with the users during development until the system is ready for User Acceptance Testing (UAT). This is the standard process in SASOL due to the scope of the IM teams. Reasons for this could include possible scope creep if additional requirements are identified by users after the requirements have been signed off. SASOL follows a patented project management development model which aligns to the SDLC of information system.

According to Verner *et al.* (2005), there have been quantitative studies that have confirmed a strong correlation between lack of effort in RE and software development project failure. However, there is a lack of research into a possible relationship between level of user involvement and the success of an information system from a user's perspective. It is envisaged that the current study will serve as a catalyst for a generation of much needed research impetus in the area of RE particularly the involvement of the end user in the SDLC.

### 1.3 Problem statement

The move by organisations towards implementing and investing in information systems has been based on cost optimisation, producing more end products whilst reducing costs, and improving the quality of services rendered (Legris *et al.*, 2003). Legris *et al.* (2003) stated that despite the considerable financial investments in information systems, a study performed in 1998 by the Standish Group yielded the following results: only 26% of all MIS projects and less than 23.6% of large company projects are completed on time, within budget and adhering to all requirements. SASOL defines a complex project to be a system requiring integration across a multitude of platforms, systems and business processes. This definition of a complex project is used when referring to information systems (IS) projects. The scope of a project, estimated costs, and timelines can also influence the complexity of a project.

Furthermore in Legris *et al.* (2003), it has been found that 46% of IS projects are over budget, delivered late and completed without all requirements being met. A further 28% of projects are cancelled. These figures, as reported by Legris *et al.* (2003) highlight the significant number of IS projects which are unsuccessful or cancelled. Although there has been an immense contribution made by the software engineering community in alleviating the problem of software project failure, there is still a high proportion of information systems that fail. The root cause of this problem may be attributed to the requirements capturing process, which forms the basis upon which systems are built.

Selection of the correct or appropriate technique to be used in RE is critical to ensure the necessary requirements are captured adequately. The importance of accurate RE is highlighted in a study by Davey and Cope (2008), where they conducted an analysis of “best practice” strategies for eliciting system requirements. As a prelude to their study, Davey and Cope (2008) alluded to RE as the “missing link” in the software process. The significant outcomes of this study are listed below:

- Experts have not reached consensus on how best to elicit user requirements
- There is an absence of comparative studies that analyse the potential of one RE technique against the capabilities of another
- Structured interviews are regarded as the most accurate form of RE (closely followed by unstructured interviews). Sekaran and Bougie (2010) defines a structured interview as conducted by a researcher or analyst and includes a predetermined list of questions that the interviewee or interviewees will be asked.

It can thus be seen that any effort to establish the potential impact of any one RE technique cannot be generalised to all situations, as there are many variables involved that may discredit any attempt at achieving some kind of generalisation. This assertion provides the “ammunition” for many technically minded analysts and developers who discuss valid requirements without giving requirements the importance and priority they deserve (Saiedian and Dale, 2000). During RE, the business analysts elicit requirements from the users and key stakeholders. As per the SDLC and project development model at SASOL, technical systems analysts and developers are involved once the requirements are signed off and the project moves into functional design stage.

Davis *et al.* (2006) further suggested that the type of RE strategy used has an impact on the outcome of the information system and that there is a need for comparative studies which examines different RE techniques and the level of project success. Davis *et al.* (2006) added that more quantitative, and possibly qualitative research needs to be obtained to provide evidence on the RE strategies and information systems.

These observations formed the backdrop for the purpose of the current study. This study examined the level of user involvement in the SDLC and RE, in conjunction with the level of user acceptance of these information systems. Recording requirements is a defined process where the requirements gathered are documented in various forms, such as use cases, process specifications, or as in the case of SASOL, in a business requirement statement (BRS). It is envisaged that the current study will deliver a “best practice” recommendation for software project development at SASOL to ensure that project failure as a consequence of poor RE strategies is minimised. At SASOL, the RE dilemma warrants investigation to determine the impact on information systems. Software project failures have incurred significant financial losses, which have impacted the image and service delivery of the information technology (IT) department at SASOL from a user perspective.

There are currently many acceptable forms of RE strategies practised in corporate organisations. These are Joint Application Design (JAD) sessions which are used to create a prototype of a system in conjunction with stakeholders. Ideally, this would involve frequent workshop sessions with stakeholders to gather requirements, review requirements and develop an information system in a shorter space of time. A number of survey methods are utilised during the RE process. The most popular is the questionnaire technique, where the focus is on establishing user requirements via a written response.



Interviews are also used in some cases; however there is no consensus in terms of a preferred strategy for a specific kind of system.

## **1.4 Rationale for the study**

The high numbers of failed projects based on inadequate or incorrect RE strategies have been identified by the research community as a problem in the information systems environment. The importance of gathering correct user requirements during the RE phase is critical to the success of information systems (Coughlan *et al.*, 2003; Verner *et al.*, 2005; Thomas and Fernandez, 2008; Pressman, 2008). Hofmann and Lehner (2001) cited deficient requirements as the single biggest cause of information system failure., closely followed by a limited user involvement in the SDLC. Research and findings in this area using a case study and based on a South African context has the potential to contribute to the information systems sphere of knowledge and research.

## **1.5 Objectives of the study**

- The main research problem investigated the Relationship between End User Involvement and User Acceptance of Information Systems Projects Implemented at SASOL. This objective was achieved by examining the relationship between the level of end user involvement in the SDLC and user acceptance of information systems projects implemented at SASOL?

The following research objectives were investigated:

- To determine the level of user acceptance of information systems projects implemented at SASOL
- To determine how user requirements are established for information systems projects implemented at SASOL
- To determine a possible relationship between the level of user acceptance and the level of user involvement during the development of information systems projects at SASOL
- To determine the main success factors of information systems developed at SASOL

## **1.6 Limitations of the study**

The study is subject to the following limitations:

- Respondents for the survey were restricted to employees from a chemical and petroleum company. The case study is based on SASOL. The inclusion of other corporate organisations would have resulted in a greater sample population and a higher level of external validity.
- Not all information management personnel could be surveyed due to the large number of staff at SASOL and the geographic dispersion of the staff on a global scale.
- Due to possibility of the study becoming too complex, the concept of information system success has been presented quantitatively from a user's perspective only. This dimension of the study could be extended in further studies to include a more qualitative measure of information system success.

## **1.7 Overview of the study**

This study consists of the following chapters:

- Chapter 2 consists of the literature review detailing the RE process, information system success and failures, and prior research into requirement elicitation.
- Chapter 3 discusses the theoretical framework used for the study. The constructs of the Technology Acceptance Model (TAM), Information System (IS) Success models and usability heuristics will be discussed in detail.
- Chapter 4 discusses the research design, analysis and findings of the study.
- Chapter 5 includes concluding discussions and recommendations for further research.

## **1.8 Summary of the chapter**

This chapter introduced the problem of requirement elicitation (RE) in the software development process. Insufficient time and resources are being invested in the RE phase of IS projects, resulting in late, cancelled or non-delivery of IS projects. The lack of end user involvement in the RE process and the SDLC is also impacting IS projects and the success thereof. This is largely attributed to inadequate requirement capturing sessions and unclear or poorly defined requirements elicited from the users and stakeholders of the proposed system. This problem is highly pertinent in business and corporate

organisations, where considerable resources and budgets are allocated to software development and maintenance. The background information, problem statement, objectives, limitations and overview of the study were presented in this chapter. The next chapter will present a detailed review of the literature on requirement elicitation, user involvement, requirements analysis and factors for information system success and failure.

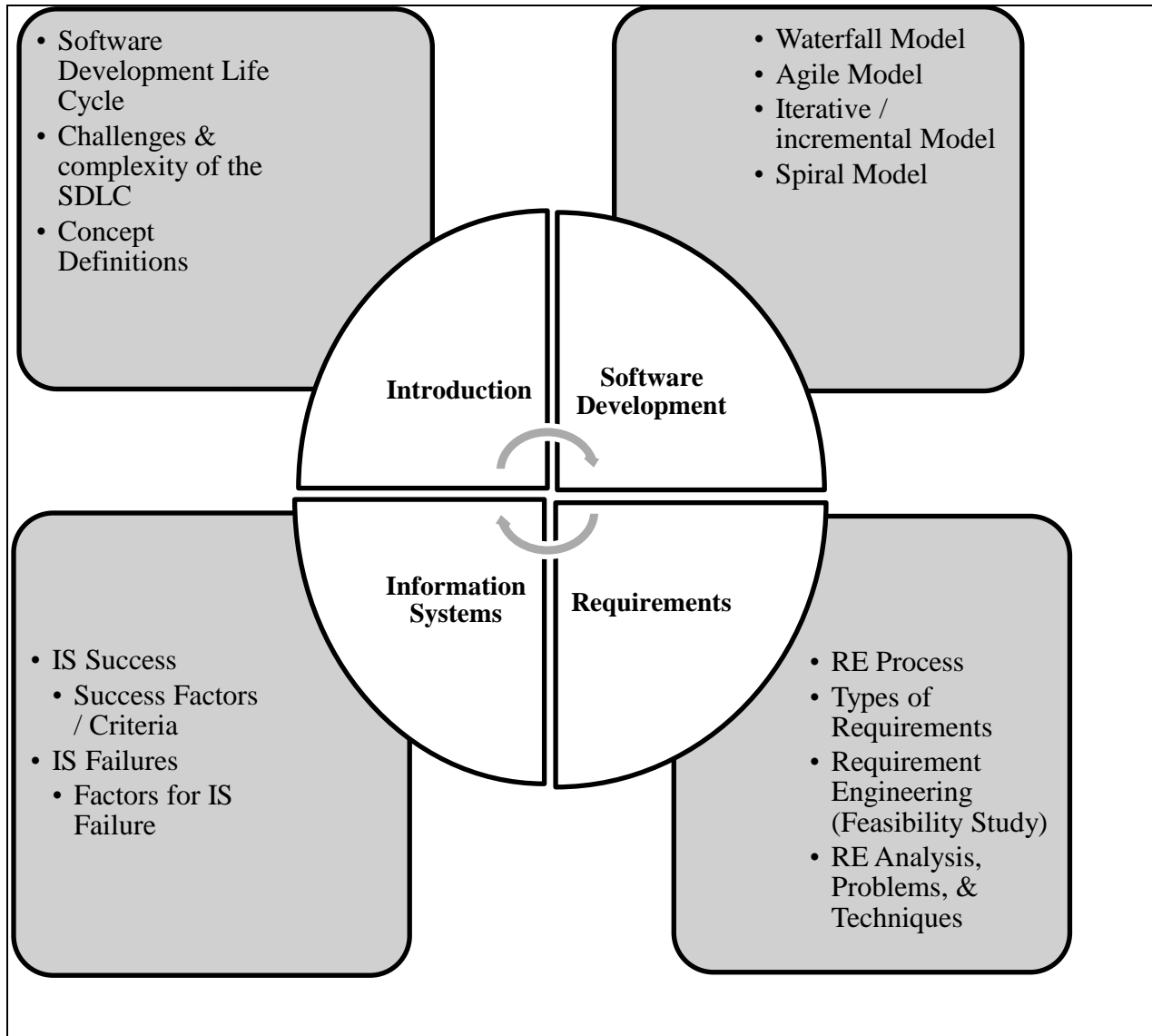
## Chapter 2: Literature review

### 2.1 Introduction

The Software Development Life Cycle (SDLC) is a concept describing the software development methodology used to create new information systems. An information system is defined to be a “set of interrelated elements or components that collect, manipulate and disseminate data and information, and provide a feedback mechanism to meet an objective” (Stair and Reynolds, 1999). The SDLC involves the following basic process: planning, analysis, design, implementation and maintenance, and describes the start to end process of developing an information system (Satzinger *et al.*, 2007). There are a number of adaptations of software development methodologies, with most methodologies following the basic principles and processes detailed in the SDLC. Hickey and Davis (2002) defined software development as a process of creating a new system or application designed to resolve a particular problem or provide a required output. This is closely linked to the SDLC purpose that provides the basic methodology upon which projects are developed.

The success of the software development process is measured by the acceptance of the information system by the end users. This claim is corroborated by prominent researchers in the field of requirements engineering as well as software engineering (Pressman, 2009; Sommerville, 2009; Cheng and Atlee, 2007). The software development process follows the Software Development Life-Cycle (SDLC) and a vital component of the SDLC is the requirement elicitation (RE) phase, where the needs of the end users and the key stakeholders are established. User acceptance of an information system (IS) depends on whether the delivered system is easy to use and meets the users’ needs, amongst a range of other factors cited in the literature.

Rajagopal *et al.*(2005) highlighted that errors occurring in the requirement elicitation (RE) phase are reflected in software development and are the most difficult to repair. The importance of obtaining clear, well defined requirements during RE has the potential to impact on a project as it progresses through the sequential stages of the SDLC. Clearly defined and good quality requirements are critical components for the success of a project (Laporti *et al.*, 2009). Various requirement gathering techniques can be employed to gather requirements from the users and key stakeholders.



**Figure 2.1: Mind map of the literature review**

Figure 2.1 provides a mind map of this chapter and the critical components to be discussed to achieve the purpose of this study. Chapter 2 will provide a detailed overview of the software development process and associated models, the requirement elicitation (RE) process, types of requirements and requirement engineering. Requirement elicitation will be further detailed into requirement analysis, problems in the RE process and the various RE techniques used in organisations. Research in the field of IS supporting the agenda for this research project will be reviewed, as well as the success and failure of IS projects. The purpose of this study is to establish a possible relationship between the level of end user involvement in the SDLC and the success of the information system from the user's perspective.

## 2.2 Definitions

In order to proceed with a discussion of issues that underpin RE within the context of software development, a definition set adapted from Hickey and Davis (2002) is provided in Table 2.1.

**Table 2.1: Definitions/ explanations of software development concepts adapted from Hickey and Davis (2002)**

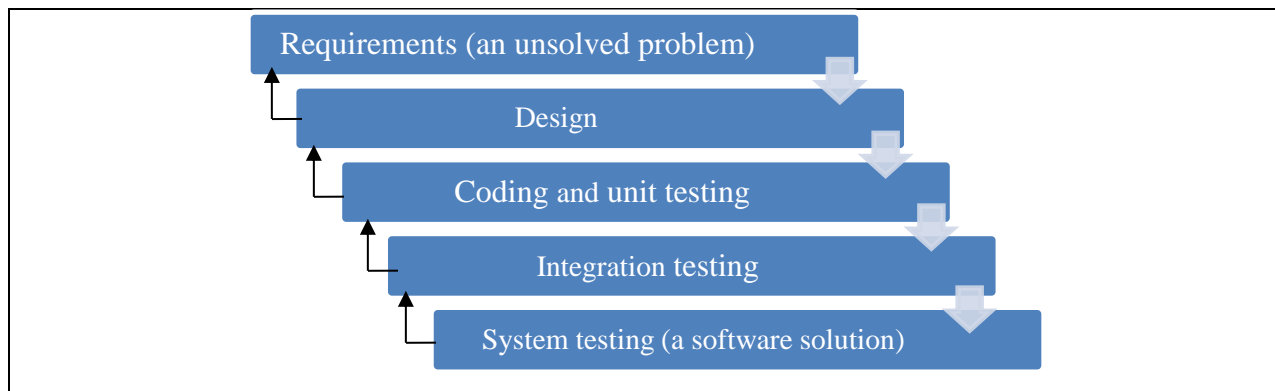
Software development concept	Definition/explanation (with examples)
Requirements process	A series of activities resulting in an understanding and documentation of the desired behaviour of a system.
Process model	A representation displaying the processes to be performed to achieve a clear and well-defined goal.
Requirements elicitation technique	A documented series of steps along with rules for their performance and criteria for verifying completion. Examples include interviewing, questionnaires, observation, modelling, prototyping, and joint application development workshops.
Methodology	A process model, along with documented techniques and/or tools to support each process in the model
Stakeholders	Individuals actively involved in information systems projects or whose interests are affected by the project. Stakeholders typically include customers, users, project managers, analysts, developers and senior managers (Hofmann and Lehner, 2001).
Information system team	A team of people who are assembled for the task of developing an information system. The team usually consists of a project manager, analysts, developers, quality assurance personnel and in some instances users (Hofmann and Lehner, 2001).

## 2.3 Software development

The SDLC methodology is followed to create an information system, which when designed and implemented, addresses an unsolved problem. Software development encompasses a range of activities involved in creating an information system. The basic phases of the SDLC are followed by all software development models (Waterfall Model, Iterative Model, Agile Model, Spiral Model); with different models placing emphasis on different phases of the SDLC. The Waterfall Model, Agile Model, Spiral Model and Iterative Models will be analysed for their focus on the RE process, user involvement and the resultant system developed at the end of the process. At the start of an IS project the resources and requirements need to be assessed, and an IS software development model selected. The chosen IS model should be commensurate with the requirements and objectives of the IS project.

### 2.3.1 Waterfall Model

The Waterfall Model illustrated in Figure 2.2 was suggested by Winston Royce in 1970 and endorsed from the early days of software development as the de-facto process for building software (Hickey and Davis, 2002).



**Figure 2.2: Waterfall Model of software development as illustrated by Hickey and Davis (2002)**

The Waterfall Model, whilst being highly popular with information system teams, has been subjected to scrutiny and criticism. Rigid design and inflexibility can be viewed as disadvantages of the model. The Waterfall Model also fails to accommodate unclear requirements during the early stages of software development. Software development using the Waterfall Model may result in a lengthy process with a workable solution only developed much later in the model.

Nevertheless, the Waterfall Model provides a generic set of activities that underpin the software development process. These activities are: RE, design, development, testing and implementation. When using the Waterfall Model, the development of the information system follows a rigid sequence of RE, analysis, design, coding and testing. Whilst there is minimal provision for backward traversal to a previous phase of the cycle, once each phase is complete, it is not re-visited. The analogy is that of water flowing down a waterfall, and not in the reverse direction. There is constant progression and forward movement.

### **2.3.2 Iterative / Incremental Model**

Previously, and as is the case with the Waterfall Model, requirements activities were performed once off at the commencement of the SDLC. Due to the volatile and fluctuating nature of information systems requirements, epitomised by constantly changing business needs and requirements, it has become necessary to perform requirements activities regularly and at the start of each cycle of the SDLC. An Iterative Model of software development entails the repetition of the different phases of the SDLC, with varying intensity resulting in an improved product at the end of each cycle. The Iterative or Incremental Model is derived from the Waterfall Model, and involves a number of repetitions of the software development process which is shown in Figure 2.2. During each iteration of the model, the requirements become more specific and detailed, resulting in an improved information system (Hickey and Davis, 2002). The origins of the Iterative / Incremental Model are linked to a number of projects and recommendations by thought leaders in the software development fraternity since the 1950's. The earliest reference to Iterative Incremental Model was in the 1930's with the work conducted by Walter Shewart who worked as a quality expert at Bell Labs and investigated a series of software development cycles (Larmen and Basili, 2003). These cycles formed part of quality improvement and attributed to the Iterative Incremental Model (Larmen and Basili, 2003).



### 2.3.3 Agile Model

Agile Modelling, as described by Dyba and Dingsoyr (2008), constitutes a set of practices for software development developed by a field of experts or experienced practitioners. This modelling technique consists of a collection of principles, guidelines, values and best practices that may be applied to software modelling and documentation of IS projects. Examples may include user involvement, stakeholder participation, prototyping, prioritization of requirements, phased system implementation and document archiving. Agile Modelling relies on the human component and creativity as opposed to being process driven and was developed by Scott Ambler in 2000. As such, Agile Modelling challenges the traditional processes adhered to for software development. It is therefore viewed as flexible and based on similar successful projects implemented in the environment. There are various criticisms of this modelling approach such as lack of focus on the system architecture and little scientific support for the claims advocated by the supporters of agile modelling. This approach may also not be suitable for large complex projects requiring integration across a number of platforms and systems (Dyba and Dingsoyr, 2008).

An example of an Agile Modelling technique is Lean software development, which is an adaption of the Toyota production system for software development. Lean software development encompasses the seven core principles listed below (Poppendieck and Poppendieck, 2003):

- Eliminate waste
- Amplify learning
- Make decisions as late as possible
- Deliver efficiently
- Team empowerment
- Integrity and
- Holistic view

If a production environment or manufacturing plant aims to improve and streamline processes to create higher output, the Agile Modelling technique could be used incorporating the knowledge and expertise developed in the Lean software development approach. Agile modelling involves principles and best practises as opposed to defined processes.

### 2.3.4 Spiral Model

The Spiral Model is closely linked to the Iterative model and consists of four phases; planning, risk analysis, engineering and evaluation, and was developed by Barry Boehm in 1986. Munassar and Govardhan (2010) described Spiral modelling as an information system repeatedly passing through the four phases, with each pass through the model constituting an iteration. These iterations are referred to as spirals. The model commences at the planning phase where requirements are gathered. Each iteration or spiral of the model will improve on the baseline requirements captured. Risk is an important component of Spiral modelling and risk evaluations are included in each phase. The planning phase facilitates the RE process and risks are identified and mitigated during the risk analysis phase resulting in a prototype being developed. The engineering phase results in a software product being developed.

Spiral Modelling is advantageous due to the emphasis on risk analysis and a resultant information system developed early in the SDLC. This technique is suitable for large complex projects, where there may be a significant amount of integrations across systems and processes. However the Spiral Model can be costly to execute due to the number of iterations and the emphasis on the risk analysis during each phase is critical and requires knowledge experts. The Spiral Model fails to deliver optimal results when executed in small scale IS projects (Munassar and Govardhan, 2010).

After numerous instances of software development failures (Pressman, 2009), the software engineering community has made strong recommendations with regard to the SDLC. These include adherence to proper information system management practices, obtaining sufficient user involvement at the analysis stage of the software development lifecycle, and the utilisation of structured requirement elicitation strategies. All these strategies should have an over-riding framework that is dictated either completely, or by a variant of, the recognised software development models such as the Waterfall Model, Iterative and Incremental Model, Spiral Model or Agile Model. These theoretical models provide a foundation for stability, accountability and adherence to the process of software development. These software development models recommend a significant proportion of development time to be devoted to the requirement elicitation phase of the software development lifecycle.

## 2.4 Requirements

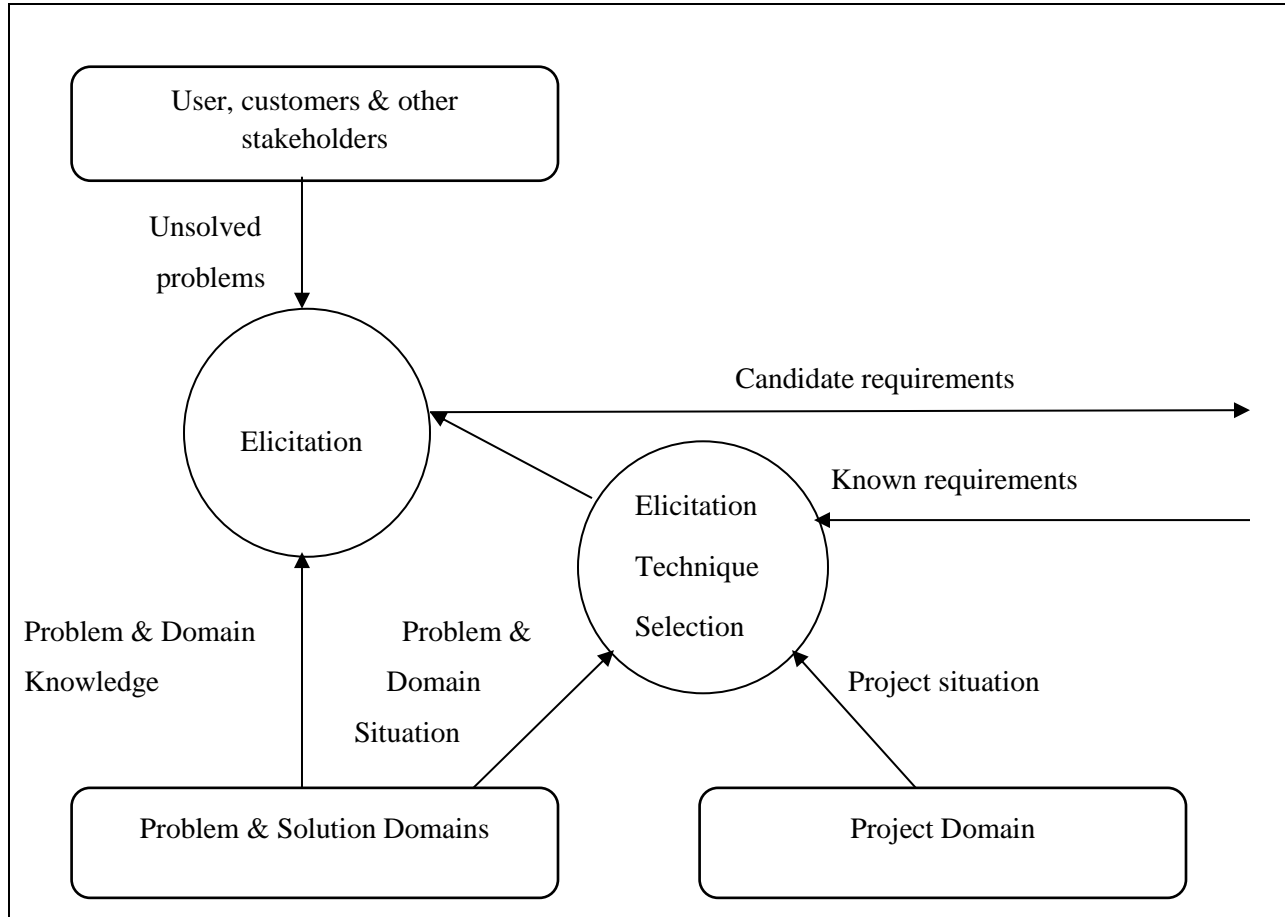
Sommerville (2009) defined requirements as end user elicited descriptions of how a system should function. These requirements can be specific and detailed enough to adequately describe the proposed systems functionality, services, desired outputs and basic need for the system. The requirements are detailed statements describing the desired functionality of the proposed system and will assist software developers in the software development process. Requirements are a critical component of the SDLC as it details the needs of the users. This section will discuss the RE process, RE techniques, RE problems and challenges, and the types of requirements. Hickey and Davis (2002) provided a user friendly illustration in Figure 2.3 depicting the RE process. Based on Figure 2.3, one can ascertain that RE is a process of establishing user requirements, contextualising these requirements from a business perspective, and then deciding upon the most feasible RE technique deemed to be the best possible match for the identified problem situation. This interpretation is supplemented by the contribution of Gunda (2008), who described requirements as specifying the services a system should provide, how these services will be provided and constraints related to these services. There are two types of requirements in information systems; user requirements and system requirements. User requirements define the need for the services, and the services the system will provide. The system requirements describe the functionality of the system, and are designed to meet the user requirements. Requirements are further defined in Sections 2.4.2 and 2.4.3.

Requirements are the basic premise required for any project or initiative, as the requirements detail the needs of the stakeholders and how the proposed system will address their needs (Laporti *et al.*, 2009). While RE seems to entail rather trivial processing, there is a strong imperative to ensure that requirements are captured correctly and verified with the users and/or key stakeholders. Gunda (2008) stated that rectifying an error as a result of incorrect requirements is more difficult than correcting the errors which occur in later phases of the project.

A more precise listing of problems emanating as a consequence of poor RE was provided by Gunda (2008):

- Delayed and/or over budget projects
- Products which do not meet the user requirements or need for the system, resulting in unsatisfied customers

- Errors encountered during the development of the system
- The continuous use of such a system results in errors increasing the maintenance costs on the system



**Figure 2.3: Software requirements as illustrated by Hickey and Davis (2002)**

According to Connor *et al.* (2009), RE is recognised as one of the most critical activities of software development and a lack of rigour in the process of eliciting user requirements increases the likelihood of the final project being deemed a failure or the quality of the information system being compromised. This observation has been the catalyst for the “spawning” of academic disciplines such as software engineering (SE), where a large focus is on requirement elicitation.

The software engineering fraternity has proposed many RE strategies, where the explicit purpose is the common aim of assisting analysts to understand the needs of the user community. Although some

analysts consider one methodology or technique to be applicable to all situations, the academic community seems to suggest that such an approach cannot be sufficient for all conditions and environments (Wood and Silver, 1995; Leffingwell and Widrig, 2000; Maiden and Rugg, 1996; Hsia, 1994; Browne and Rogich, 2001; Pressman, 2009; Liebowitz, 2001).

#### **2.4.1 Activities in the requirements process**

Hickey and Davis (2002) provided a technical elaboration on the RE process and the five activities comprised therein. The first activity is elicitation and involves the “learning, uncovering, extracting and or discovering the needs of customers, users and other potential stakeholders” (Hickey and Davis, 2002, p 3). The business analyst (BA) engages with the users and key stakeholders during this phase to gather the requirements and understand the need for the system.

The second activity is modelling, which focuses on the creation of models based on the initial requirements captured. Analysis of the models occurs to facilitate increased understanding and consensus on the requirements amongst the users, stakeholders and BAs. Any inconsistencies or gaps in the requirements will be identified during this phase and included in the models.

The third activity is triage, which involves determining which requirements will be addressed in which release of the system. This is done in collaboration with the key stakeholders, BAs and requirements engineers. Some systems are developed and implemented in a phased approach, with each phase of the system building upon the development and functionality of the previous version. This approach is commonly used for implementing urgent and complex systems.

The next activity of specification details the behaviour and outputs required for the system as per the stakeholder and user requirements. This phase may include the development of high level interface diagrams and navigation slides through the proposed system. The BA and requirements engineer will delve into more detailed requirements, in consultation with the users and stakeholders, to obtain the details on the system output. The final activity in the RE Process is verification, which determines the “reasonableness, consistency, completeness, suitability and lack of defects in a set of requirements” (Hickey and Davis, 2000, p3). Verification is a critical activity in ensuring the stakeholders, users, BA and requirements engineers understand, verify and validate the need for each requirement. A requirements review is conducted during this phase to clarify, confirm and prioritise the requirements.

## **2.4.2 User Requirements**

User requirements detail the expected services a system should provide and validate the need for the proposed system. Requirements are gathered from the users and key stakeholders of the system based on understanding of the environment, validating the need for the system and incorporating the sponsors of the project. The requirements are gathered from the users and must be constructed simply; without technical jargon. This ensures the requirements are easily understood by all users and stakeholders, regardless of a technical background.

## **2.4.3 System Requirements**

Whitten *et al.* (2001) defined system requirements as a description of the needs and behaviours a system should exhibit. System requirements prescribe the detailed services the system will offer and the constraints within which the system will operate. System requirements are classified into functional requirements and non-functional requirements.

### ***2.4.3.1 Functional Requirements***

Functional requirements refer to the list of activities and services a system must provide to the end users (Gunda, 2008). Functional requirements define what services and interaction the system should provide, as well as how the system should respond to a particular event. Functional requirements also include the activities and transactions the system should be prohibited from executing, for example managers at different levels in an organisation may only approve purchases up to a certain financial value. If the value of the item is greater than that which the manager can approve, the approval must route to next manager who is authorised to approve or release requests of such a financial value. Any constraints or challenges that may impact the IS project during the SDLC will also form part of the functional requirements. Functional requirements may include financial or budget constraints, availability of technical resources or subject matter experts (SMEs), timelines, geographical locations and IT infrastructure.

### ***2.4.3.2 Non Functional Requirements***

Gunda (2008) describes non-functional requirements as defining the effectiveness of the functions of the system. Non-functional requirements form the basis of the quality of the system by providing a reliable service and ensuring a secure system. Whitten *et al.* (2001) described non-functional requirements as the features and characteristics of the a system. Non-functional requirements may include performance,

information, economy, security and controls, efficiency and services required for the system to operate efficiently. Additional non-functional requirements identified include the safety and security measures provided by the system as well as the reliability, robustness, efficiency, portability and integrity displayed by the system (Gunda, 2008).

#### **2.4.3.3 Cost of poor RE**

The risk of poorly defined functional and non-functional requirements and ad hoc requirement engineering processes leading to failed or cancelled projects is high. A report published by the Standish Group listed lack of user involvement, unstable requirements and poor project management as three of the top ten reasons for challenged or failed projects (Group, 1999). A study by Hall *et al.* (2002) conducted on 12 companies in the United Kingdom indicated that requirement problems were responsible for 48% of all software problems. Verner *et al.* (2005) concluded that poor requirements negatively impact the schedule, cost and human resource estimation process. Hofmann and Lehner (2001) cited deficient requirements as the single biggest cause of information system failure, with RE being deficient in more than 75% of all enterprises. Simply put, obtaining the right requirements may be one of the most difficult and important parts of the project.

## **2.5 Requirements engineering**

Requirements engineering is a two-step process consisting of specifying requirements by interacting with stakeholders and assessing stakeholder needs, and analysing and refining stakeholder requirements (Hofmann and Lehner, 2001). They referred to specifications as the primary outputs of the RE process, defined as a brief statement of requirements of the proposed system. Specifications provide stakeholders with a clearly defined set of expectations of the system and assist developers in understanding the stakeholder's needs from the system.

Requirement engineering consists of the following four activities: elicitation, modelling, validation and verification. During the development of a new IS requirements are first elicited from stakeholders and available information sources. The requirements are then modelled to specify a possible solution. After a review process, an acceptable specifications list is validated and verified. Elicitation is the process of interviewing users, analysing documents, and conducting focus groups or workshops to obtain requirements for proposed systems. The concept of elicitation is extended to include activities on how software can aid organisations in meeting goals, exploring alternative solutions and creating stakeholder

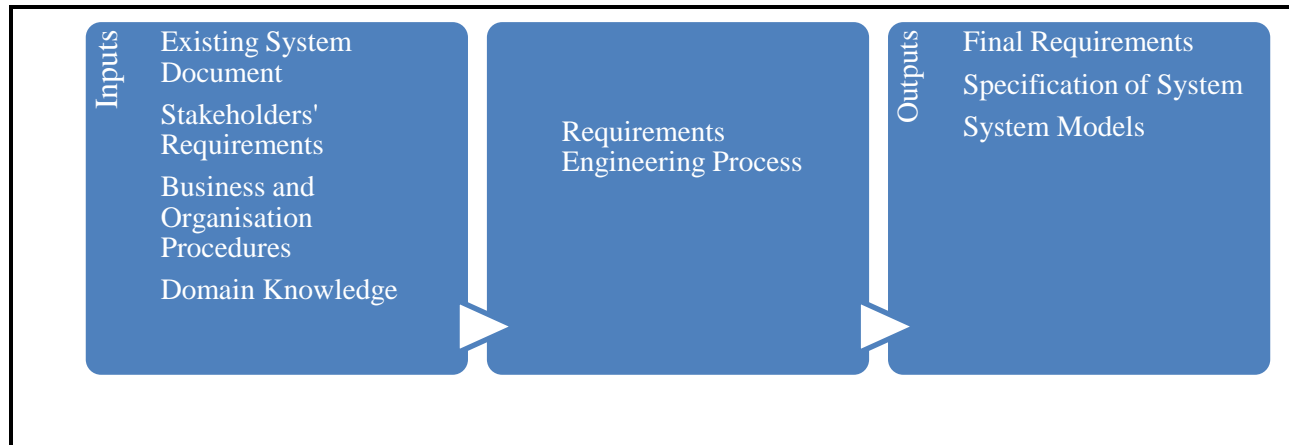
impact. Modelling assists in defining requirements and specifications using possible prototypes. Prototypes can be developed as an operational model allowing stakeholders to interact directly with a scaled down version of the proposed system. Validation of requirements ensures conformity and alignment with the stakeholder's intentions. Verification determines if the work product conforms to the specified requirements. It is important to prioritise requirements during this stage as this can reduce project costs and duration by addressing high priority requirements first. Priorities should be revised and revisited during the development process to ensure the stakeholder's needs are being addressed. Peer reviews, inspections, walkthroughs and scenarios are typical methods for validating and reviewing requirements (Hofmann and Lehner, 2001).

Factors leading to IS project success were investigated by Verner *et al.* (2005) who conducted a study on RE and information system success. The study entailed an industrial survey based on software development companies in the United States and Australia. The survey designed by Verner *et al.* (2005) aimed to investigate those software development practices, in particular which requirement engineering practices lead to successful projects. Feedback received highlighted the following factors as highly significant; good requirements, high level of customer/user involvement and effective management of requirements. Verner *et al.* (2005) study yielded the following results: one third of projects did not have a defined methodology, almost half of the projects began with incomplete requirements, the project scope changed frequently, and requirements are a problem for software development and are a common cause of runaway projects. Positive findings of the study were that good, complete and accurate requirements captured at the start of projects culminated in well-defined and clear software deliverables. The requirements and software deliverables correlated positively with project success. User involvement in requirements gathering exercises was deemed critical to project success. These results are a testimony to the growing body of evidence that advocates the need to have proper RE processes embedded in the software development process in order to ensure information system success. Gunda (2008) added further support to the need to instil structure in the RE phase of software by describing RE as a structured process consisting of planned activities to translate user inputs into outputs. This process of set activities entails elicitation, verification and validation of the requirements elicited from the users or stakeholders.

The structural component of RE consists of a feasibility study, requirement elicitation and analysis, requirements validation, requirements management and requirements documents. The RE lifecycle is made up of a number of different activities that connect and interact. Figure 2.4 depicts the inputs and outputs of the RE process as a complex combination of stakeholders and processes, with the final



deliverable being a set of specifications/models/narratives that succinctly describe what the user expects and what the developer has to deliver.



**Figure 2.4: Inputs and Outputs of the RE process adapted from Sommerville (2009)**

### **2.5.1 Feasibility Study**

A feasibility study as described by Sommerville (2009) is one of the first steps in the RE process and examines the necessity for the system. The outputs of the feasibility study are recommendations on whether development of the proposed system should proceed and if the RE process should commence. The feasibility study is an important step as it assists requirements engineers to determine if the proposed system will meet the overall objectives of the organisation, whether it is possible to develop the system within the constraints of time and budget, and if the proposed system is compatible with existing systems in the organisation. The feasibility study consists of activities such as information gathering, assessment and reports on available information. The assessment activity involves finding different solutions to problems identified in the feasibility process. Questions pertaining to the proposed system can be answered from available information once a solution has been identified. A feasibility report is compiled at the end of the feasibility phase and forms the basis for critical decisions regarding the software development.

## 2.6 Requirement elicitation

Laporti *et al.* (2009) defined requirement elicitation as the process of negotiating and collaboration, where documentation and sharing of information occurs. During this phase the stakeholders discuss the activities and expectations the proposed system will perform. The RE process is complicated due to differing viewpoints and expectations amongst the users, stakeholders and BA. Users and stakeholders are also not clear on the needs for the proposed system, which increases the complexity of the RE process.

Requirement elicitation can also be described as the process of gathering requirements, whereby technical professionals engage with the users of the system to elicit the proposed system requirements. Sommerville (2009) described the requirement elicitation process as a chain of processes that interact with each other to produce requirements documentation. The requirement elicitation process includes the analysts involved in the project needing to understand the background and domain knowledge of the proposed system. Gathering the requirements entails interacting with the stakeholders and users to obtain the requirements of the proposed system. Requirements classification involves the organisation of the requirements. Requirements conflict involves the stakeholders and requirement engineers and entails the resolution of problematic requirements which contradict with the organisation and or business rules. The requirement elicitation process further involves interacting with the stakeholders to prioritise the requirements and lastly the requirements check, which is a validation of the stakeholder's expectations and the requirements gathered (Gunda, 2008).

Hickey and Davis (2002) stressed upon the importance of implementing the correct RE technique in order to gather requirements. Hickey and Davis (2002) further endorsed the sentiment of Hofmann and Lehner (2001) that the quality of requirements captured during the elicitation process will be reflected on the success of the project. Verner *et al.* (2005) conducted an industrial survey in Australia and the United States focusing on RE and success of information systems. The following areas directly related to requirements issues were investigated; requirement practices, stakeholder involvement and project management. Some of the more significant results were that good requirement elicitation strategies that had high stakeholder involvement, coupled with effective management of these user requirements, resulted in successful projects. One of the outcomes of this study which differed from other studies was the emphasis on the importance of clear requirements and the effective management of these requirements during the lifecycle of the project.

### **2.6.1 Requirements analysis**

The problems, challenges and complexity with requirement elicitation, coupled with limited user involvement in the SDLC, and analysis prevalent in the 1980s are still problematic in the 21<sup>st</sup> century (Cheng and Atlee, 2007; Gunda 2008; Davis *et al.* 2006; Hofmann and Lehner, 2001, Pressman, 2009; Sommerville, 2009). This entrenches the importance and significance of this study as a valid requirement in the IS industry.

Requirements analysis consists of three activities; eliciting requirements, analysing requirements and recording the requirements. Eliciting requirements is the task of the BA or IT department engaging with stakeholders and users to determine what the requirements are. This can also be referred to as requirements gathering. Analysing requirements entails determining whether the stated requirements are clear, complete and valid. If requirements are deemed to be unclear, incomplete, ambiguous, or contradictory, these issues are then resolved by engaging with the users and stakeholders during requirement review or clarification sessions.

### **2.6.2 Requirement elicitation problems**

Requirement elicitation (RE) is considered to be one of the most knowledge intensive and critical activities in the SDLC. A failure to execute RE adequately can adversely impact the final project implemented (Hickey and Davis, 2002). Due to the complexity of RE, a number of problems may be experienced. McDermid (1989) classified requirement elicitation problems into the following three categories:

- Problems of scope: where the system boundaries are not clearly defined.
- Problems of understanding: entail the users not having a clear understanding of their needs. Analysts also experience problems of understanding regarding the domain of the system.
- Problems of volatility: where requirements alter over time due to a change in need by the users or changing perceptions by the business and key stakeholders.

Requirement elicitation is a critical process in the SDLC and the problems highlighted by McDermid (1989) add to the complexity of the RE process. A number of interventions were identified by Rajagopal *et al.* (2005) to address the RE problems and improve the RE process. User training is an important intervention which can improve the process. If users are adequately informed of the capabilities and

limitations of software developers and information systems, the requirements proposed may be more realistic and valid. Recording of keywords from users and stakeholders can add value to the process ensuring that no key requirements are omitted. A visual representation or spider diagram of the keywords and requirements can increase agreement and consensus on the requirements amongst the users. The mapping of keywords to generate requirements is another valuable intervention. The Capability Maturity Model (CMM) was proposed to ensure system risks are considered as part of the requirements. Risks can severely impact on the RE process and SDLC as a whole. It is important to identify and track risks at each stage of the process, mitigating the risks if possible.

Sommerville (2009) alluded to the requirement elicitation process offering benefits to organisations such as gathering requirements, analysis of the requirements and business procedures of the organisation. Sommerville (2009) suggested a number of activities which contribute to complexity and challenges of the requirement elicitation and analysis process. Lack of technical knowledge and background of the system from the stakeholder perspective, unclear and unrealistic requirements, and difficulties aligning general requirements to technical requirements, make the RE process challenging.

### **2.6.3 Requirement elicitation techniques**

Requirement elicitation involves the gathering of requirements for a system or product by engaging with the relevant users and/or stakeholders. The RE process investigates the functions of the proposed system, the services expected from the system, and any constraints. An interacting chain of activities results in a requirement document which forms the basis of the system (Gunda, 2008). The requirement elicitation techniques below are tested, proven methods and include a combination of classic and modern elicitation techniques.

#### **2.6.3.1 Interviews**

Interviews have been identified in the literature as a popular method for requirement elicitation (Gunda, 2008, Kotonya and Somerville, 1998). Interviews are held between the analyst, requirement engineers and stakeholders to understand the requirements and objectives of the system. Interviewing requires social skills, listening skills and knowledge on interviewing guidelines and principles, and consists of four steps; identifying the candidates, preparing for the interview, conducting the interview and following up after the interview. Key stakeholders are the ideal candidates to be interviewed (Goseva, 2006).

There are two types of interviews; open interviews and closed interviews, which are also referred to as structured and unstructured interviews (Gunda, 2008). In closed interviews, the requirements engineer or analyst prepares a set of predefined questions for the stakeholders in order to gather the requirements and objectives of the proposed system. During open interviews no questions are prepared and open discussions are conducted to gather the required information from the stakeholders. Interviews are effective for understanding problems with existing systems and obtaining general requirements, however it is difficult to use the interviewing technique to determine the boundaries of new systems. For effective interviews the interviewers need to be open-minded and patient with the interviewees, and interviewees need to be expressive and provide the necessary information (Gunda, 2008; Kotonya and Sommerville, 1998).

### ***2.6.3.2 Questionnaires***

Questionnaires are a cost effective way of gathering requirements from a large group of users in a short space of time. Honesty of the participants and the design of the questionnaire are critical factors which influence the results obtained using this method. User requirements, objectives and system constraints can be elicited from users with a well-designed questionnaire (Gunda, 2008). Gunda (2008) recommended the following steps when using questionnaires for RE: define the purpose of the survey, select the sample group, develop the questionnaire, distribute the questionnaire, and finally, gather and analyse the results.

### ***2.6.3.3 Rapid Prototyping***

Rapid Prototyping was described by Goseva (2006) as involving a preliminary study of the requirements elicited from users. A prototype of the system is then developed based on the users' requirements. This prototype will reflect much of the functionality required by the users in the end product. The users can navigate through the prototype of the system identifying which of the requirements have been met and which requirements require further development and/or improvement. Rapid prototyping forms the basis for the system specifications, with a development process being implemented thereafter to develop the actual system. This approach aids in the understanding and refinement of user requirements. Rapid prototyping serves to capture and reflect user requirements at a high level, and the prototype is discarded after it has served its purpose. Certain modules of the prototype may be incorporated into the final system, if testing standards have been met.

Prototyping offers advantages such as reduced time and costs for development, visual representation of the proposed system for users, higher levels of user satisfaction and a means to identify possible system enhancements. Possible disadvantages of prototyping include user expectations that the final product will be similar to the prototype, risk of the prototype becoming the final product and incomplete system implementation (Gunda, 2008).

#### **2.6.3.4 Group Workshop**

Coughlan *et al.* (2003) described the workshop method as a popular technique used during the elicitation of requirements. Group workshops work well in overcoming barriers and engaging users and stakeholders from different areas in an organisation. The workshop structure facilitates information flow and communication to the users and stakeholders, and results in a requirements document. Disadvantages associated with group workshop include the fact that insufficient preparation from stakeholders can result in a session where insufficient information has been gathered. Some users tend to drop out of group workshops; hence user commitment is another possible disadvantage.

#### **2.6.3.5 Scenarios**

Scenarios are utilised after the initial requirements gathering phase and provide the different interactions of the system based on the requirements (Gunda, 2008). Scenarios assist in investigating different situations of the system, investigating the requirements and assisting users with understanding and providing detailed requirements. Detailed requirements specifications are derived at the end of the scenario. The scenario technique includes use cases for users to identify what is required in each interaction. User and stakeholder involvement is critical when using the scenario based technique.

#### **2.6.3.6 Brainstorming**

This requirement elicitation technique is suitable for small groups and involves soliciting, consolidating and evaluating ideas and thoughts on a defined problem. The problem, possible causes, system requirements, alternative solutions and similar problems may be discussed during brainstorming sessions (Duggan and Thachenkary, 2004). Brainstorming facilitates synergy amongst the group, resulting in innovative ideas suggested by participants. These sessions encourage active participation amongst individuals, without fear of criticism or judgement. Brainstorming sessions involve two phases: the generation phase where a list of ideas are proposed and the consolidation phase, where the ideas generated are then discussed and revised.

### ***2.6.3.7 Joint Application Development (JAD)***

Duggan and Thachenkary (2004) defined Joint Application Development (JAD) as a facilitated group technique used to obtain requirements from users and stakeholders. JAD sessions are designed to encourage team synergy and cohesive thinking. Benefits of JAD sessions are that feedback is received from the combined knowledge of groups of participants, resulting in shortened development times for the system. JAD sessions were developed as an alternative to conventional interviews for obtaining requirements and are used in combination with Rapid Application Development sessions (RAD). Possible negative effects of JAD sessions are disruptive group behaviour and conflict, therefore effective facilitation is critical for this technique.

### ***2.6.7.8 User Centred Design***

User centred design is closely related to Joint Application Development. The only difference is that user centred design includes the end user in closer interaction with the development team. This is beneficial as the end user is highly involved with the development team and can provide immediate feedback. User centred design activities as proposed by Gunda (2008) include usage centred requirements for requirements analysis and specification, structured user interface for system design and innovation, continuous usability assessment for evaluation and improvement, and lastly human centric factors for quality procedures.

### ***2.6.7.9 Nominal Group Technique (NGT)***

The Nominal Group Technique (NGT) involves individuals working together with limited interaction; individuals work independently generating ideas. The facilitator thereafter records the ideas one at a time in a round robin format from all participants. Ideas may be discussed amongst the participants for clarification. Participants then independently rate and rank each idea, and the group prioritises the importance of the ideas (Duggan and Thachenkary, 2004). This approach promotes innovative thinking and reduces conformity to requirements. Different ideas and requirements are proposed independently by users, and then discussed as a group. This approach encourages interaction from all the users in the group ensuring that all requirements are reviewed and discussed.

#### ***2.6.7.10 Observation***

Maiden and Rugg (1996) described the observation technique, also referred to as Social Analysis, involving the requirements engineer observing the actual practices in a particular environment. This technique is simple to execute and does not require detailed training or a high level of preparation. A limitation of this technique could be a large amount of irrelevant data being captured, possible problems accessing restricted sites such as the chemical and manufacturing sites at SASOL, and difficulty estimating how long the observation should last.

#### ***2.6.3.11 Requirements reuse***

Reusing the requirements of an existing system includes benefits of reduced time and cost in gathering requirements. Requirements reuse is applicable in user interface designs and organisations security policies. Requirements need to be checked and validated before being incorporated into the new system. Stakeholders are required to provide requirement documents on the existing system, from which requirements worthy of reuse will be identified. A number of researchers have suggested that finding and using reusable requirements is one of the best ways of gathering requirements (Sommerville, 2009; Maiden 1995; Cheng and Atlee, 2007).

#### ***2.6.3.12 Acquisition of Requirements (ACRE)***

Acquisition of Requirements (ACRE) is an alternative technique proposed by Maiden and Rugg (1996) for eliciting requirements from users and stakeholders. There is a range of requirement elicitation techniques and methods, as documented above. The ACRE Framework encompasses the range of requirement elicitation techniques and offers guidelines on selecting the appropriate technique or combination of techniques, taking cognisance of the benefits of each technique, the different features of the techniques and the different environments within which the techniques may be applied (Maiden and Rugg, 1996). ACRE's framework provides twelve techniques to obtain requirements from stakeholders, with each acquisition method striving to improve on the communication between the stakeholders and the requirements engineers or BA. The ACRE framework supports the notion that no single elicitation technique can be used during RE, but rather a multi-dimensional range of techniques depending on the scope of the initiative, the business environment and culture of the organisation.



#### **2.6.4 Prior research in requirement elicitation**

Gunda (2008) conducted a survey using 35 specialists working in the areas of requirements and software development. The survey was designed to gather information on the requirement elicitation techniques and the problems the specialists encountered using those techniques. The sample selected for the survey had an adequate background and knowledge on requirement elicitation. The questionnaire was circulated electronically to the sample group which was selected from seven different companies in India. The educational background of the sample group was in Information Technology, Computer Science, Business Administration and other forms of electronic certifications. An important finding of the survey was related to the years of experience the respondents had. Respondents with higher years of experience considered requirements engineering an important phase in software development. Respondents highlighted the following requirement elicitation techniques as popularly used in their respective organisations; interviews, questionnaires, social analysis, prototyping, scenarios, brainstorming, JAD, use case diagrams and reusing requirements. Reusing requirements was the most popular RE technique from Gunda's (2008) survey.

Other significant findings of Gunda's (2008) survey included the selection of social analysis and prototyping as RE techniques effective for any type of system or application. JAD and prototyping were effective elicitation methods used for complex systems and applications. The benefits of JAD and prototypes are the visual representation of the proposed system which allows users to better understand the requirements, the system and the interaction thereof. Requirements can be easily clarified and additional functionality and requirements built upon. Questionnaires and requirements reusing were noted as popular methods and as being less time consuming. Gunda's (2008) study discovered that developers avoid direct interaction with the users which results in higher costs for the project.

Although prototyping was found to require considerable resources in terms of time and cost, it is one of the popular methods utilised in industry. The benefits of prototypes are highly advantageous and of value add to the users. Questionnaires were noted to be a popular requirement elicitation technique from Gunda's (2008) survey, however questionnaires are highly dependent on the respondents. An interesting finding was that established companies adhere to the traditional methods for RE, whilst newer organisations are more innovative and open to implementing new methods which may yield a faster result, using fewer resources (time and cost).

Hofmann and Lehner (2001) conducted a field study to investigate three factors; team knowledge, allocated resources and RE processes; and the impact on project success. The field study encompassed 15 RE teams in nine software companies and organisations in the telecoms and banking industry. The study included 76 stakeholders, 15 PMs, 34 team members, and 27 other relevant resources. Data was collected through questionnaires and interviews to obtain information and a clearer understanding of the RE process. Findings from the survey indicated that involving the stakeholders early in the process increased the understanding of the RE process. Lack of skilled resources, training and project management knowledge resulted in teams with less knowledge on the RE process. Hofmann and Lehner's (2001) findings indicated that organisations should assign PMs based on capabilities rather than availability.

According to Hofmann and Lehner (2001), RE would in the past receive a small percentage of project resources during the software development lifecycle, however the last 20 years has seen an increase in the resources allocated to RE activities. The survey conducted on the nine software companies reflected on average that 15.7% of resources were assigned to RE activities. In total the average amount of time utilised on RE activities accounted for 38.6 % of the project duration. Several RE teams in the survey used an internal web site to post documentation, requirements and project progress. This facilitated communication and kept all stakeholders informed on the project.

With regards to the RE process, only some projects in Hofmann and Lehner's (2001) survey defined the RE process in detail or customised the process to the organisation's needs. The customised RE process included a collection of RE methods, templates and tools according to the characteristics of the project. Although most RE teams did execute a documented RE process, the stakeholders perceived RE as an ad hoc process. A significant finding of the survey was that the RE teams performed multiple iterations of the RE process. This would have increased the understanding and definition of the requirements, with the potential to impact positively on the project outcomes. The survey reflected that the RE teams focused more on the elicitation and modelling of the requirements as opposed to the verification and validation, however the requirements were verified and validated with the stakeholders. Brainstorming, unstructured interviews and focus groups were used by the RE teams to elicit requirements. Workshops were conducted by only two of the nine teams to elicit requirements.

Hofmann and Lehner's (2001) study yielded results indicating that top performing teams in the study found effective means to balance knowledge, processes and resources. Successful projects in the study spent twice as much effort on RE and repeated RE throughout the project (on average at least three

iterations of RE). This ensured that requirements were well understood, clearly defined and validated by the project team. It is important that RE teams consist of skilled individuals in the application domain, IT and the RE process. The right resources need to be involved in the correct stages of the project. It is critical to have experienced and capable PMs assigned to the project, as they are the key drivers of the project and ensure that stakeholders are well informed on the progress of the project. The PM ensures the project is on track with regards to the project plan, budget and resource constraints. Risks are also effectively managed and mitigated if possible by the PM.

Table 2.2 on page 35 is adapted from Hofmann and Lehner's (2001) study and details the focus area, best practice, costs and the key benefits of the focus area and best practice. The information in this table can be adapted and used in other projects to ensure best practices are followed, impacting positively on the outcomes of the project.

**Table 2.2: Best practice for RE teams adapted from Hofmann and Lehner (2001)**

Focus area	Best practice	Cost of introduction	Cost of application	Key benefit
Knowledge	Involve customers and users throughout RE	Low	Moderate	Better understanding of “real needs”
Knowledge	Identify and consult all likely sources of requirements	Low to moderate	Moderate	Improved requirements coverage
Knowledge	Assign skilled project managers and team members to RE activities	Moderate to high	Moderate	More predictable performance
Resources	Allocate 15 to 30 percent of total project effort to RE activities	Low	Moderate to high	Maintain high quality specification throughout the project
Resources	Provide specification templates and examples	Low to moderate	Low	Improved quality of specification
Resources	Maintain good relationships among stakeholders	Low	Low	Better satisfy customer needs
Process	Prioritise requirements	Low	Low to moderate	Focus attention on the most important customer needs
Process	Develop complementary models together with prototypes	Low to moderate	Moderate	Eliminate specification ambiguities and inconsistencies
Process	Maintain a traceability matrix	Moderate	Moderate	Explicit link between requirements and work products
Process	Use peer reviews, scenarios and walk-through to validate and verify requirements	Low	Moderate	More accurate specification and higher customer satisfaction

## **2.7 Information systems development projects**

Yeo (2002) defined information systems as a combination of hardware, communication technology and software designed to handle information related to processes. There are numerous projects running in any environment at any given time. A new and valid business requirement or need is usually addressed by a project, be it a large scale project following a full SDLC, or a minor project following a basic software development methodology. The focus of a PM allocated to a project is to deliver a successful system by meeting the basic user requirements, delivering the system within budget, on time and obtaining user acceptance of the system. These expectations are well enshrined within the discipline of software engineering (Pressman, 2009). According to Yeo (2002), the implementation of an information system entails the design, delivery and use of the system in the organisation it was designed for.

### **2.7.1 Information system success**

DeLone and McLean (1992) alluded to the measurement of information system success as being critical to the understanding and value adds of information systems. The DeLone and McLean IS Success Model was developed in 1992 to serve as a framework to conceptualise the success of an information system. The model comprises concepts from Shannon and Weaver (1949) and Mason (1978). A multi-dimensional model for IS success was developed which incorporated concepts proposed by DeLone and McLean (1992), Shannon and Weaver (1949) and Mason (1978). The model defined a technical level of communications to describe the efficiency and effectiveness of the system. The semantic level refers to the success rate of the conveyance of the intended meaning of the information system. The effectiveness concept describes the effect of the information on the receiver. Systems quality in DeLone and McLean's IS Model measures the technical success of the system, information quality measures the semantic success and effectiveness success is measured by the use of the system, satisfaction levels and net benefit of the system.

In efforts to establish critical factors leading to successful projects, Hofmann and Lehner (2001) emphasised the importance of clear and well defined requirements for a successful project. Hofmann and Lehner (2001) conducted a study aimed at identifying the requirement engineering practices contributing to the success of projects. 76 stakeholders were involved in the study on an analysis of newly commissioned business critical projects. Analysis into the RE process identified the following four separate but interrelated activities: elicitation, modelling, validation and verification. The study focused on investigating three particular factors which could potentially contribute to the success of the project.

These are knowledge, resources and process. Findings indicated that early involvement of stakeholders was a contributing factor to project success. Stakeholders were involved in the process and understood the requirement elicitation processes being used. Resources are not generously allocated during the requirement elicitation phase of projects and the majority of requirement elicitation teams involved in the survey repeat the requirement elicitation process to ensure elicitation of sufficient requirements. An interesting observation from the study was the priority attached to elicitation of the requirements rather than validation and verification of these requirements.

A number of criteria have been identified on what constitutes a successful project (Hofmann and Lehner, 2001; Young, 2006b). In their contribution, Hofmann and Lehner (2001) discussed the three most important factors contributing to the success of a project. These are knowledge, resources (personnel, financial and time) and process. Young (2006b) cited 12 basic requirements which contribute to a projects success. This list includes: trained project team members, user involvement, defined project requirements process, proper documentation, proven requirement elicitation techniques, effective automated requirements tool and proactively addressing requirement related risks. Young (2006b) extended the concept of critical requirements by providing a list of criteria defining good requirements. Ideally requirements should be necessary, feasible, correct, concise, unambiguous, consistent, verifiable, traceable and design independent (Young, 2006b). The importance of requirement elicitation, management of user expectations linked to requirements and detailed analysis and design into requirements features highly on Young's (2006b) list of requirement basics for project success. Young (2006b) further recommended that one continuously revise and improve on the requirements process as the value-add to the end product and impact on the project will be high.

Verner *et al.* (2005) concluded that the most important project success prediction factors are good requirements and requirements being managed effectively, yielding a predicted 93% of successful projects, therefore it is critical to have customers/users involved in the requirement elicitation process to obtain good requirements. A well-defined project scope and appropriate lifecycle methodology were other factors highlighted by Verner *et al.* (2005) as critical to IS project success.

Thomas and Fernandez (2008) conducted a study on how companies define and measure information technology project success. The study was based on 36 companies in Australia. After a series of interviews with PMs and a review of the literature, Thomas and Fernandez (2008) concluded that information systems success is a multi-dimensional construct encompassing project implementation and

system success. Systems success can be detailed further into technical development, deployment to the user and delivery of business benefits (Ballantine *et al.*, 1996). Another perspective considers project management successes to be defined by delivering projects on time, within budget and adhering to quality (Cooke-Davis, 2002).

Thomas and Fernandez (2008) conducted a study examining the success criteria used by companies when evaluating IS projects. The criteria were divided into three categories: project management success, technical success and business success. Of the companies interviewed for this research project, most companies considered between two and eleven success criteria for projects. The results of this study also highlighted a number of new success criteria not frequently discussed in the literature; sponsor satisfaction, business continuity, project team satisfaction and steering group satisfaction. The detailed list of the success criteria and link to the associated category is depicted in Table 2.3.

**Table 2.3: Criteria used by survey participants to judge IS success adapted from Thomas and Fernandez (2008)**

Success criteria	Category		
	Project management	Technical	Business
On time	X		
In budget	X		
Sponsor satisfaction	X		
Steering group satisfaction	X		
Project team satisfaction	X		
Customer / user satisfaction	X	X	
Stakeholder satisfaction	X	X	
System implementation		X	
Requirements met		X	
System quality		X	
System use		X	
Business continuity			X
Met business objectives			X
Delivery of benefits			X

There is a multitude of research articles, literature reviews and projects on what constitutes a successful information system (DeLone and McLean, 1992; Ballantine *et al.*, 1996; Fowler and Walsh, 1999; Procacciono *et al.*, 2002; DeLone and McLean, 2003; Verner *et al.*, 2005; Raymond and Bergeron, 2008; Thomas and Fernandez, 2008; Westner and Strahringer, 2010). A review of the literature on IS success indicates there are a number of different components and variables which contribute to IS success, but no set defined criteria that have been agreed upon by researchers and IS specialists. The field of information systems projects and implementation has a range of intangible variables and incorporates the complexity of human users of a system. As such there are no set criteria for implementing a successful information system. One needs to incorporate a multi-dimensional model incorporating different criteria based on the scope and requirements of the proposed information system. This is concerning as it implies that many projects are initiated without clear criteria on what would classify the project a success (Remenyi and Sherwood-Smith, 1999). Thomas and Fernandez (2008) alluded to the limited number of research studies investigating what constitutes a successful project. Defining and measuring project success on the project outcomes is a niche area where limited research has been conducted. This study aims to contribute to that gap.

Table 2.4 on page 40 illustrates the constructs of the DeLone and McLean IS Success Model and the associated success metrics in the context of an e-commerce site. The system quality can be measured accordingly to adaptability, availability and reliability of a system. How easily one can use a system, and navigate through to system is linked to usability of the system, with efficiency of a system measured in terms of response time, are other important metrics associated with system quality. The use of a system can be measured by the number of visits to a site and the number of transactions performed on the system.

User satisfaction of a system can be measured by how often users access a system and perform transactions on an e-commerce site. Questionnaires and surveys can provide additional information on how the system can be improved, impacting on the usability and usage of a system. Net benefits are important as these are the value adds of the system to both individuals and organisations.



**Table 2.4: E-commerce success metrics adapted from DeLone and McLean (2003)**

<p><b>Systems quality</b></p>	<ul style="list-style-type: none"> <li>• Adaptability</li> <li>• Availability</li> <li>• Reliability</li> <li>• Response time</li> <li>• Usability</li> </ul>
<p><b>Information quality</b></p>	<ul style="list-style-type: none"> <li>• Completeness</li> <li>• Ease of understanding</li> <li>• Personalisation</li> <li>• Relevance</li> <li>• Security</li> </ul>
<p><b>Service quality</b></p>	<ul style="list-style-type: none"> <li>• Assurance</li> <li>• Empathy</li> <li>• Responsiveness</li> </ul>
<p><b>Use</b></p>	<ul style="list-style-type: none"> <li>• Nature of use</li> <li>• Navigation patterns</li> <li>• Number of site visits</li> <li>• Number of transactions executed</li> </ul>
<p><b>User satisfaction</b></p>	<ul style="list-style-type: none"> <li>• Repeat purchases</li> <li>• Repeat –visits</li> <li>• Questionnaires</li> </ul>
<p><b>Net benefits</b></p>	<ul style="list-style-type: none"> <li>• Cost savings</li> <li>• Expanded markets</li> <li>• Incremental additional sales</li> <li>• Reduced search costs</li> <li>• Time savings</li> </ul>

There are a number of factors cited in the literature on factors contributing to IS project success (Au *et al.*, 2008; Cooke-Davies, 2002; Group 1999; Thomas and Fernandez, 2008; Young, 2006b). DeLone and McLean's IS Success Model (2003) is a widely used model to measure IS success and were referenced in at least 285 papers in 2012. DeLone and McLean's IS Model (2003) cited the following components as critical to IS success; system quality, information quality, service quality, usage, user satisfaction and net benefits measuring the impact of the system on the users. The D&L IS Success model forms one of the critical components of the theoretical framework for this study and will be discussed in further detail in Chapter 3.

#### ***2.7.1.1 Effective management of requirements***

Verner *et al.*'s (2005) study highlighted effective management of requirements as a good predictor of information system success. 93% of the projects were predicted correctly to be successful projects. The study further concluded that effective and efficient project management is critical for effective requirement elicitation. An evaluation of all responses received from the surveys indicated that good requirements were the best predictor of project success, predicting 89% of project successes, 58% of project failures and 78% of projects overall.

#### ***2.7.1.2 Customer/user involvement***

A high level of customer/user involvement in general, was another predictor of project success suggested by Verner *et al.* (2005), coupled with high levels of customer/user confidence in the development team. These factors predicted 90% of project successes, 51% of project failures and 78% of projects predicted correctly overall. Project management was the third factor highlighted as a good predictor of project success. Appropriate requirements information, appropriate development methodology for the project and effective management of requirements predicted project outcomes for 77% of projects. User involvement is critical to ensure the requirements are well understood, clarified and linked to the functionality of the final system. The ultimate users of the system are the end users and customers. It is critical for user representatives to provide feedback on usability components and requirements. Users should be involved in all phases of the SDLC, especially during RE and user acceptance testing. The level of user involvement will vary during different phases of the SDLC, for example during the technical specification and functional design, user involvement will be low, as opposed to user acceptance testing where user involvement will be high. Communication and training material should be prepared in

conjunction with users, ensuring the language is not technical jargon, suitable for users and relevant to the users operations on the finalised system.

### ***2.7.1.3 Training***

One of the success criteria for information systems is user acceptance and use of the system. For users to be comfortable and actively use the system, training is required. Paula Vaughan (2001) recommended the following components for a successful training programme; detailed documentation and training manuals; appropriate timing and coordination between the project team, trainers and users; an appropriate training type, be it classroom, one-on-one or computer based; and an extended training plan to continue training beyond the implementation of the system.

### ***2.7.1.4 Project Scope***

The stakeholder's vision for the proposed system should be documented in a project vision. The scope of the project will be linked to the vision document. Consensus on the project scope amongst the stakeholders of the project is critical. Support and buy in from the different stakeholders will be easier to achieve if all stakeholders are aligned to and concur on the project scope and vision. Stevens *et al.*(1998) suggested that it is important to engage stakeholders throughout the SDLC, as projects that do so are more successful. The reasons for this are improved communication amongst stakeholders and realistic expectations.

### ***2.7.1.5 Requirement elicitation techniques***

Young (2002) alluded to the importance of using workshops, prototypes and visual presentations to achieve stakeholder support for a new system. These RE techniques: workshops, prototypes and visual presentations, appear to be the more successful of more than forty requirement elicitation techniques investigated by Young (2006b). Workshops facilitate knowledge sharing and understanding of the overall need for the system amongst the stakeholders. Workshops are also a cost effective way of reviewing requirements, reviewing issues and making decisions with the relevant stakeholders. Prototypes are effective for RE as prototypes can be designed, developed and implemented cost effectively. Visual representations are effective for receiving immediate feedback from stakeholders and users on the design interface and services of the system (Young, 2006b).

### ***2.7.1.6 Tools***

Complex projects (defined in SASOL as requiring integration across a number of systems, platforms and processes) should utilise an automated requirements tool for storing detailed information and attributes on each requirement. A senior project manager (PM) at SASOL defined a complex project to range from R10 million to R500 million for project capital, project duration to range from 1 to 3 years, team structure to consist of an average of 25 members, organisational change and wide impact, and a high risk project; amongst other variables. Requirements can be tracked and managed using an appropriate tool. Requirement information relating to the source of the requirement, priority, complexity, cost, classification criteria, traceability, status and change history of requirements can be managed using a requirements tool. Different stakeholders in the project may require information on the requirements gathered, and the level of detail and complexity will differ according to the stakeholder. For example, users will require high level information on the requirements, whilst requirements engineers will require detailed information. The automated requirements tool should be configured to provide reporting based on the requirements of stakeholders (Young, 2006b).

### ***2.7.1.7 Mitigate Risks***

The project teams need to proactively identify, mitigate and address risks to the project. A number of researchers support the importance of addressing requirements related risks, as minor risks noted in early stages of the SDLC compound into critical risks in later stages (Young, 2006a, Wiegers, 2003). Young (2006b) identified a number of risks and the recommended risk response per identified risk. Changing requirements is a risk in all projects, be it IS, CTL or GTL projects, and can be addressed by frequent requirements review sessions with the project team and relevant stakeholders. Incomplete, invalid and unclear requirements are a significant risk to projects. This risk can be addressed by requirement workshops to identify missing requirements and to clarify unclear ones. Requirements should be elicited from the correct range of stakeholders. Reviewing the requirements and validating the need for the requirements will assist in mitigating the risk. Innovative requirements may be a risk and can be addressed by obtaining information on similar projects, conducting a detailed requirements analysis and liaising with subject matter experts. Non-verifiable requirements can be mitigated by including testers earlier in the project to verify and validate the requirements. Frequent requirement review sessions and detailed requirements analysis can address the various requirement risks identified by Young (2006a). It is interesting to note that the risks identified by Young (2006a) are largely requirements risks. This

reiterates the importance of requirements and the RE process in the SDLC, validating the need for this study in the South African context.

#### ***2.7.1.8 User Satisfaction***

According to Xiao and Dasgupta (2002) and Au *et al.* (2008), user satisfaction is considered one of the most critical measures of IS success. User satisfaction is a critical construct in IS usage and the subsequent success of information systems. The widespread use of technology and the Internet has increased the flow of communication and means of engagement on a global scale. The last two decades has an increase in the number of internet sites and technology users, but limited research has been conducted on the user satisfaction of internet sites and information systems. Since the 1980's user satisfaction has been receiving increasing attention. Xiao and Dasgupta (2002) used five components to study user satisfaction of web based systems: content, accuracy, format, ease of use and timeliness. These components were derived from the end-user computing satisfaction (EUCS) instrument, developed to measure user satisfaction of internet sites and information systems. Additional components such as privacy and security can also be measured for user satisfaction, especially in the context of banking and e-commerce sites. The components to measure user satisfaction are highly dependent on the context of the information system or internet site used. Banking, airlines, news, education and shopping sites will have different components to measure user satisfaction. The importance is engaging with users and understanding which measures are important to them for satisfaction.

#### ***2.7.1.9 End User Involvement***

End user involvement and end user acceptance are critical components in the study of information systems. Mahmood *et al.* (2000) conducted research on the variables affecting information technology and end user satisfaction. According to the literature and cited in Mahmood *et al.*(2000) the degree to which end users accept a system can be used as an indicator of end user satisfaction and predictor of information success. Nine constructs linked to the DeLone and McLean IS Success Model and TAM were examined to determine the relationship and impact of the variables; PEOU, ease of use, user expectations and experiences, user IT skills set, user involvement, attitude and organisational support were some of the variables measured and investigated. A critical and significant relationship found in Mahmood *et al's* (2000) study was user involvement during the SDLC, the end user experience and satisfaction with the final system which influenced the users attitude when using the information system. End user involvement can be directly linked to end user acceptance of an information system.

### **2.7.2 Information system failures**

According to Yeo (2002), information systems are pervasive in almost all aspects of organisations. Past studies have highlighted the cause of failed projects to a combination of budget, timelines and/or not satisfying user requirements. The Standish Group Report (1999) stated that software development projects are in “chaos”, with a high rate of failed, abandoned or cancelled projects. Project impairment or failure of an information system may not only be attributed to technical fault. User acceptance and soft issues such as cultural and social issues can impact on the implementation of an information system.

Problems have been identified by Williams (2003) which cause requirement engineering project failures. Changes in the requirements can affect the scope of the IS project and introduce instability, uncertainty and confusion. Communication amongst the stakeholders and project team is critical during IS projects. Quantitative data on project status, progress and quality is important and ensures that project planning is executed effectively. Incorrect or non-verified financial estimations can result in quality and development problems. Requirements are often intangible, increasing the complexity of tracking these requirements and variables. Intangible variables and factors related to the requirement engineering process may be difficult to measure and omitted in the RE process. This can result in critical requirements being overlooked and can contribute to software project failures. Communication between the RE process and stakeholders is highlighted as critical and can severely impact projects if all stakeholders are not clearly aligned on requirements.

Four categories of IS failure were defined by Lyytinen and Hirschheim (1987). Correspondence failure occurs when the system’s basic design objectives and requirements are not met and the system is therefore considered a failure. Process failure occurs when the proposed information system cannot be developed within the resource constraints of budget and timelines. There are two types of process failures; the first whereby no workable system can be produced and the second process failure is when the system is developed having massively exceeded the budget and timelines. Poor project management is usually responsible for systems that fail due to process failure. Interaction failure occurs when user interaction with a system cannot be used to accurately measure user satisfaction. High system usage may be a result of legal compliance, process driven or lack of alternative systems to perform tasks. Expectation failure is due to an information system not meeting its stakeholder requirements or expectations. This entails the system not meeting the basic requirements specified by the user and key stakeholders regarding the expected output and services the system was required to provide.

Flowers (1996) described the following scenarios to define an information system failure: an information system failing to function as expected, or functioning with sub-optimal performance; an information system that does not perform as per original requirements and specification; and an information system which is rejected by users or underutilised. Information systems which result in development costs exceeding the value add of a system (for the systems lifetime) or, projects being abandoned during the SDLC, are deemed IS failures.

There are a range of critical failure factors (CFFs) in information systems such as organisational, financial, technical, human and political factors. These factors alone or an interaction of these factors can result in system failure. When all work related to developing an information system has ceased, the system has failed. The following results on IT project failures were summarised by Tichy and Bascom (2008). Table 2.5 highlights the research trends of project failures and the financial losses incurred by the organisations as a result.

**Table 2.5: Research findings on failed projects adapted from Tichy and Bascom (2008)**

Study	Sample	Results
Aberdeen Group	Unknown	90% of projects are late 30% of projects are cancelled.
Gartner (2000)	1375 participants	40% failed to meet requirements \$1 million was wasted on IT projects in one year.
KPMG (1997)	176 projects	61% failed to meet requirements 75% missed deadlines 51% exceeded timelines.
The Standish Group (1994)	365 participants 8300 software implementations	31% delivered expected value 16% were cancelled 51% defined as challenged

General factors for IS project failure can include project teams continuing with a failing project. Corporate cultures, economic climate, business need or sponsors may change during the project; however the project team or project owner may be reluctant to halt the project due to the resources already invested in the project thus far. IS projects may also fail due to inadequate communication or collaboration with

the business users and stakeholders. The key stakeholders are not updated and kept informed of changes or progress on the project, leading to dissatisfaction and possible impact on the user satisfaction component. The integration of people and technology can be challenging in different organisations and technology implementations. Regulatory compliance can impact negatively on an IS project if there are strict regulations which limit the flexibility of the IS. This may impact on the IS delivering on its intended purpose, making the project difficult to continue. Stakeholder accountability is another critical component which may lead to IS project failure if not managed correctly. Poor sponsorship, lack of management support, lack of a strong champion, insufficient resources and unrealistic timelines can be major factors influencing the outcomes of IS projects. The culture in an organisation is also critical for IS projects. Some organisations have a corporate culture that is tolerant to change and innovation. Organisations have to engage with the IT departments and support the initiatives underway, considering IT as an enabler of technology and processes.

## **2.8 Support for the study**

The delivery of effective, quality information systems which meet user expectations and which are delivered within budget and on time, can be realised by improving the requirements engineering process (Williams, 2003). An improvement on the requirements engineering process will include a higher level of involvement of the end user in the SDLC. Enhancements to the current RE processes and models to include feedback loops and more than one iteration of RE can lead to an improved RE process, resulting in the implementation of an improved quality information system. Garmer *et al.* (2004) alluded to the importance of using a combination of requirement elicitation techniques to obtain, define and understand the end users requirements.

Finkelstein (1994) described the RE process as one of the most important processes in software engineering. Chatzoglou (1997) highlighted the importance of requirements engineering as one of the first stages of software development, therefore being critical for the success of the whole software development lifecycle. Failure to correctly execute RE can impact negatively on the remainder of the project and adversely affect implementation and user acceptance of the system. End users are a critical component to the success of an IS and should be included in the RE process and more involved in the SDLC.



A consequence of the lack of focus on the requirement elicitation phase of the software development lifecycle is that many information systems fail in terms of functionality or fail to deliver on user expectations of the system (Thomas and Fernandez, 2008; Hall *et al.*, 2002; Verner *et al.*,2005). An evaluation of these failed projects often leads to an identification of an array of factors that may contribute to the failure. Some of the common issues that have contributed to project failure are: lack of user involvement, resource constraints (financial and human resources), lack of management support, scope creep and ineffective project management (Pressman, 2009). However, the consequences of these factors are not as significant as the consequence of a poor requirement elicitation process with low levels of user involvement. Projects are systems or products built to meet a stakeholder's need or requirement. In order to correctly address the system requirements that the final product will offer, it is imperative to clearly define stakeholder requirements.

The elicitation of user requirements is a fundamental part of any product life cycle. Rexfelt and Rosenblad (2006) referred to the fulfilment of user requirements being imperative for successful product development. It was further claimed by Rexfelt and Rosenblad (2006) that elicitation of user requirements is critical in the software development lifecycle, but it is equally important to ensure that the development process enables the project team to fulfil these requirements. Based on the requirement elicitation process, requirements engineering bridges the divide between the end-user and the system developer. Without proper requirement elicitation, the entire software development lifecycle can be adversely affected by unclear requirements, impacting on the software development and user satisfaction with the system (Hickey and Davis, 2002). The consequences of poor requirements capturing sessions is that user expectations of the system will not be met. According to Saiedian and Dale (2000), poor requirement elicitation will result in an uninformed development team and a set of users who will be unsure of what system functionality to expect. There will also be a lack of detailed documentation regarding business requirements that can be used to compare the system developed and the initial user requirements.

Selection of the correct or appropriate technique to be used in requirement elicitation is critical to ensure that the necessary requirements are captured adequately. The importance of accurate requirement elicitation was highlighted in a study by Davey and Cope (2008), where they conducted an analysis of best practice strategies for eliciting system requirements. As a prelude to their study, Davey and Cope (2008) alluded to requirement elicitation as the “missing link” in the software process.

The significant outcomes of this study, which are listed below, can be regarded as somewhat contradictory and yet quite insightful. These are:

- Experts have not reached consensus on how best to elicit user requirements
- There is an absence of comparative studies that analyse the potential of one requirement elicitation technique against the capabilities of another
- Structured interviews are regarded as the most accurate form of requirement elicitation (closely followed by unstructured interviews)

Hence it can be seen that any effort to establish the potential impact of any one requirement elicitation technique cannot be generalised to all situations, as there are many variables involved that may discredit any attempt at achieving some kind of generalisation. This assertion provides the “ammunition” for many technically minded analysts and developers to focus on good requirements and allocate the importance to the RE process that it deserves (Saiedian and Dale, 2000).

Davis *et al.* (2006) suggested further that the type of requirement elicitation strategy used has an impact on the outcome of the information system. They also suggest that there is need for comparative studies which examine different requirement elicitation techniques and the level of project success. On the basis of a preliminary investigation, Davis *et al.* (2006) made the claim that requirement elicitation techniques cannot be used interchangeably. RE techniques need to be suitable to the environment or organisational culture. RE techniques cannot be simply chosen and executed in a one-size-fits-all approach. Organisations, cultures and people are different. Some organisations may be open and share information openly. As such a group workshop will work well to elicit information. In other organisations where information is confidential and limited to certain groups of users a group workshop will not be suitable. In such an organisation, individual interviews may need to be conducted to obtain information and requirements. However Davis *et al.* (2006) added the disclaimer that the conclusion made needs to be corroborated with more quantitative and possibly qualitative evidence.

The information and research studies discussed in this chapter highlight the problems and challenges of requirement elicitation in IS projects. The impact of incorrect requirements on the final outcomes of the project is pivotal as highlighted by Kotonya and Sommerville (1998). Challenges faced in the RE process in the 1980s continue to be prevalent in IS projects in the 21<sup>st</sup> century, as per findings of research studies by Westner and Strahringer (2010), Munassar and Govardhan (2010), Thomas and Fernandez (2008) and

Gunda (2008). Verner *et al.* (2005) highlighted that quantitative studies have confirmed a correlation between the RE process and the success of the IS implemented. Obtaining information on the economic and quantitative measures for the success of information systems is difficult, resulting in many researchers relying on a subjective assessment (Saarinen, 1996). There is however a lack of research into involvement of end users in the SDLC and the success of an information system from a user's perspective. Further to that, a number of research studies have been conducted overseas with no such study undertaken in a South African context, to our knowledge. This study focuses on IS projects implemented within a South African petrochemical company. Although SASOL has a global footprint, the sample group for the survey was based on users and projects implemented in South Africa. The researcher is currently employed at SASOL and access to resources and information was easily available.

## **2.9 Summary of the chapter**

According to Verner *et al.* (2005), there have been quantitative studies that have confirmed a strong correlation between lack of effort in RE and project success. However, there is a lack of research into a possible relationship between the type of RE strategy coupled with the level of user involvement in the SDLC and the success of an information system from a user's perspective.

Although an immense contribution has been made by the software engineering community in alleviating the problem of software project failure, there is still a high proportion of information system projects that do fail. The root cause of this problem may be attributed to the requirements capturing process which forms the basis upon which systems are built. The current study entails an inquiry on the RE strategy used for each of 3 IS projects implemented at SASOL and whether these systems are perceived to be successful by the community of end users. The process of establishing the success of each system is contextualized via an academic framework that is further discussed in Chapter 3.

## Chapter 3: Theoretical framework

### 3.1 Introduction

According to Davis (1993) user acceptance is a pivotal factor in determining the success of an information system. Davis' assertion regarding the success of an information system is endorsed by Legris *et al.* (2003) who contend that user acceptance often determines the success or failure of new information systems. Based on this assertion, the Technology Acceptance Model (TAM) was used as the anchoring theory around which a conceptual framework for the current study was constructed. While TAM has gained widespread recognition with regards to user acceptance of technology, the concept of information system success is still an area of much debate and little consensus. According to Rai *et al.* (2002), success is a vital criterion for evaluating an information system. However, information system success is still a very ambiguous concept that theorists are finding very difficult to quantify. Al-Ahmad *et al.* (2009) went as far as making the comment that it may be wiser to view information system success as a subjective judgement rather than making sense of the ambiguity inherent in the notions of success and failure. However, instead of resorting to such an extreme measure, the current study makes use of the well-established DeLone and McLean's (1992) Information System Success Model (ISSM) in conjunction with TAM to quantify the concept of information system success.

Each of these theories, which collectively form the theoretical framework for this study, are discussed in detail and illustrated in Figure 3.3 of this chapter.

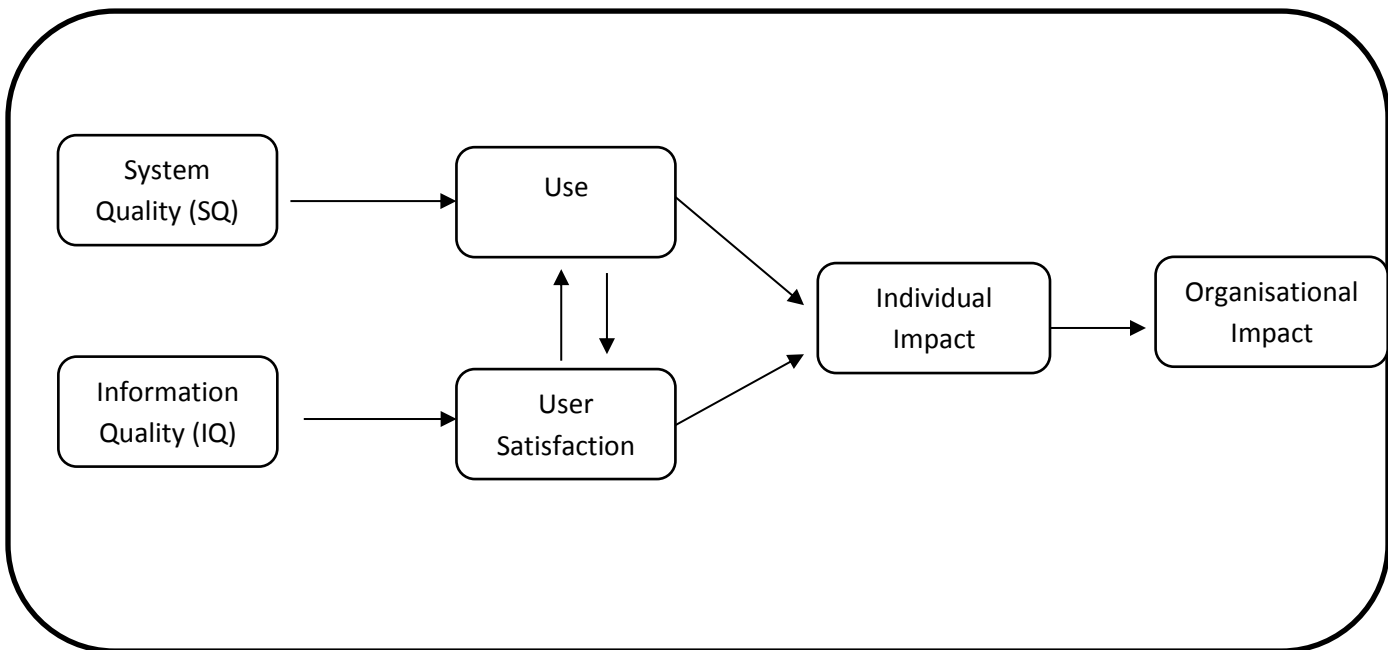
The two models; TAM and the ISSM formed the basis for this study and the constructs and variables in each model were linked to questions in the survey issued to the users at SASOL. These two models were selected for their focus on the user acceptance and success of an information system.

## 3.2 Contributing IS Theories

In order to contextualise the theoretical framework used in the current study, each of the contributing theories is discussed in an individual capacity. However, as the discussion unfolds, the inter-linking of the individual constructs that underpin each theory to the composite academic framework illustrated in Figure 3.1 should become apparent.

### 3.2.1 Information Systems Success Model

The DeLone and McLean IS Success Model was developed to quantify the success of an IS by measuring the dependent variables in a system and is illustrated in Figure 3.1. The model consists of six constructs; system quality, information quality, system quality, use, user satisfaction, individual impact and organisational impact. The construct of System Quality will impact and influence the use of the system or technology. The output of the system and the quality of information obtained, will influence the user satisfaction with the system. The constructs of use and user satisfaction will influence the impact on the user and ultimately the organisation as a whole.



**Figure 3.1: DeLone and McLean Information Systems Success Model (DeLone and McLean, 1992)**

### ***3.2.1.1 System Quality (SQ)***

DeLone and McLean's contribution with respect to SQ was an identification of criteria that would provide an indication of the level of quality contained in an IS. These indicators consisted of: "ease of use; functionality; reliability; flexibility; data quality; portability; integration and importance" (DeLone and McLean, 2003, p13). They contend that these attributes are critical for information systems' success. The main rationale behind their assertion is that if systems are extremely difficult to use and users are not adequately trained on the system, this could result in an under-utilised system. Information systems need to have a reliable uptime and should allow flexibility, catering for human error and quick recovery thereof. Portability is of importance in an information age where a number of applications are used to access and view information (tablet devices, mobile computing, different operating systems, applications and hardware models). Information Systems should provide critical and necessary information to the users, and not overload them with unnecessary and irrelevant data.

### ***3.2.1.2 Information Quality (IQ)***

From an IQ perspective, the Information System Success Model (ISSM) uses attributes such as accuracy, timeliness, completeness, relevance and consistency as its indicators. Individual impact on information quality is measured in terms of decision making performance, job effectiveness and work quality. IQ is a critical IS "output" of the software development process. Depending on the nature of the application and the environment in which it is used, the quality and accuracy of information should be suitably applied.

### ***3.2.1.3 Net Benefits (Organisational and individual impact)***

Net benefits describe the final success variable of the system that is the individual and organisational impact in the IS Success Model. The ISSM measures the success of IS and the degree to which the constructs influence this success. This construct is important in measuring and assessing the value-add of the information system to the users and the organisation as a whole; contributing towards the cost benefit analysis of information systems after implementation. In the field of information systems and software development, the focus and drive is usually to develop and implement a solution within the shortest time frame and within budget. The users are trained and provided with access to the system, and the project continues into the maintenance phase of software development. The value-add of the system is generally not tracked or measured over a period of time, as the development project team and valuable resources are assigned to other IS projects. It may add value if the SDLC includes the cost benefit and net benefit value

of the IS implemented. Currently this area appears to be lacking in projects (Luftman and Ben-Zvi, 2009). With the current economic and financial challenges and constraints faced by organisations, the net benefit construct may increase in importance to highlight the value-add of IS projects and support requests for the required IT budget.

#### ***3.2.1.4 Use***

This construct measures the user's navigation and interaction with the system, information retrieved and activities processed through the system (Venkatesh and Davis, 2000). Usage of an information system forms one of the critical factors in determining the success of an Information System. If users do not use the information system as required, the IS project can be deemed a failure (Legris *et al.*, 2003). There will be no value-add and benefits to the organisation if the end users do not engage with the system and use the critical services configured for the system.

#### ***3.2.1.5 User satisfaction***

User satisfaction is a critical construct in measuring the user's opinions on the system as it measures the user experience of the system (Venkatesh and Davis, 2000; DeLone and McLean, 1992). This construct is closely linked and aligned with the TAM model in terms of variables and constructs to measure user acceptance of a system or technology. If users are not satisfied with a system it will adversely affect the usage of the system, impacting on the success of the IS implementation.

The various constructs discussed in the DeLone and McLean IS Success Model (1992) support the user's engagement and interaction with the IS, measuring and assessing the success of the IS. The six constructs of the IS Success Model are all valid constructs and are aligned to other models in the environment which measure user satisfaction, usage and the quality of systems implemented. The DeLone and McLean ISSM is currently not formally used or acknowledged as a benchmark of IS success in any of the systems implemented, however the individual constructs underpinning the ISSM are used in isolation in different processes that form part of different systems that are used at SASOL. The incorporation of these constructs is evident in some of the mainstream systems used at SASOL, such as user surveys, a centralised helpdesk and different feedback mechanisms that are available to address service or information quality issues with respect to IS projects in the organisation.

### **3.2.1.6 Findings of past IS Success research**

A research study by Nasir and Sahibuddin (2011) examined successful projects implemented over the period 1990 to 2010 on a global scale. Out of this research study emanated a number of critical factors that contributed to the success of the software projects and information systems. The review conducted by Nasir and Sahibuddin (2011) examined findings on successful IS projects implemented over a 20 year period. Clear requirements and specifications, objectives and goals, feasible timelines, effective skills and competencies related to project management, upper management support, user involvement and effective communication were proposed by Schmidt *et al.* (2001), Sauer and Cuthbertson (2003) and Wateridge (1998). Nasir and Sahibuddin (2011) examined 43 articles that supported IS success research, from which 26 critical success factors were found to directly impact IS project success.

A number of successful IS projects have been implemented at SASOL such as the document management solution, Global Enterprise Portal (which is a SAP module) to view and process employee requests, reporting tools, Sharepoint project sites and Telepresence, allowing users to have video conferencing and feel as if they are all physically seated in the same room. In the science and engineering fraternity successful IS projects lead to the development of new plants in Doha (Qatar), Nigeria, India, Canada and Lake Charles (US). The implementation of successful IS projects and the resultant benefits of those information systems justifies the cost and productivity required to develop and implement such systems.

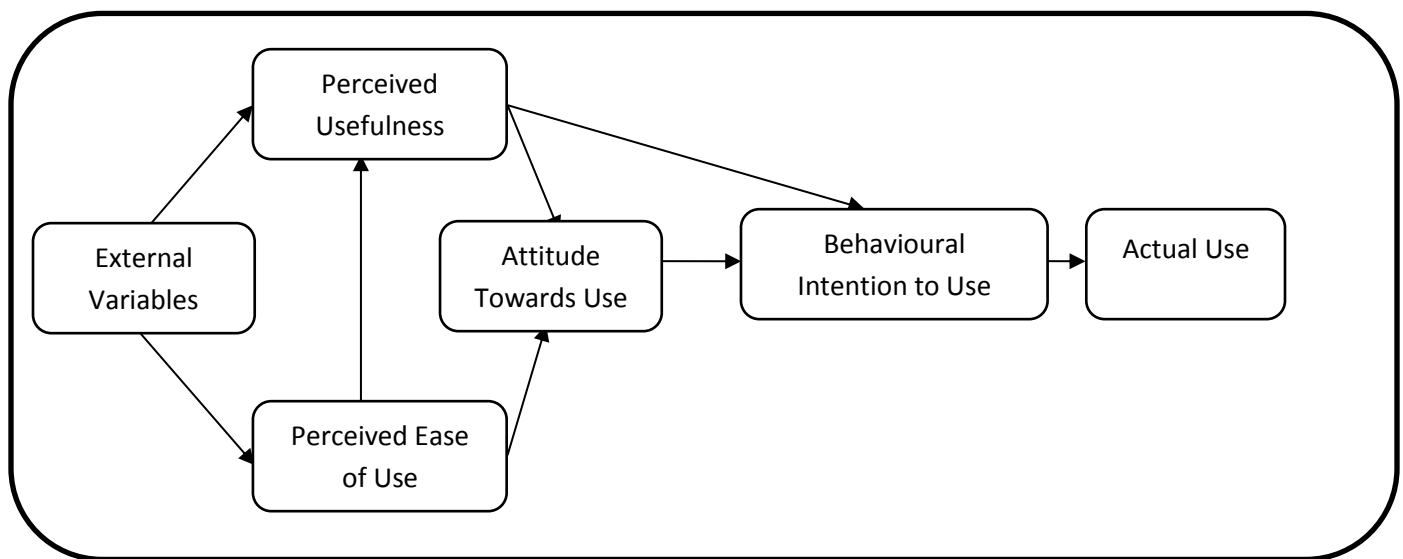
### **3.2.2 Technology Acceptance Model (TAM)**

As discussed earlier, TAM is a model in IS research related to technology acceptance and use of information systems by users. TAM's goal is to predict the user acceptance of the IS by using the TAM constructs. TAM was originally proposed by Davis (1986) and was designed to operationalise the user satisfaction variable and investigate the adoption rate of new systems by impacted users. A number of iterations of TAM have been researched and built upon. The model assists in explaining and predicting usage of information technology and information systems (Park, 2009; Legris *et al.*, 2003).

Detailed studies have been conducted on TAM since its inception in 1986, with various iterations by Davis (1986), Venkatesh and Davis (2000) and Venkatesh *et al.* (2003). Details on the perceived usefulness (PU), perceived ease of use (PEOU), attitude toward using the system, and actual usage behaviour of new systems have been conducted in numerous research studies (Gefer *et al.*, 2003; Straub, 1994; Davis, 1986; Davis and Venkatesh, 1996; Taylor and Todd, 1995; Venkatesh and Davis, 2000;



Venkatesh *et al.*, 2003). TAM consists of four major variables; Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Behavioural Intention (BI) and Behaviour (B), which are used to assess, measure and predict user acceptance of a technology. These constructs are based on the relative ease with which users can use the system, how easy the users find it to navigate through the system, the user's perception on the value added by this system to the user's productivity and efficiency, and the user's intention to actively use the system. Figure 3.2 details the constructs and relationships thereof as designed by Davis in 1986.



**Figure 3.2 Technology Acceptance Model (TAM) (Davis, 1986)**

### 3.2.2.1 Perceived Usefulness (PU)

Perceived usefulness refers to the extent to which users believe using the system will enhance user performance and effectiveness. Malhorta and Galletta (1999) defined Perceived Usefulness as the user's subjectivity regarding a certain system increasing the user's performance or efficiency within the organisation. According to Lee *et al.* (2003), PU is predicted by PEOU.

### 3.2.2.2 Perceived Ease of Use (PEOU)

PEOU refers to the level to which the user expects the system to be easy to use, free of complexity and requiring minimum effort. The variables of PU and PEOU can be used to predict the user's attitude toward using the system. Ease of use is very important during system interface design. The navigation

through the system should also be easy and effort free. Systems should be designed for effective and efficient use by users, as per Nielsen's (1994) usability heuristics.

### **3.2.2.3 Behavioural Intention (BI)**

The variable of BI describes the user's behaviour and intention to use the system or technology. The relationship between PU and BI is important as PU is a stronger determinant of BI (Lee *et al.*, 2003). Behavioural Intention is used to determine the user's actual use of the system and is a strong predictor of IS use.

### **3.2.2.4 Behaviour (B)**

The variable for behaviour is usually measured by frequency of use, amount of time using and usage (Lee *et al.*, 2003). This construct will assist in assessing user acceptance based on the user's engagement with the system, how often the user accesses the system and the amount of time spent navigating through and deriving valuable output from the system.

### **3.2.2.5 Findings of past TAM research**

There have been a few iterations of TAM by different researchers, and TAM is the ideal model for assessing user acceptance of information systems. Lee *et al.* (2003) described TAM as a highly influential and frequently used theory used to describe end user acceptance of an information system. Adam *et al.* (1992) applied TAM to five different Information Systems applications; word processors, graphics, spread sheets, email and v-mail. They concluded that TAM was consistent in measuring users' acceptance of Information Systems, regardless of the nature of the application. Davis (1993) replicated a previous study (Davis, 1989) using TAM, and the results were consistent as TAM was successful in explaining the adoption of the technology. 32 leading IS researchers were contacted by Lee *et al.* (2003), and respondents maintained that TAM contributes significantly to IS research and measure of user acceptance on IS projects.

Research conducted from 1989 to 2003 (Venkatesh *et al.*, 2003; Venkatesh and Davis, 2000; Hickey and Davis, 2000; Davis and Venkatesh, 1996; Davis, 1989; Davis, 1993; Davis *et al.*, 2006) on TAM yielded positive results of it being able to successfully predict IS acceptance behaviour, regardless of the technology and scenario. The simplicity and ease of use of the TAM model is advantageous. TAM is highlighted as a powerful model measuring user acceptance of technology using critical constructs (Davis

and Venkatesh, 1996). TAM was found to yield reliable, consistent and valid results during assessments of user acceptance of information systems (Lee *et al.*, 2003; Adams *et al.*, 1992).

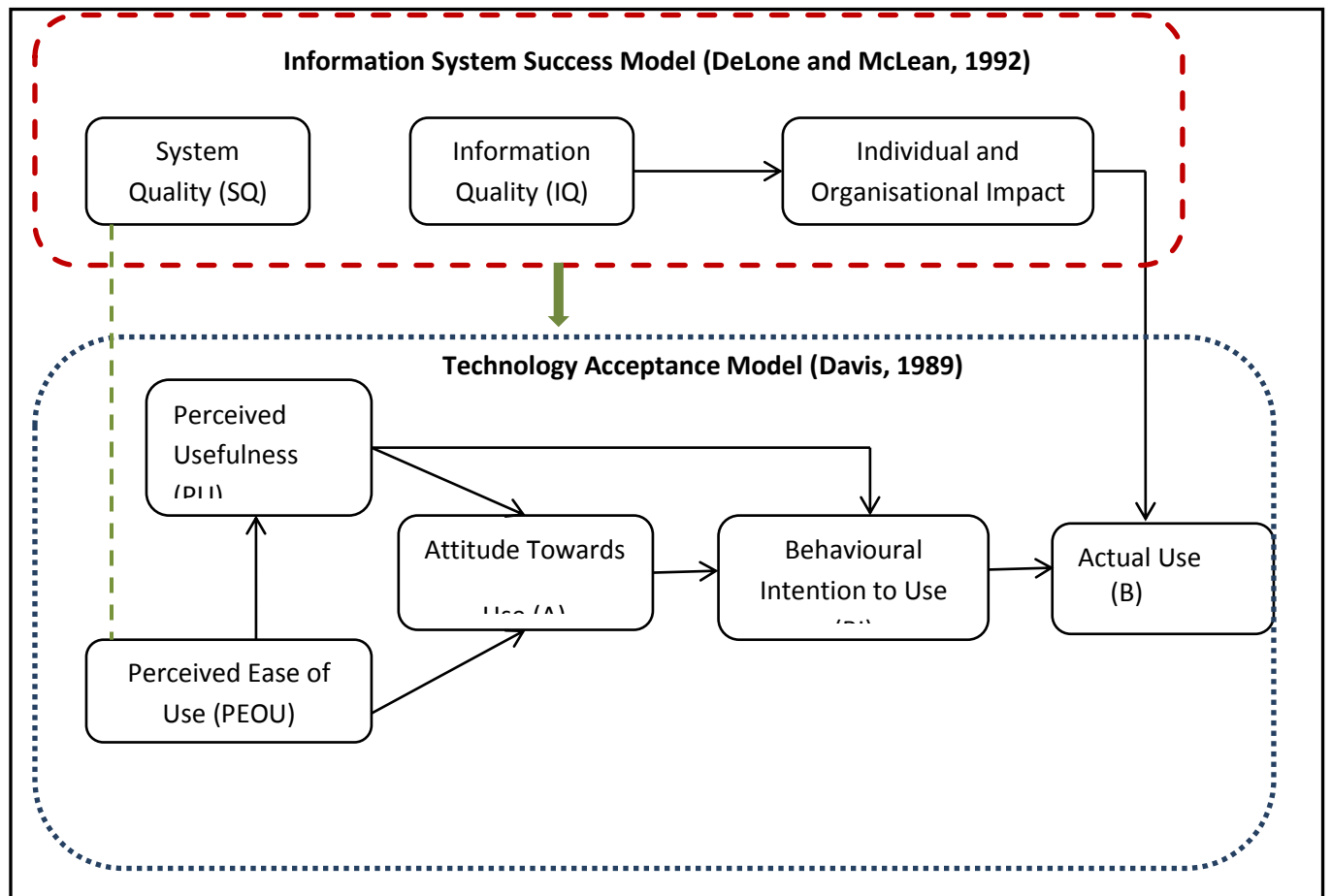
A study conducted by Kim *et al.* (2008) investigated the relationship between information system quality, perceived value and user's acceptance of a new front end system in the hospitality industry. Kim *et al.* (2008) investigated perceived ease of use, perceived usefulness, attitude towards use, actual use, information system quality and perceived value in the study. TAM is highlighted as an important model in determining user acceptance of technology, as its variables and the interaction amongst these variables can explain the process of the acceptance of IT on an individual level, as specified by Davis (1989). The Hotel Information System (HIS) is the most commonly used information system in the hotel industry, and consists of four subsystems; front office system, back office system, restaurant and banquet system, and guest related interface (Kim *et al.*, 2008). The Hotel Front Office System (HFOS) is the most widely used component and Kim *et al.* (2008) study examined the employees who utilise the system, determining user acceptance through variables of the TAM framework.

Over thirty different information systems have been used in TAM research as target systems. These ISs can be grouped into four major categories: communication systems such as email, fax, vmail and other communication methods; general purpose systems such as Windows, personal computers and the internet; office applications such as word processors and excel spread sheets; and specialised business systems such as MRP II and Expert Systems. Various external variables have been introduced into TAM and include system quality, training, compatibility, computer anxiety, IT support, experience and enjoyment (Lee *et al.*, 2003). These variables further entrench the usability aspects and success measures for systems and applications from a user perspective.

The most commonly reported limitation of TAM is self-reported usage. Most studies rely on self-reported usage as compared to actual usage. Utilisation of only one information system with a homogenous group of subjects is the second most cited limitation of TAM (Lee *et al.*, 2003). The use of largely student subjects contributes to the limitations of TAM. The current study sought to minimise the limitations of TAM noted in previous studies by using at least three information systems and actual system users as subjects. Lee *et al.* (2003) cited single measurement scales; relatively short exposure to the technology before testing; and self-selection biases of the subjects, as other limitations of TAM. The information systems used in the current study have been in the SASOL corporate environment for at least 12 months; hence the subjects have been exposed to the systems.

### 3.3 Theoretical Framework for the Dependent Variable

In order to operationalize information system success, the main dependent variable of the study, a theoretical framework contextualising the concept of information system success had to be compiled. An inspection of the underlying theories from the theoretical framework reveals four dependent variables. These are IQ, SQ from ISSM and PEOU and PU from TAM as indicated in Figure 3.3.



**Figure 3.3: Collective configuration of individual theories that contribute to the theoretical framework**

In an application of the ISSM, DeLone and McLean (1992) suggest that SQ is a general description for the software attributes of usability, adaptability and system response time. These characteristics are aligned to TAM's PEOU construct. This suspicion is confirmed in Rai *et al.* (2002) as well as Seddon (1997) where it is suggested that SQ is a proxy for PEOU from TAM. A further observation is that the items used by Seddon and Kiew (2007) to measure SQ included measures such as: ease of use; user friendliness and easy to learn. These items are identical to the items used by (Davis, 1993) to measure

PEOU in the questionnaire used as part of his study to ascertain user acceptance of an information system. Hence, in order to simplify the variable inter-connections of the study in accordance with these literary contributions and observations, the variable set emanating used to operationalize information system success from the academic model illustrated in Figure 3.3 has been reduced to PU, PEOU and IQ. This strategy is similar to the one used by (Rai *et al.*, 2002).

### **3.4 Theoretical Model for Requirements Elicitation**

According to Hickey and Davis (2003), the quality of requirements is greatly influenced by techniques employed during RE. RE is a process whereby the needs of users are communicated to the system builders. However, Browne and Rogich (2001) contend that RE techniques have received very little attention from the academic fraternity, thereby reducing the prospect of making use of validated theoretical models required to study the concept of RE. Hence, methods used for eliciting systems requirements from users have in general been ad hoc and there have been few recommendations in the literature to facilitate an improvement of the situation. Hickey and Davis (2003) concede that software development methodology experts have identified specific RE techniques such as interviewing, surveying, prototyping, JAD sessions, collaborative workshops and modelling. However, there have been no studies that classify the RE according to the type of software system being developed. In an attempt to address this problem, Hickey and Davis (2003) used a qualitative research approach and conducted interviews with nine software methodology experts in an attempt to find a classification model for RE techniques. Whilst the outcome of this study was difficult to interpret, with very little convergence achieved, one of the outcomes was that the RE technique used is usually a function of stakeholder availability during the RE phase.

In most of the interviews conducted, a common theme that emanated was that stakeholder representation was vital in order to obtain concise knowledge of the requirements of the system. This pattern of responses is consistent with Baroudi *et al.* (1986) who claim that better user involvement during the RE phase may lead to improved systems quality and enhance end user acceptance of the system. In order to accommodate many end users in the RE phase of system development, the experts interviewed the study by Hickey and Davis (2003) suggest that RE techniques that are collaborative in nature, such as such as workshops and JAD sessions would be more effective. Hence, there is strong emphasis on expressing RE technique relative to user involvement in the SDLC process. According to Dennis *et al.* (2008), user involvement refers to the time and effort the end users of the system must spend to understand the system

and how it will function from a user perspective. This interpretation of user involvement is commensurate with Kujala (2003) that user involvement has been primitively viewed as the level and intensity of direct involvement with the end users or a sample thereof. A high level of user involvement would entail a democratic, participatory RE strategy where the system analysis and design team establish an early and iterative focus on the end users of a system. Such an approach would ensure much less effort with the implementation phase of the system (Kujala, 2003; Gould *et al.* 1987) because developers would be more knowledgeable of the type of system required by the end users. This sentiment is endorsed by Nielsen (1992) who alludes to the need for a representative set of end users so that the development team has interpretive access to the users' views of the system. Nielsen stresses that RE should be an activity that entails an effort to communicate directly with the end user of the system and not just the business managers who requested the system (Nielsen, 1992). Maciaszek (2007) is of the similar opinion and alludes to the importance of acquiring not only the specific requirements of the system, but also the essence of the context within the organisation, in which the system will be implemented. This can only be achieved via interactive sessions with the end-user community. Hence, the level and/or intensity of user involvement in the SDLC process is an important defining characteristic of the RE strategy. From the preceding discussion, a high level of user involvement would subscribe to the following characteristics:

- A participatory and democratic RE strategy
- An iterative RE strategy where users are consulted on a regular basis regarding the development of the system at all phases of development
- The use of RAD tools so that a representative set of end users can provide feedback to the development team

In conjunction with this characteristic definition and the classification of RE techniques proposed by Nuseibeh and Easterbrook (2000), a model for the classification of RE techniques to be used in the current study is shown in Table 3.1 on page 62.

**Table 3.1: RE Classification Framework adapted from Nuseibeh and Easterbrook (2000)**

Type of Technique	Description of Technique	Instruments Used	Level of End User Involvement
Traditional Techniques	Generic techniques that depend on quick feedback	Questionnaires, surveys and interviews and analysis of existing documents	Variable
Group Elicitation	Aim to foster stakeholder agreement and buy-in, while exploiting team dynamics to elicit a richer understanding of needs	Brainstorming, focus groups, RAD/JAD sessions	High
Prototyping	Used for elicitation where there is a great deal of uncertainty about the requirements, or where early feedback from stakeholders is needed; normally conducted with the system owner or business manager	RAD tools	Low
Cognitive	Techniques developed for knowledge acquisition	Protocol analysis – involves an expert or stakeholder who thinks aloud while performing a task, to provide the observer with insights into the cognitive processes used to perform the task.	Low

Based on the description of each technique together with the emphasis on user involvement emanating from the study by Hickey and Davis (2003), each type of RE technique has also been classified according to the expected level of end user involvement in the SDLC process. The classification shown in Table 3.1

will be used to identify the type of RE strategy used for the development of the systems coupled with the level of involvement of the end users in the SDLC that are the focus of the current study. As has been suggested in this classification, the level of end user involvement would be used as a criterion to classify the type of RE used.

### **3.5 Summary of the chapter**

The theoretical framework used for this research study encompassed leading IS theories related to user acceptance of information systems. Information system success is operationalized via the constructs used in TAM and the ISSM. The main variables identified in this respect are PEOU, PU and IQ. The independent variable in the study is the RE technique used to develop the systems that are the focus of the study. Whilst the classification of RE techniques is commonly accessible via software methodology textbooks e.g. Pressman (2009) and Schach (2008), the classification proposed by Nuseibeh and Easterbrook (2000) is adapted to be used in the current study as a theoretical model for the identification of the type of RE technique used by the systems that are the focus of the current study. The title of the dissertation reads “The Relationship between user involvement in the Information System Development and User Acceptance of the Information System: A Case Study at SASOL”. In an attempt to quantify the main variables of the study via an academic framework, it becomes apparent that RE and information system success are amorphous in nature and difficult to quantify with great precision. From what has been achieved in the development of the academic framework, the study will adopt a strategy of quantifying information system success by virtue of a measurement of the variables PU, PEOU and IQ. The RE strategy would be classified according Table 3.1. This classification will be informed by obtaining a measure for the level of user involvement in the development of each system.



## **Chapter 4: Research design, findings and analysis**

### **4.1 Introduction**

The previous chapter examined the theoretical framework on which the study is based. The Technology Acceptance Model and IS Success Model are the core theoretical models used to underpin the current study.

The research design and methodology used in the study will be discussed in the current chapter. An initial discussion of the research instruments, sample population and data analysis techniques will be used to contextualise the report on the analysis and findings of the study.

### **4.2 Research design**

As mentioned earlier, the objective of the study is to ascertain whether there is relationship between the user involvement and user acceptance of the IS at SASOL. Hence, the variables and the theoretical framework underpinning the study have been identified. According to Sekaran and Bougie (2010), the next step is to select an appropriate research design strategy so that the required data can be gathered and analysed in order to find a solution to the research questions underpinning the study.

The difficulty of conducting research on RE is well documented in Cheng and Atlee (2007). Hence putting together a research design in this topic area in a controlled, contrived manner is not easy to achieve. However, at SASOL, an opportunity presented itself when the researcher had become aware of three information systems that were developed using varying RE techniques. This development had presented a non-contrived setting to conduct a correlational study between the level of user involvement in the development of the three information systems and user acceptance of these systems. According to Sekaran and Bougie (2010), "...correlational studies done in organisations are referred to as field studies". However, the focus on the development of three specific information systems at SASOL would involve a collective case study of the development and user acceptance of these three specific systems.

#### **4.2.1 Case Study Research**

According to Leedy and Ormrod (2005), a case study approach involves an in-depth study of an event for a defined period of time. A collective case study is undertaken for the purpose of making comparisons in

order to propose a generalisation or possibly build theory. The objective of the current study is to propose a generalisation with regards to the possibility of a relationship/correlation between the RE strategy adopted for each of the three information systems identified as the focus of the study and the user acceptance of these systems.

The case study approach is traditionally classified as a qualitative research design (Leedy and Ormrod, 2005, Sekaran and Bougie, 2010). As such, the dominant instrument of data collection would be interviews, thereby facilitating a deeper understanding of responses from the sampled subjects of the study. However, according to Yin (2009), a respected authority on case study research, quantitative or qualitative methods are equally compatible with case study research. Yin (2009) further states case studies are an ideal method to follow in the presence of three factors: “how” and “why” research questions; when the researcher has little control over events; and if the phenomenon occurs within a “real life context”.

With regards to the petrochemical company selected for this study, it is an established company operating in South Africa and globally for the last 65 years. An established project management framework has been implemented and patented by SASOL, which is followed throughout the company during Information System (IS), Gas-to-liquids (GTL) and Coal-to-liquids (CTL) projects. GTL and CTL projects are SASOL’s core production processes, where gas and coal are converted to fuel via the Fischer Tropsch process. As such, traditional RE techniques are frequently used in SASOL. Should projects fail or result in delayed implementation, the team reviews the progress of the project and the alignment to the organisations project framework to identify where the errors occurred. The project framework details the mandatory documents required for each phase of the project, the accountability and responsible persons required to draft, review and approve project documents, and the review panel responsible in approving projects to proceed to the next phase in the SDLC.

## **4.2.2 Overview of the Case Study**

In order to provide the context for the remainder of this chapter, an overview description of each of the three information systems that formed the focus of the study is provided.

### ***4.2.2.1 Information System 1 (IS 1) – Integrated Talent Management System (ITMS)***

The Integrated Talent Management System (ITMS) was developed to facilitate career and succession planning as well as personal development plans for the employees at SASOL. The processes are initiated by the line managers and involve automation of the review, submission and approval of employee performance appraisals and personal development plans. The ITMS also provides reporting functionality to the Human Resources department regarding employee statistics. There are 1500 end users for the ITMS system within the different business units which collectively constitute the SASOL Business Division. This project was requested by the SASOL Human Resources departmental managers to optimise the manual process.

### ***4.2.2.2 Information System 2 (IS 2) – SAP Resource and Portfolio Management System (SAP RPM)***

The SAP RPM system was implemented to maintain and manage resources, as well as the portfolio of projects executed in various areas of the organisation. The main users of the system are the business analysts (BAs) and project managers (PMs). All information regarding the project documents, review processes, costs, resources and project plans amongst other documents, are stored on this system. Furthermore the system provides management with reporting functionality regarding resource capacity and utilisation for IS projects. There are currently 50 end users for the SAP RPM system. This project was requested and driven by an Information Manager to manage resources, costs and capacity on the Business Analysts and Project Managers assigned to projects in the environment.

### ***4.2.2.3 Information System 3 (IS 3) – Service Catalogue System (SCS)***

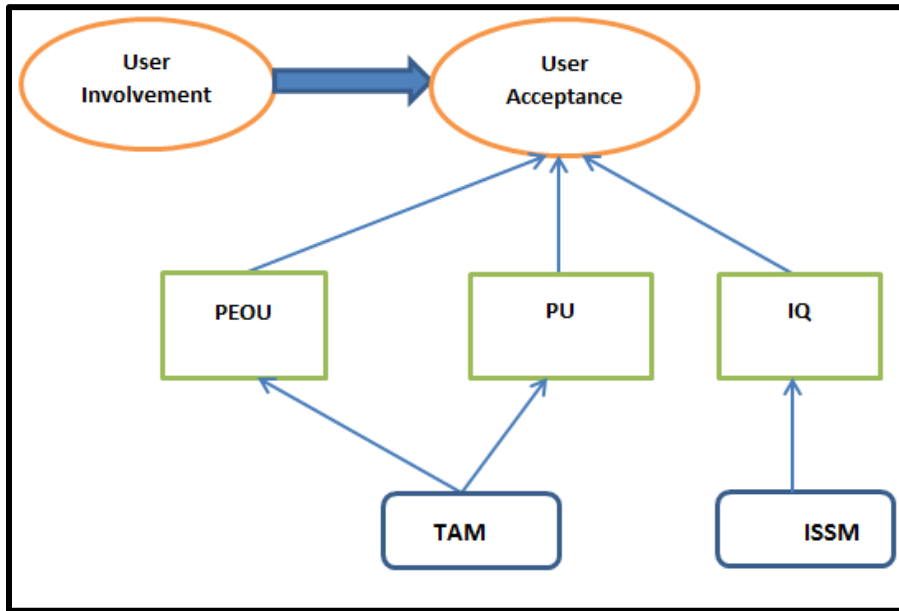
The Service Catalogue system was rolled out to users in SASOL and initiated by the IM department to optimise the requesting of IT Services. The system caters for all IT requests such as updating user contact details, creating user profiles, requesting hardware and peripherals, increasing the size of mailboxes or personal documents folders, accessing calendars and shared folders on the network and software requests, amongst a range of other services. The system is completely paperless and allows for automated

approvals from the user's line manager and the Information Management (IM) division. There are currently 1200 end users of the Service Catalogue System.

#### **4.2.3 The Research Work Plan**

While the research design alludes to the logical aspect of the study, these aspects of the study will be detailed as part of the research work plan. The independent variable of the study has been identified as the user involvement used to facilitate the development of each information system while the dependent variable is the user acceptance of each information system. User acceptance of the information system will be operationalized in accordance with the theoretical framework by achieving a quantitative measure of the perceived ease of use (PEOU) and the perceived usefulness (PU) (taken from TAM) as well as the information quality (IQ) (taken from the ISSM). In order to obtain a representative view from an end user community that was in excess of 1000 users for two of the systems, the researcher decided to make use of the survey technique for data collection, a strategy suggested by Leedy and Ormrod (2005), Sekaran and Bougie (2010) and Remler and Van Ryzin, (2011) as an ideal instrument to learn about a large population by surveying a representative sample of that population. The implementation of the surveying approach renders a large part of the current study as a quantitative study. However, in order to obtain a more complete picture of the development of each of the three information systems, interviews were conducted with key stakeholders involved in the development of each system.

The interview component of the study heralds an incursion into the qualitative research paradigm. However, there is no intention to classify this study strictly along the dimensions of a qualitative study. The independent variable, the dependent variable as well as the constructs used to operationalize the dependent variable and their association to the academic framework of the study is illustrated in Figure 4.1.



**Figure 4.1: The Research Design with respect to the variables and the academic framework of the study**

### **4.3 Research Instruments**

Research instruments refer to those methods used to gather data from a sample population and include surveys, questionnaires and interviews (Remler and Van Ryzin, 2011, Sekaran and Bougie, 2010). Two research instruments were used for this study. A questionnaire was designed to elicit quantitative data from a representative sample of end users of each of the three information systems. Interviews were designed to obtain an insight into the actual development of each information system, with a major focus on the RE technique(s) used for each system. After initial consultation with the PMs involved in the development of each system, the researcher realised that the RE technique used for each system did not accurately fit any of the recognised techniques for RE. This realisation necessitated the invocation of an interviewing strategy with the PMs in order to obtain as much information as possible regarding the RE process and then making an informed judgement on the type of RE elicitation used. It was also established that the PMs worked closely with the BAs. Hence, the interviewing strategy incorporated interviews with the BAs as well.

### **4.3.1 Questionnaire Design**

The main objective of the questionnaire (see Appendix A) was to obtain a quantifiable measure of end users' acceptance of each information system. In the current study, end user acceptance has been operationalized via the academic framework of the study to the constructs of PU, PEOU and IQ. According to Sekaran and Bougie (2010), the next step is to identify a representative set of items that are an acceptable measure of each of the constructs identified as the dependant variables in the study. This is referred to as establishing the internal validity of the questions in the questionnaire. One possible way of achieving internal validity is by making use of measures that have already been developed, validated and reputed to be "good" rather than making the effort of developing an original measure that needs to be subjected to validation tests (Sekaran and Bougie, 2010). Questions 1 to 15 of the questionnaire are aligned to the academic framework of the current study and serve the purpose of achieving a measure of quantification of user acceptance of an information system. The items used to measure PEOU, PU and IQ emanate from validated instruments used by Davis (1993) and Kim *et al.*, (2008).

Questions 16 to 18 of the questionnaire are specifically directing at establishing the level of user involvement in the development of the information systems. User involvement is not recognised as a variable of the current study (explained in 4.3.1.4). However, the researcher is of the opinion that the inclusion of user involvement as part of the quantitative aspect of the study would be helpful in providing insight into the information system development process as well as another dimension from which to perform the quantitative analysis of data. The remaining questions in the questionnaire (i.e. questions 19 to 24) were used from the perspective of establishing a "fuller picture" of the system development process and user involvement in this process. These questions were not used in the data analysis conducted as part of the current study.

#### ***4.3.1.1 Questionnaire Design for Perceived Ease of Use (PEOU)***

The current study adopted the scales for the measurement of PEOU from the instrument developed by Davis (1989) where he asserts that both PEOU and PU are fundamental determinants of user acceptance. Davis proposed a six item measurement tool for PEOU. Davis (1989b) validated this instrument by testing for content validity, reliability and construct validity in two studies involving 152 users and four application programs.

According to Legris *et al.*, (2003), the measurement tool developed by Davis (1989) for PEOU is centred on the following constructs:

- the ease of initially learning to operate an application
- the ease of manipulating an application
- the ease of adapting/adjusting the application
- the overall ease and comfort of using the application

Questions 1 to 6 of the questionnaire (shown in Table 4.1 below) used in the current study (Appendix A), are aligned to the constructs used by Davis (1989) to measure PEOU.

**Table 4.1: Questionnaire Items to Measure PEOU**

Question No	Questions
1	It is easy to learn how to use the system
2	It is easy to become proficient in using the system
3	It is easy for me to recover if I make a mistake whilst working with the system
4	I am able to understand the functionality of the menu options available
5	The system responds in a timely manner to my processing requests.
6	The system is error prone

#### **4.3.1.2 Questionnaire Design for Perceived Usefulness (PU)**

The items to measure PU were also adapted from the instrument used by Davis (1989). According to Legris *et al.*, (2003), the measurement tool developed by Davis for PU is centred on the following constructs:

- influence on job productivity
- influence on job performance
- influence on job effectiveness

Questions 7, 8, 9 & 10 of the questionnaire used in the current study (refer to Appendix A for the questions) are aligned to the constructs used by Davis to measure PU. These questions are displayed in Table 4.2 below.

**Table 4.2: Questionnaire Items to Measure PU**

Question No	Questions
7	The system increases my work productivity
8	The system improves the quality of my work
9	I enjoy using the system
10	I intend to use the system regularly at work

#### ***4.3.1.3 Questionnaire Design for Information Quality (IQ)***

The academic framework for the current study also incorporates the DeLone and McLean (1992) Information System Success model where information quality and system quality are regarded as two of the main determinants of information system success. As explained in Chapter Three, the measuring of system quality is closely aligned to the measurement scale used for the PEOU construct of Davis' TAM also confirmed in (Petter *et al.*, 2008). However, the “collapsing” of the information quality dimension into any of the TAM constructs diminishes insight into the success and user acceptance of an information system. In order to avoid this loss of insight, many studies on information system success have developed and validated their own scales of measurement of information quality. Information quality (IQ) is centred on characteristics of the system output such as relevance, accuracy, conciseness, completeness and understanding (Petter *et al.*, 2008) as well as currency, relevance and efficiency (Kim *et al.*, 2008). These characteristics are incorporated in the scale of measurement used by Kim *et al.* (2008) to quantify information quality as part of an extended TAM model in a study of user acceptance of a hotel front office system.

Questions 11 to 15 of the questionnaire used in the current study are aligned to the constructs used by Kim *et al.* (2008) in their study (see Table 4.3).



**Table 4.3: Questionnaire Items to Measure IQ**

Question No	Questions
11	The system provides meaningful output.
12	The system supplies accurate information.
13	The information supplied by the system is relevant and necessary for my work requirements.
14	The system is able to present information in different formats.
15	The system can exchange information easily with other systems.

#### **4.3.1.4 Questionnaire Design for User Involvement**

As mentioned earlier, it was envisaged that the response from this section of the questionnaire served the purpose of providing the researcher with an insight into the level of user involvement in the development of each system. According to Coughlan *et al.* (2003), “user-involved” approaches enhances the prospect of successful requirements elicitation. This assertion is upheld by Kujala (2003) on the basis of an analysis of the results of four studies that examined the influence of user involvement on the end user acceptance and success of an information system. The level of user involvement is intrinsically linked to the independent variable of the study. Whilst the researcher acknowledges that there could be other significant variables linked to the RE strategy (such as time, availability of representatives from the user community, the software development life-cycle, budget), aligning more variables to the academic framework presented a challenge that added complexity to the current study and may be seen as a limitation of the study. A possible defence of this stance is provided in the updated version of the Information Systems Success model where Delone and McLean (2003) allude to the “multidimensional and contingent nature” of studies relating to information system success and suggested that an attempt should be made to reduce the number of different measures used in the context of dependent and independent variables to measure information system success. However, quantifying user involvement can also be subject to much controversy. According to Baroudi *et al.* (1986), there is little consensus within the research community on items that are a valid measure of user involvement. Also, terms such as user involvement, evolutionary design and participatory-design are used interchangeably to denote the same thing. These complications made the researcher wary of including user involvement as a variable in the current study. However, the researcher is of the opinion that the study would lose an element of “richness” if the opportunity to obtain an insight into end user involvement was not tactfully captured.

Hence, it was decided to include three questionnaire items as a separate (from PEOU, PU and IQ) measure of user involvement in the development of the system. From a quantitative data computation perspective, this added dimension would provide a means to quantitatively compare user involvement with the success of each information system. It is envisaged that the user involvement component would corroborate with the information obtained from the interviews with the PMs regarding the RE strategy used for each system. The items used to measure user involvement in the development of each system are shown in Table 4.4.

**Table 4.4: Questionnaire Items to Measure User Involvement**

Question No	Questions
16	How would you rate your involvement in identifying requirements for the information system?
17	How would you rate your involvement in testing of the information system?
18	How would you rate the options available so that you could provide feedback regarding your interaction with the system?

### 4.3.2 Pre-testing of the questionnaire

The user community at the different business units within SASOL consists of an average of 1500 users. A pilot study was conducted by administering the questionnaires to approximately 10 people. The pilot study aimed to ensure that all questions were clearly understood by the recipients before conducting the final survey. The questionnaire consisted of Likert Scale type questions calibrated on a 5 point scale with the options ranging from “strongly agree” to “strongly disagree”.

The questionnaire comprised largely of closed ended questions and one open ended question. The open ended question merely served an information purpose with the intention of providing respondents with the facility to openly express their opinions on how the requirements elicitation process can improve the quality of information systems developed in the organisation. Whilst this information did not form part of the statistical analysis for the current study, it was insightful for the researcher to obtain this information in order to gain a deeper understanding of issues that impact on IS acceptance within the user community.

Sekaran and Bougie (2010) advocate the use of closed-ended questions as this format of questions encourage users to make efficient decisions by reviewing the options available. A pilot study conducted before the questionnaire was issued to 10 users testing the suitability and clarity of the questions. Minor recommendations and suggestions from the pilot study were incorporated into the questionnaire to improve the understanding of the questions from the user perspective. The pilot study also assisted in establishing the time taken to complete the questionnaire.

#### **4.3.3 Ethical clearance**

The interview questions (Appendix B) and user questionnaire (Appendix A), were issued to the Ethical Committee at UKZN for review and full ethical clearance was granted (refer to Appendix J). Permission was sought from the Office of the CIO at SASOL to conduct research on the IS Projects in 2010, and again in 2012 to issue the survey to the users and conduct interviews with the respective project team members (refer to Appendix C). Final approval was obtained from the Office of the CIO to proceed with submission of the thesis (refer to Appendix C). The Intellectual Property department at SASOL, which supervises the legal contracts, patents and protection of the organisations intellectual property (IP), provided the final approval to proceed with submission of the thesis to the university. Letters of informed consent on the questionnaire and interviews provided a background to the study, assurance on the anonymity of the results and the researchers contact details, if required. The user accessing the e-survey is proof of their voluntary participation in the survey. The information collected was also exported to a compact disc for storage.

#### **4.3.4 Distribution of the questionnaire**

The initial intention was for the researcher to circulate hard copies of the questionnaires to users in the organisation. This approach would be time consuming for the distribution and collection of the questionnaires taking cognisance of the large number of users. A more effective way of distributing the questionnaires was found to be the use of an e-survey tool. The researcher made use of the in-house e-survey tool that SASOL uses to collect data. The questionnaire for the current study was converted into the e-survey format. The benefits of the e-survey were increased efficiency and effectiveness on collection as well as analysis of the data. The data collected easily exported into MS Excel for data clean up and consolidation before being transferred to SPSS for statistical analysis.

SASOL's internal mailing list was used to randomly select users and departments to complete the questionnaire. User lists specifying which users had access to the respective information systems were obtained from the project teams. This ensured that users receiving the e-survey were familiar with each information system under review and would be in a position to provide feedback, based on their interaction with the system. The link to the questionnaire was issued via email, and the survey was open for a period of three weeks (refer to Appendix I). After the first week of the survey, the user response rate was low. A reminder email was issued to the sample population for users who had not completed the survey.

The advantage of mailing questionnaires and using e-surveys is the high rate of anonymity of respondents; as respondents are able to complete the survey during a convenient time and respondents from wide geographic locations can be reached (Sekaran and Bougie, 2010). This is particularly important in the case of the end user community at SASOL, as the employees are geographically dispersed across South Africa and the rest of the world. Some of the significant disadvantages of mailing questionnaires is the risk of low response rates (30% is acceptable), and the lack of opportunity to clarify questions for respondents (Sekaran and Bougie, 2010). However, for the current study, the researcher decided that the benefits of an on-line survey, such as ease of administration, inexpensive distribution method and efficient delivery to a large sample population outweighed the disadvantages. Also, reminders to complete the survey could be efficiently delivered to the sample population via email.

To recap, a user questionnaire was designed to elicit information from the users of each information system, for the quantitative section of the study. This questionnaire aimed to establish user acceptance and success of each information system under review. This was accomplished by gathering information on the perceived ease of use (PEOU), perceived usefulness (PU) and information quality (IQ) of each system. A pilot run of the questionnaire was conducted to ensure the questionnaire was ready for distribution, easy to understand and adhered to quality standards. The questionnaire was thereafter translated into an online questionnaire and the link to the questionnaire was emailed to users. Users were randomly selected to complete the questionnaire, using SASOL's internal email system. The benefits of an online electronic questionnaire allowed for easy access to view the number of responses to the survey. The data collected was exported into an MS Excel spread sheet for analysis and statistical tests.

#### **4.4 Presentation of the Study's Quantitative Data**

In order to contextualise the study's quantitative data, a discussion of the population, sampling frame and sample size used in the study is undertaken. Sekaran and Bougie (2010) define the population as a selection of people or events which the researcher wants to investigate, and make deductions or inferences about. However, if the population is large, thereby presenting logistical constraints with regards to obtaining data from all members of the population, a representative sample of the population is targeted. In order to select the sample, the researcher has to have access to a sampling frame, a physical representation of all elements in the population, from which the sample is drawn (Sekaran and Bougie, 2010). In the case of the current study, the sampling frame was obtained by firstly consulting SASOL's application user directory that lists all the information systems currently in use at SASOL as well as the set of end users. SASOL's mailing list was also used to contact the selected participants for the study.

In the case of IS 1 and IS 3, the end user population is in excess of 1000 users each. For each of these systems, the large user base necessitated the extraction of a representative sample. According to Sekaran and Bougie (2010), when the sample size is large, the shape of the distribution of the sampling means assumes normality, thereby allowing the researcher to conduct parametric testing of the data. It is also that when the population is in excess of 1000, then an approximate sample at the 95% level of confidence is 300. The sample size that was targeted for IS 1 and IS 3 was approximately 50% of the population in order to be well within the parameters suggested by Sekaran and Bougie (2010). In order to enhance the generalizability of the study, a systematic random sampling approach was adopted. For each of IS 1 and IS 3, every second end user listed was targeted as a respondent. Initially, the response rate was quite low thereby necessitating a bit of intervention by sending reminder e-mails to the subjects of the sample of the study. In the case of IS 2 where there were only 50 end users, a census approach was adopted and the entire set of end users was targeted as respondents. The population, sample size and number of responses received for each information system is shown in Table 4.5.

**Table 4.5: Sample size per IS Project**

System No	System Abbreviation	Total Population	Sample Size	Response	Valid Response	Representivity %
1	ITMS	1500	750	562	381	25.4%
2	SAPRPM	50	50	36	36	72%
3	SCS	1200	600	341	309	25.75%

## 4.5 Data analysis

Sekaran and Bougie (2010) describe data analysis as the statistical analysis of the data gathered through the research instruments. The data collected for the current study was exported into MS Excel from the e-survey administration site on the SASOL system. The quantitative data was inspected for abnormalities, cleaned and imported into SPSS. The questionnaire consisted mostly of Likert Scale type of questions that ranged from “Strongly Agree” to “Strongly Disagree”. All, but one of the questions (Question 6) were positively worded towards each of the aspects that were being measured.

With regards to the data preparation, the data was captured in Microsoft Excel format and then subsequently imported into SPSS version 19 for further analysis. Coding of the data involved assigning a value of 5 to “strongly agree” and a value of 1 was assigned to “strongly disagree”. Question 6 was then reverse coded to compensate for the negatively phrased wording of the question. The coding strategy involved the assigning of higher numbers to represent responses that were positive towards each aspect of system usage.

According to Sekaran and Bougie (2010), when many items are used to measure a single construct, the factor analysis technique should be used to confirm that the data obtained is a valid measure for that construct. Factor analysis, also used by Davis (1989) in his study, is “...a multivariate technique that confirms the dimensions of the concept that have been operationally defined” (Sekaran and Bougie, 2010). In the case of the current study, the three dimensions/factors identified in accordance with the theoretical framework were PEOU, PU and IQ. SPSS was used to conduct a principal component analysis using Varimax rotation, and specifying a three factor solution (to match each of the dimensions

of the study as mentioned above). Figure 4.2 shows the results of the factor analysis. It can be seen in Figure 4.2 that all items load highly on their predicted factors.

Rotated Component Matrix <sup>a</sup>			
	Component		
	PEOU	PU	IQ
I am able to understand the functionality of the menu options available.	.892	.283	.289
It is easy to become proficient in using the system.	.882	.293	.233
The system responds in a timely manner to processing my requests.	.850	.302	.316
It is easy to learn how to use the system.	.840	.268	.223
The system is error prone.	.829	.316	.276
Recovery from Mistake	.759	.244	.339
The system increases my work productivity.	.290	.799	.270
The system improves the quality of my work.	.312	.780	.376
I intend to use the system regularly at work.	.306	.739	.339
I enjoy using the system.	.408	.703	.367
The system can exchange information easily with other systems.	.234	.234	.795
The system is able to present information in different formats.	.270	.289	.779
The system supplies accurate information.	.398	.319	.633
The information supplied by the system is relevant and necessary for my work requirements.	.229	.367	.594
The system provides meaningful output.	.391	.469	.584

Extraction Method: Principal Component Analysis.  
 Rotation Method: Varimax with Kaiser Normalization.<sup>a</sup>  
 a. Rotation converged in 6 iterations.

**Figure 4.2: Three Dimensional Factor Analysis**

Having confirmed the construct validity of the measurement instrument used in the study, the remainder of the data analysis followed a sequential approach consisting of:

- A Cronbach’s Alpha computation to ensure “interitem consistency” reliability is achieved, i.e. testing the consistency of respondents’ answers to all questions in specific groups or subsections (Sekaran & Bougie, 2010). Cronbach’s Alpha is commonly used in research to measure the internal validity or the “...cohesiveness of the individual question” (Alhujran, 2009). In the case of the current study, the Cronbach Alpha test was performed to measure the internal validity of the questions used to measure the constructs of PEOU, PU and IQ. A Cronbach’s Alpha value of less than 0.6 indicates an invalid result (Weiers, 2008), while a Cronbach’s Alpha value in excess of 0.6 indicates an acceptable level of cohesiveness with respect to the grouping of questions.
- It is reported in Sekaran and Bougie (2010) that several questions may be used to measure a single concept. In order to obtain a measure of quantification, “... scores on the original question

have to be combined into a single score” (Sekaran and Bougie, 2010). In accordance with this suggestion, the analysis of the responses was conducted by collapsing the individual measures of the study’s variables into three single dependent variables that represented the mean of the individual responses. The dependent variables were represented by PEOU, PU and IQ. In accordance with the academic framework of the current study, this measure would contribute to determining whether user acceptance on each information system had been achieved.

- The Independent samples t-test was used to evaluate pair wise differences in the means of the dependent variables for the systems that were the subject of this study. It is reported in Sekaran and Bougie (2010) that the Independent samples t-test establishes the “significant mean difference” between any two groups. However, when it came to comparing the means of the dependent variables for all three systems, the Analysis of Variance (ANOVA) test, which according to Sekaran and Bougie (2010) checks for mean differences between the variables when comparing two or more groups.

## 4.6 Quantitative Results

The questions in the questionnaire were positively phrased towards each of the dimensions (PEOU, PU and IQ) of the study. Responses were coded on a scale from 5 to 1 where a 5 indicates a strong agreement with the positively phrased statement while a response of 1 represented strong disagreement. As an example, the first question of the questionnaire which is classified as one of the items that contributed to a measure of PEOU read: *It is easy to learn how to use the system.*

There were six questions (Questions 1 to 6 of the questionnaire) that were used to provide a quantifiable measure for PEOU. The mean value of the responses was used to provide a quantified measure of PEOU for a specific information system from a specific respondent. Similarly, four questions (Questions 7 to 10 of the questionnaire) were grouped to obtain a quantifiable measure for PU and another five questions (Questions 11 to 15) were used to obtain a quantifiable measure for IQ. Having obtained these discrete values, the t-test and Anova test was conducted to compare mean values between each of the systems in order to make significant conclusions regarding the PEOU, PU and IQ of each system.



#### 4.6.1 IS 1 – Integrated Talent Management System (ITMS)

The Integrated Talent Management System (ITMS) was developed to facilitate career and succession planning as well as personal development plans for the employees at SASOL. The processes are initiated by the line managers and involve automation of the review, submission and approval of employee performance appraisals and personal development plans. The ITMS also provides reporting functionality to the Human Resources department regarding employee statistics.

There are 1500 end users for the ITMS system within the different business units which collectively constitute the SASOL Business Division. 750 end users were randomly selected using a systematic sampling strategy where every second end user listed was targeted as a respondent, of which 562 responses were received. However, due to incomplete survey responses, only 381 of these responses were valid and included in the following analyses.

##### 4.6.1.1 Perceived Ease of Use (PEOU) of ITMS

Cronbach's Alpha test was the first statistical test conducted on the perceived ease of use for IS 1 which is the Integrated Talent Management System. The Cronbach's Alpha value obtained for PEOU of the ITMS was 0.821, as depicted in Figure 4.3. The value was greater than 0.6 and therefore fell within the acceptable range as defined by Sekaran and Bougie (2010). This Cronbach's Alpha value confirms that the data obtained from the users on the perceived ease of use of the ITMS system is reliable and consistent.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.821	.820	6

**Figure 4.3 Cronbach's Alpha value for PEOU for ITMS**

The mean value derived for the perceived ease of use (PEOU) for ITMS is 2.87 (ranked on a scale from 1 to 5 where 1 indicates strong disagreement that the system is perceived as easy to use and 5 indicates strong agreement that the system is perceived as easy to use). This value is generally endorsed as acceptable ( $M=2.87$ ), as reflected in Figure 4.4. This was achieved for an N value of 381 respondents.

The results are significant at the 95% confidence level (the standard error is 0.028), reflecting that the mean value computed for PEOU is representative of the population of end users for the ITMS. The mean values obtained for PEOU for the ITMS is illustrated in Figure 4.4.

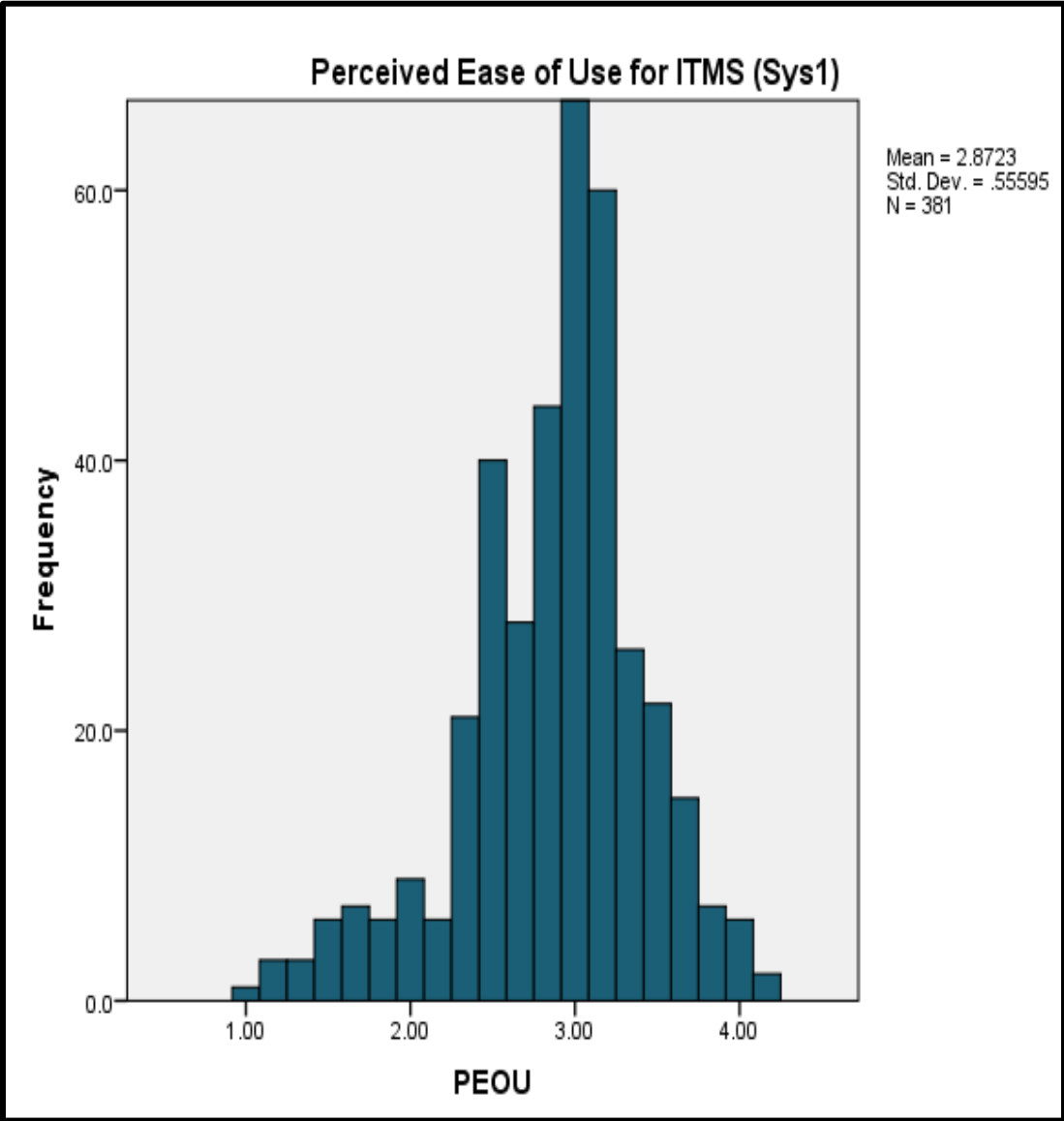


Figure 4.4 Mean Values for PEOU for ITMS

#### 4.6.1.2 Perceived Usefulness (PU) of ITMS

The Cronbach's Alpha value obtained for the perceived usefulness of the ITMS System, as illustrated in Figure 4.5, is 0.907. This value fell within the acceptable range as defined by Sekaran and Bougie (2010). The results therefore indicated that the data collected from the survey on the perceived usefulness of the ITMS is reliable and consistent for the sample of users selected.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.907	.908	4

Figure 4.5: Cronbach's Alpha value for PU for ITMS

The mean value obtained for PU of the ITMS System is 3.34, as is reflected in Figure 4.6. The PU of the ITMS is generally endorsed as good with a mean value of 3.34 (significant at the 95% confidence level) by the community of end users of the ITMS System.

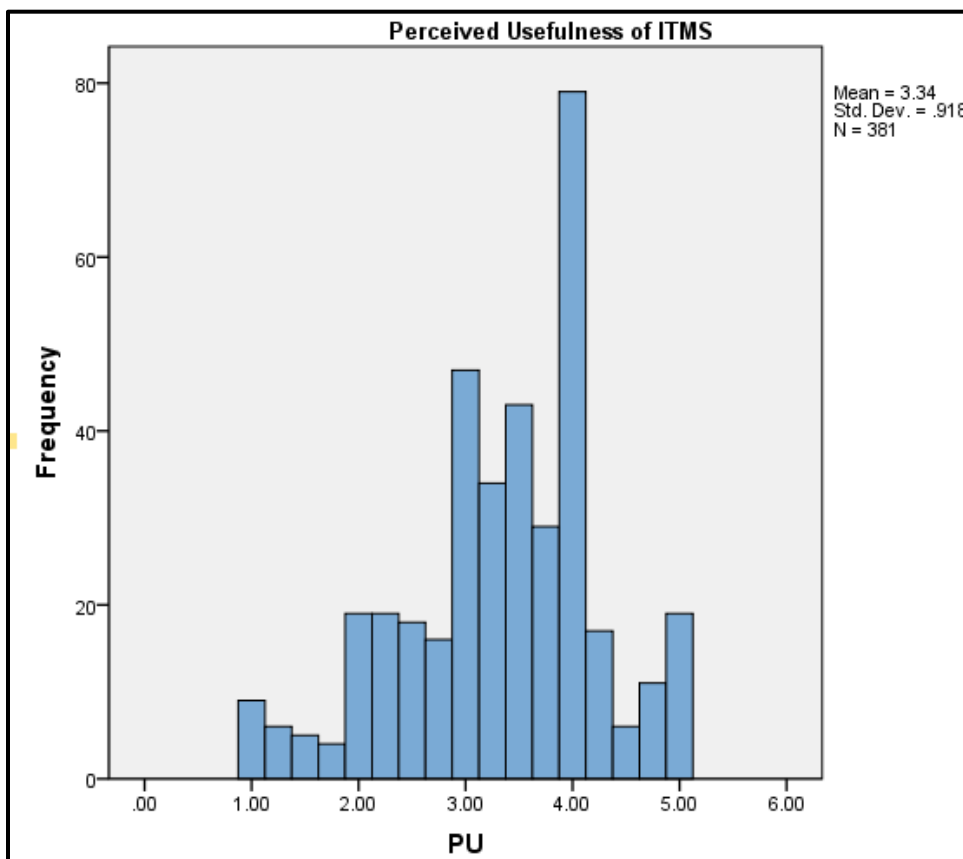


Figure 4.6: Mean values for PU for ITMS

#### 4.6.1.3 Information Quality (IQ) of ITMS

The Cronbach's Alpha value obtained, as shown in Figure 4.7 was 0.890 which fell within the acceptable range of values as defined by Sekaran and Bougie (2010). The results indicated that the data from the sample population is consistent and valid for the construct of information quality of the ITMS.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.890	.890	5

Figure 4.7: Cronbach's Alpha value for IQ for ITMS

The quality of information delivered by the ITMS to its end users is generally endorsed as very good ( $M=3.58$ ; significant at the 95% confidence level), as reflected in Figure 4.8.

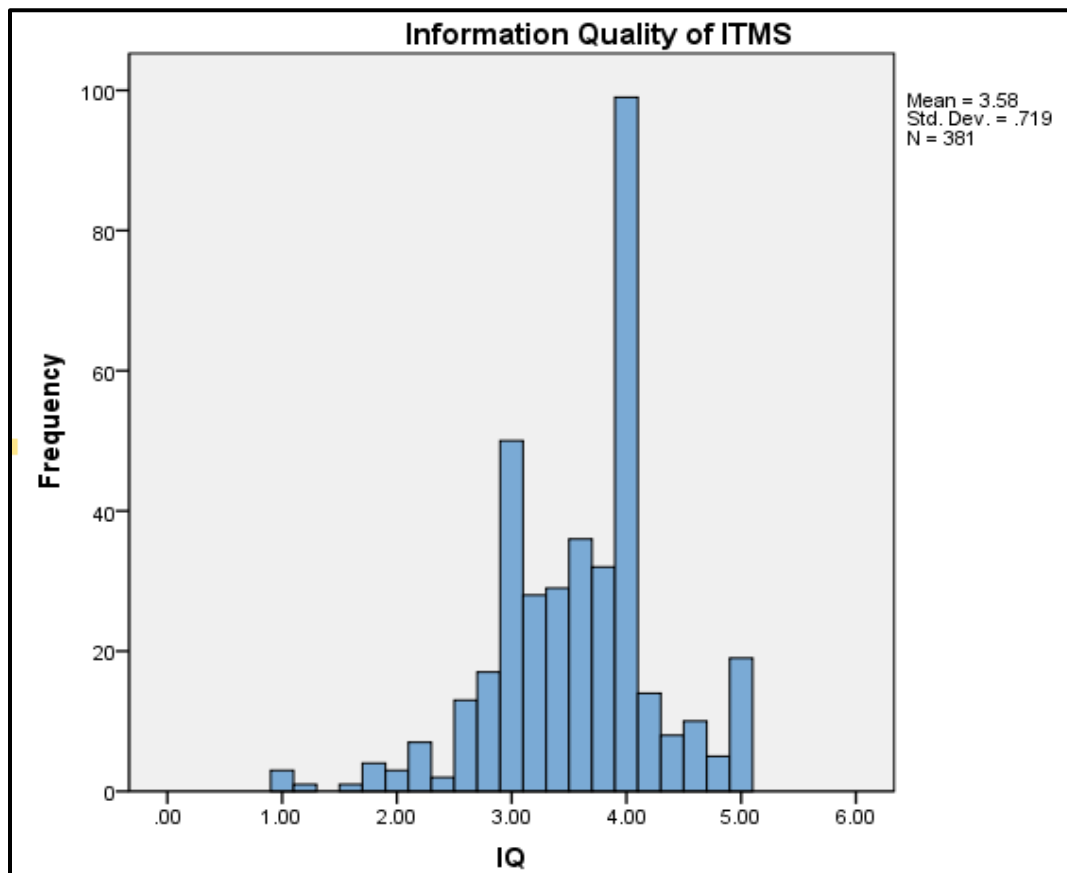


Figure 4.8: Mean values for IO for ITMS

#### 4.6.1.4 User Involvement in RE for ITMS

The Cronbach's Alpha value obtained, as shown in Figure 4.9, was 0.934 which fell within the acceptable range of values as defined by Sekaran and Bougie (2010), and is considered reliable and consistent.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.934	.934	3

Figure 4.9: Cronbach's Alpha value for IQ for ITMS

A medium level of user involvement ( $M=3.11$ ) in the RE phase of the development of the ITMS was reported from the 381 respondents.

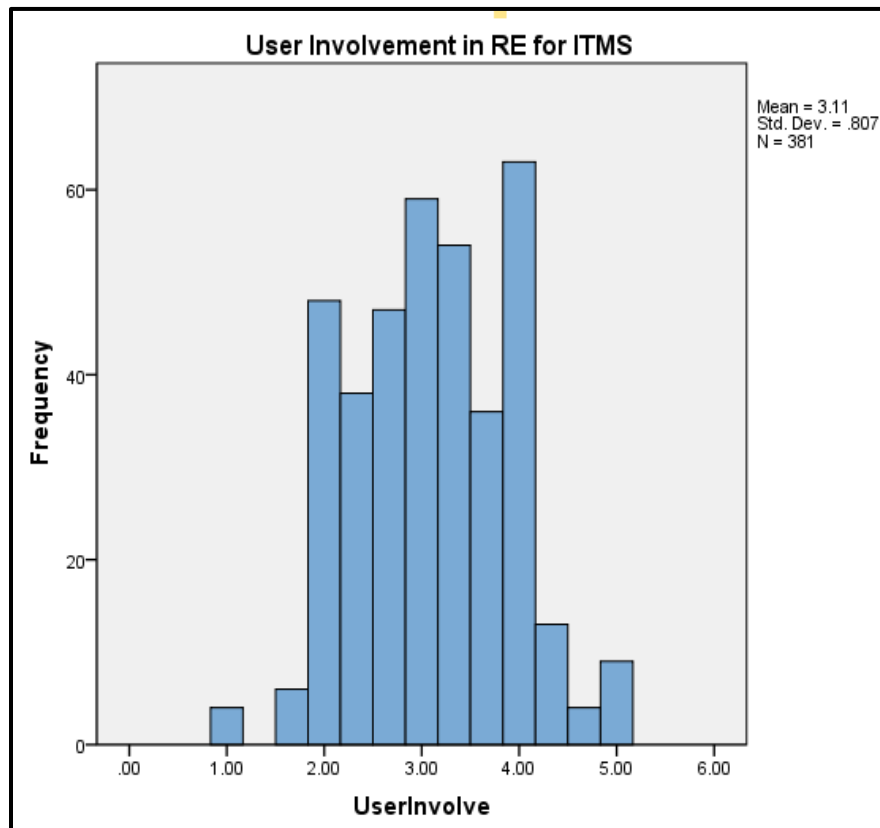


Figure 4.10: Mean values for user involvement in RE for ITMS

#### 4.6.1.5 Pearson Correlation between level of user involvement and level of user acceptance for ITMS

A Pearson Correlation computation reveals a significant positive correlation between user involvement in the RE phase of development of the ITMS and user's acceptance of the system (as indicated by the variables PEOU, PU & IQ).

**Table 4.6: Correlations between PEOU, PU, IQ and user involvement for ITMS**

Correlations Between PEOU, PU, IQ and User Involvement for ITMS					
		PEOU	PU	IQ	UserInvolve
PEOU	Pearson Correlation	1	.646**	.701**	.597**
	Sig. (2-tailed)		.000	.000	.000
	N	381	381	381	381
PU	Pearson Correlation	.646**	1	.834**	.719**
	Sig. (2-tailed)	.000		.000	.000
	N	381	381	381	381
IQ	Pearson Correlation	.701**	.834**	1	.702**
	Sig. (2-tailed)	.000	.000		.000
	N	381	381	381	381
UserInvolvement	Pearson Correlation	.597**	.719**	.702**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	381	381	381	381

\*\* . Correlation is significant at the 0.01 level (2-tailed).

#### 4.6.2 IS 2 – SAP Resource and Portfolio Management (SAP RPM) System

The second system under investigation, the SAP RPM system was implemented to maintain and manage resources, as well as the portfolio of projects executed in various areas of the organisation. The main users of the system are the BAs and PMs. All information regarding the project documents, review processes, costs, resources and project plans amongst other documents, are stored on this system. Furthermore the system provides management with reporting functionality regarding resource capacity and utilisation for IS projects.

There are currently 50 end users for the SAP RPM system. All users were surveyed, of which 36 valid responses were received representing a response rate of 72%.

#### 4.6.2.1 Perceived Ease of Use (PEOU) of SAP RPM

The Cronbach's Alpha value obtained, as shown in Figure 4.11, was 0.605, which being slightly greater than 0.6, fell within the acceptable range as defined by Sekaran and Bougie (2010). This Cronbach's Alpha value confirmed that the data obtained from the users on the perceived ease of use of the ITMS system was reliable and consistent.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.605	.575	6

Figure 4.11: Cronbach's Alpha value for PEOU for SAP RPM

It should be noted that two of the questions alluding to the presence of errors as well as the timeliness of the system response seem to have resulted in inconsistent responses. This can be ascertained by the results that indicate a Cronbach's Alpha value in excess of .65 if either of these questions is left out. A summarised view illustrating a histogram of the mean responses for the PEOU variable is illustrated in Figure 4.12.

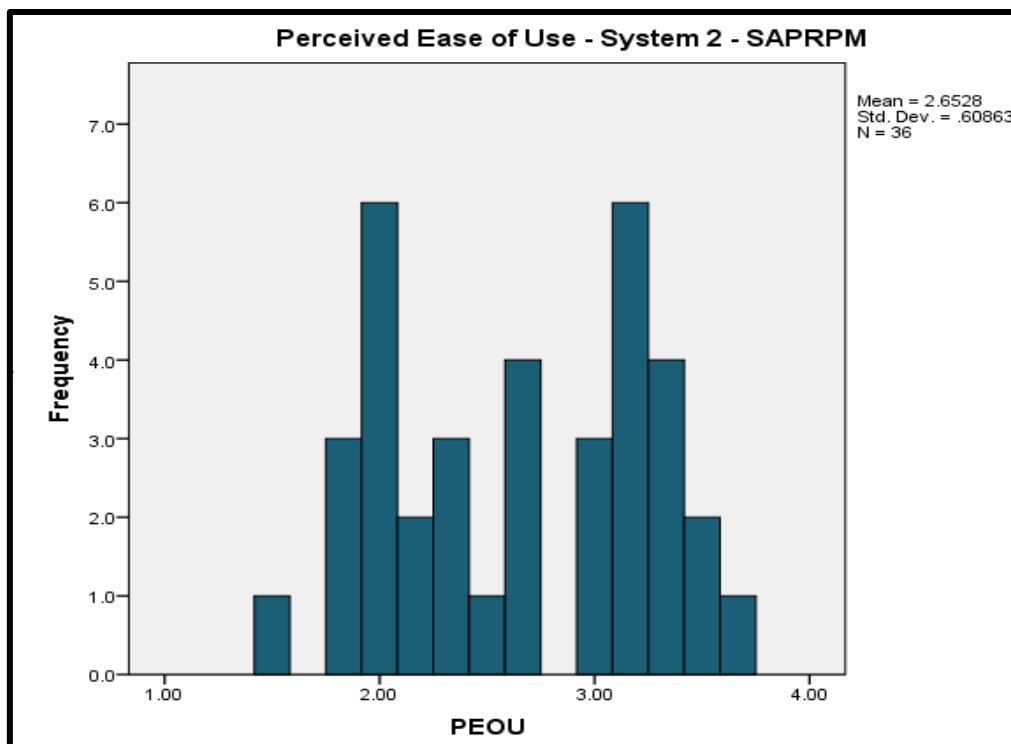


Figure 4.12: Mean Values for PEOU for SAP RPM

The PEOU for the SAP RPM system cannot be definitively rated ( $M=2.65$ ) as there was a “liberal” presence of mixed responses regarding the ease of use of the system.

#### 4.6.2.2 Perceived Usefulness (PU) of SAP RPM

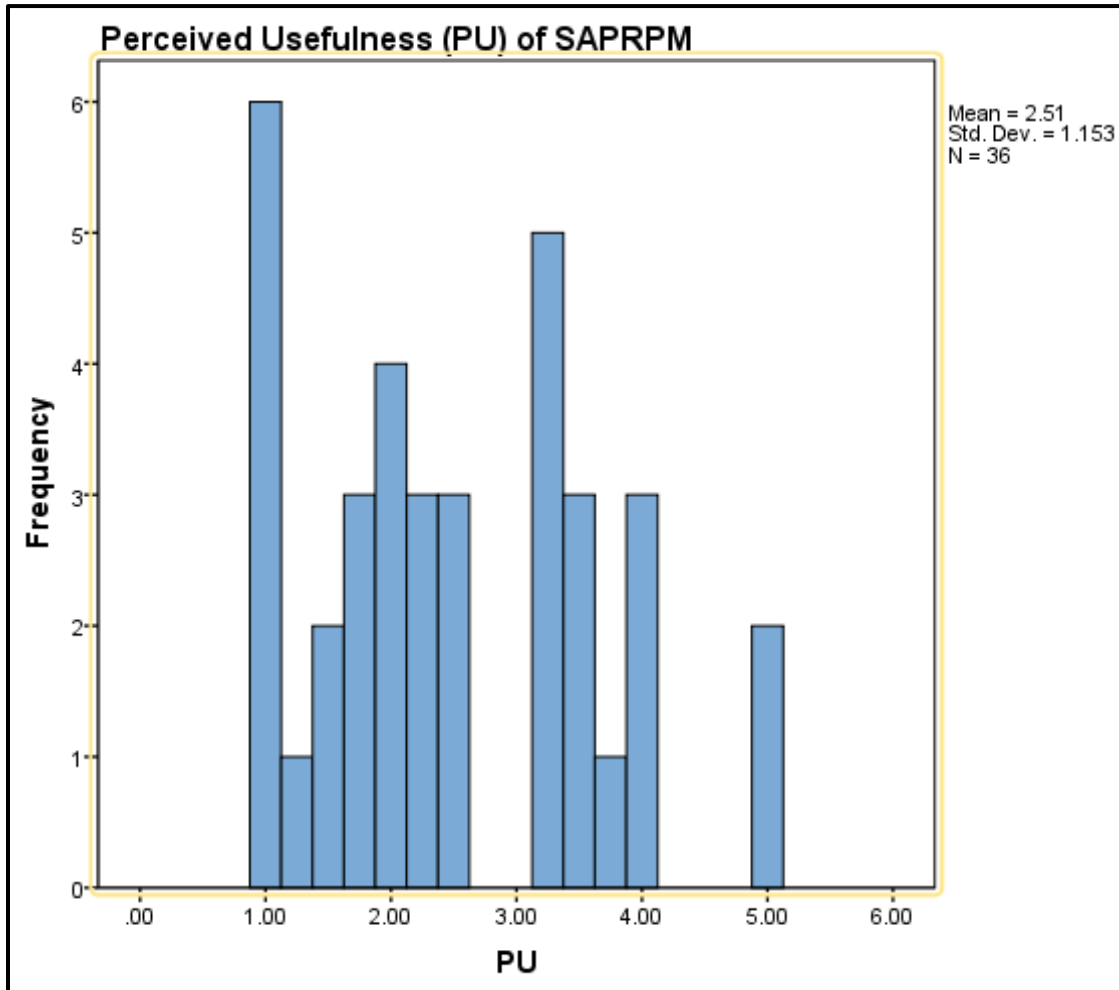
The Cronbach’s Alpha value obtained, as shown in Figure 4.13, was 0.956 which fell within the acceptable range as defined by Sekaran and Bougie (2010). The nearer a Cronbach’s Alpha score is to 1, the greater the “internal consistency reliability” (Sekaran and Bougie, 2010). The results were therefore valid and consistent.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.956	.956	4

**Figure 4.13: Cronbach’s Alpha value for PU for SAP RPM**

A summarised view illustrating a histogram of the mean responses for the PU variable is illustrated in Figure 4.14. The PU of the SAP RPM system could not be definitively rated ( $M=2.51$ ), although the high variability ( $SD=1.15$ ) indicated that the mean value may be somewhat misleading. This assertion was supported by the mode ( $Mode=1$ ), which is indicative of a perception that the system is not generally viewed as useful to its end users.





**Figure 4.14: Mean values for PU for SAP RPM**

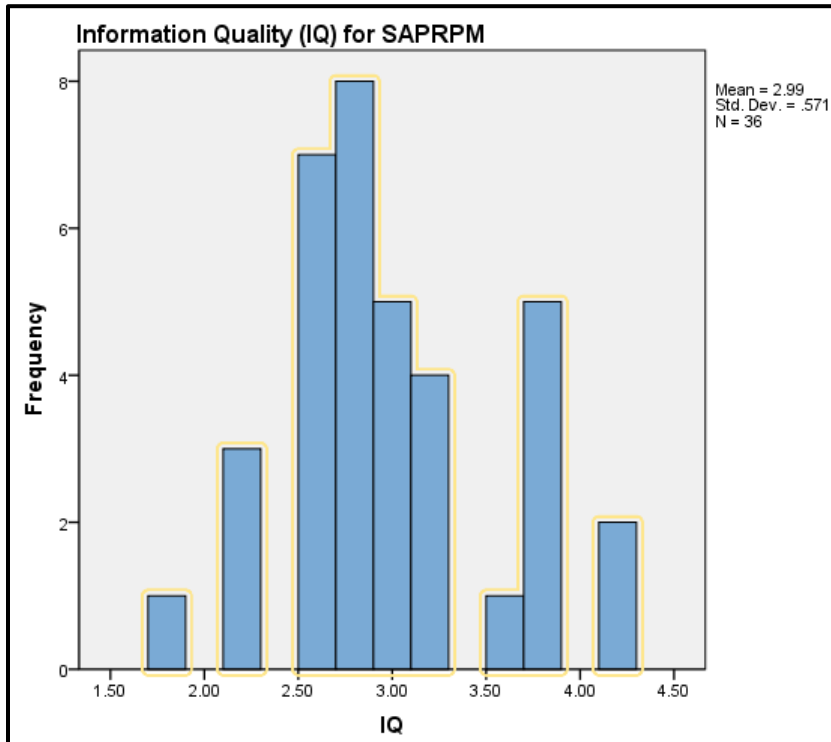
**4.6.2.3 Information Quality (IQ) of SAP RPM:**

The Cronbach’s Alpha value obtained, as shown in Figure 4.15, was 0.677 which falls within the acceptable range as defined by Sekaran and Bougie (2010). The results obtained were therefore valid and consistent.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.677	.726	5

**Figure 4.15: Cronbach’s Alpha value for IQ for SAP RPM**

A summarised view illustrating a histogram of the mean responses for the IQ variable is illustrated in Figure 4.16. The IQ delivered by SAP RPM to its end users is generally endorsed as average ( $M=2.99$ ).



**Figure 4.16: Mean values for IQ for SAP RPM**

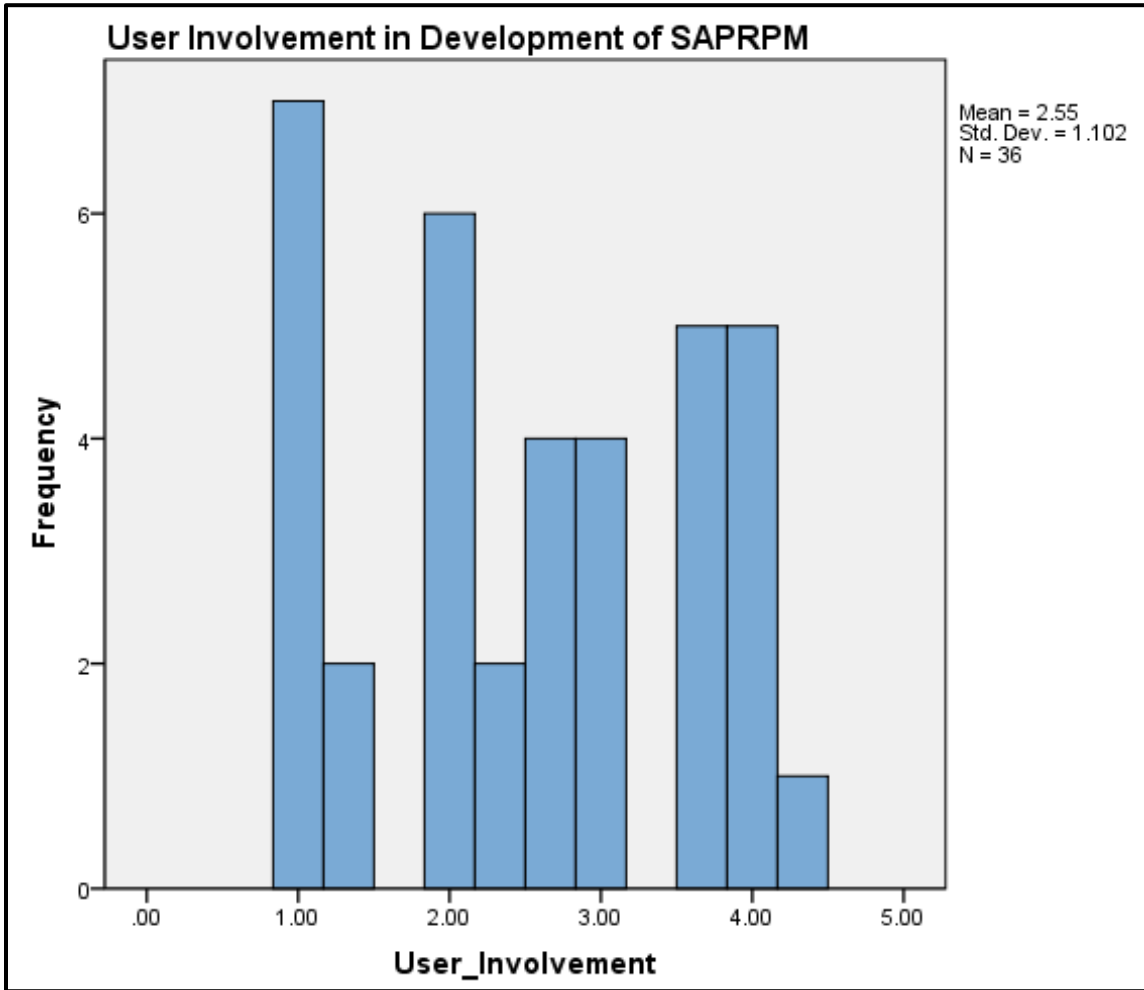
#### 4.6.2.4 User involvement in requirement elicitation (RE)

The Cronbach's Alpha value obtained, as shown in Figure 4.17, was 0.933 which fell within the acceptable range as defined by Sekaran and Bougie (2010) and was indicative of internal consistency reliability.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.933	.933	3

**Figure 4.17: Cronbach's Alpha value for user involvement in RE for SAP RPM**

A summarised view illustrating a histogram of the mean responses for the user involvement variable is illustrated in Figure 4.18. User involvement in software development for SAP RPM can be viewed as low ( $M=2.55$ ) with a high number of users indicating little involvement the RE phase of software development.



**Figure 4.18: Mean values for user involvement for SAP RPM**

#### ***4.6.2.5 Correlations between PEOU, PU, IQ and user involvement for SAP RPM***

After computing a Pearson Correlation between the level of user involvement and the level of user acceptance of the system, it can be ascertained from Table 4.7 that there is a significant positive correlation between user involvement in the RE phase of development of the SAP RPM system and the users' acceptance of the system (as indicated by the variables PEOU, PU & IQ).

**Table 4.7: Correlations between PEOU, PU, IQ and user involvement for SAP RPM**

Pearson Correlations between PEOU, PU, IQ & User Involvement for SAPRPM					
		PEOU	PU	IQ	User_Involvement
PEOU	Pearson Correlation	1	.628**	.603**	.568**
	Sig. (2-tailed)		.000	.000	.000
	N	36	36	36	36
PU	Pearson Correlation	.628**	1	.760**	.758**
	Sig. (2-tailed)	.000		.000	.000
	N	36	36	36	36
IQ	Pearson Correlation	.603**	.760**	1	.787**
	Sig. (2-tailed)	.000	.000		.000
	N	36	36	36	36
User_Involvement	Pearson Correlation	.568**	.758**	.787**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	36	36	36	36

\*\* . Correlation is significant at the 0.01 level (2-tailed).

#### 4.6.3 IS 3 – Service Catalogue System

This system was rolled out to users in SASOL, and caters for IT requests such as updating user contact details, creating user profiles, requesting hardware and peripherals, increasing size of mailboxes or my documents folders, accessing calendars and shared folders on the network and software requests, amongst a range of other services. The system is completely paperless and allows for automated approvals from the user’s line manager and IM division. There are currently 1200 end users of the Service Catalogue System. 500 users were randomly selected, of which 341 responses were received with 309 valid responses representing the response rate.

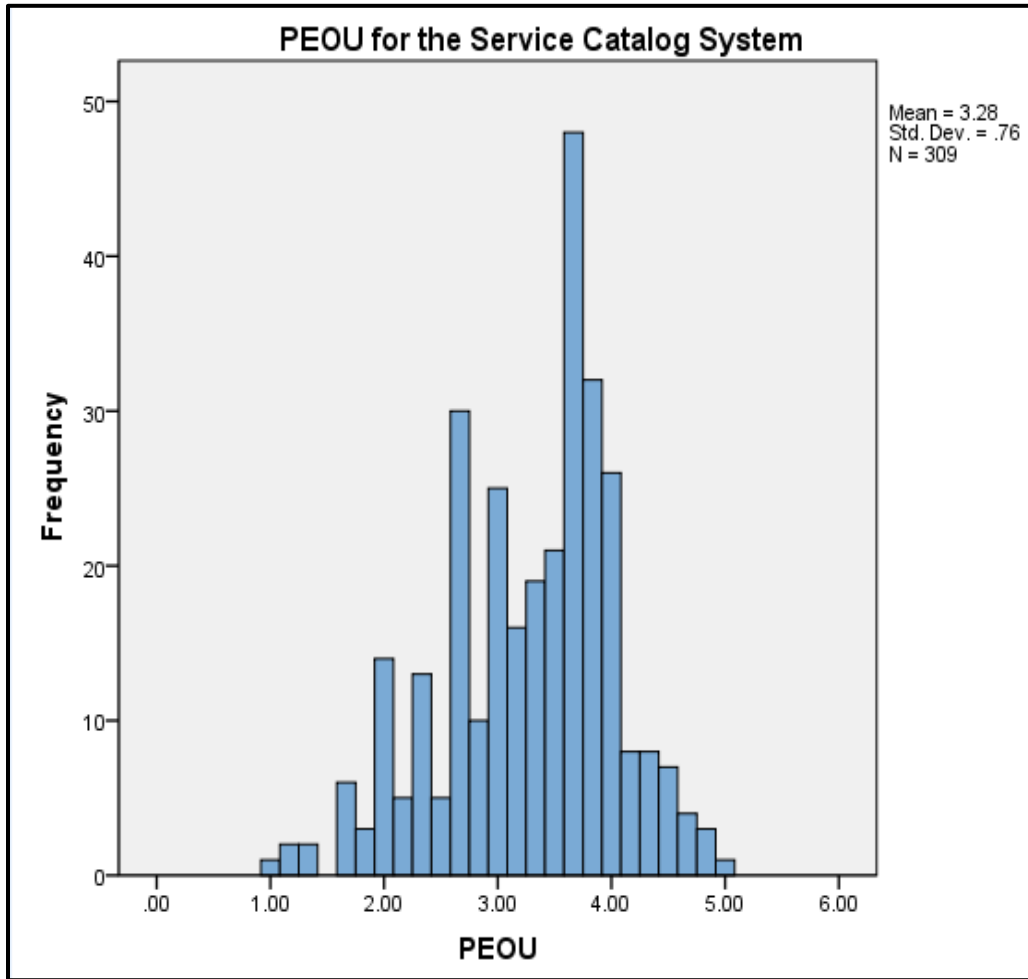
#### 4.6.3.1 Perceived Ease of Use (PEOU) of Service Catalogue System

The Cronbach's Alpha value obtained, as shown in Figure 4.19, was 0.851 which fell within the acceptable range as defined by Sekaran and Bougie (2010). The results were therefore consistent and valid.

Reliability Statistics		
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.851	.843	6

**Figure 4.19: Cronbach's Alpha value for PEOU for Service Catalogue**

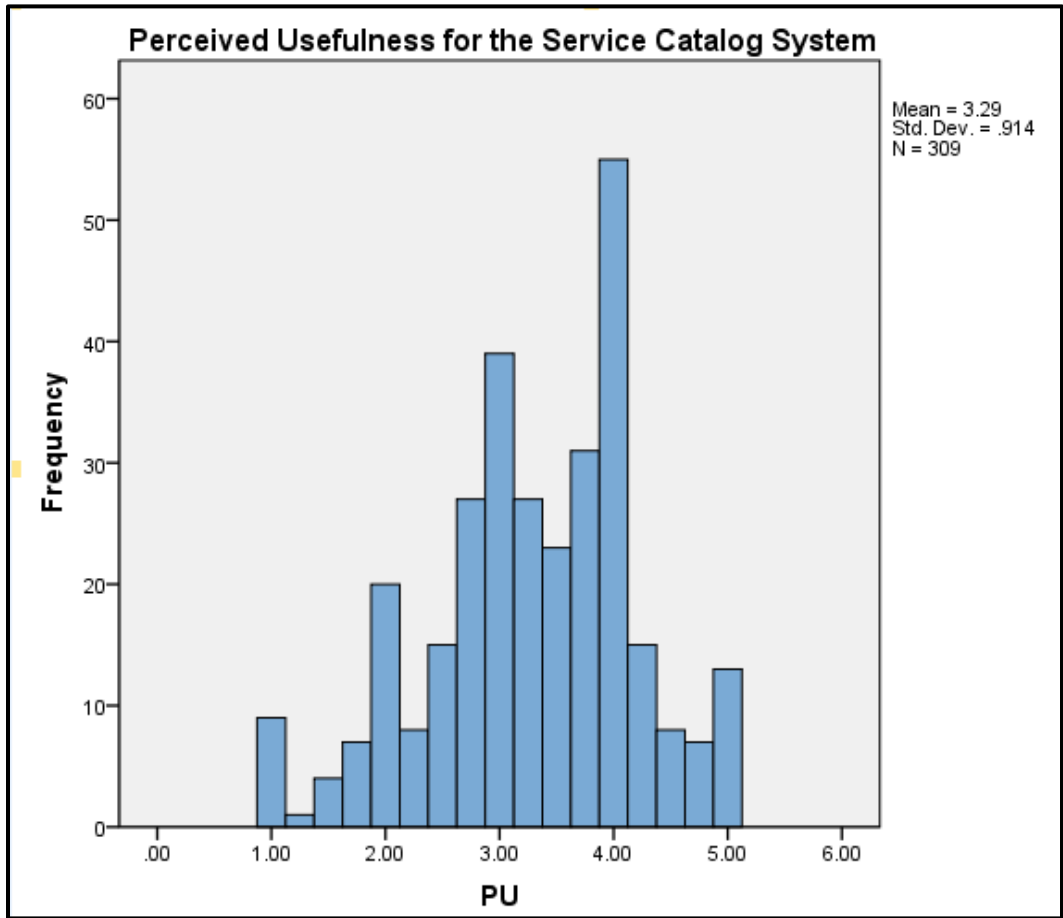
The perceived ease of use (PEOU) for the Service Catalogue System is generally endorsed as average, lying between the middle and upper quartile of the data set ( $M = 3.28$ ), as reflected in Figure 4.20. The Service Catalogue System was designed for users to submit IT service requests. The system did not include a large amount of users in the RE phase for the organisation, however super users from the IM department and IT service specialists formed part of the super users involved in the SDLC. During the user acceptance testing, users were selected from different business units within the petrochemical organisation. These users added value during user acceptance testing and contributed to the user interface design of the system. There was a significant amount of communication prior to the deployment of this system. Email notifications, pamphlets, posters and coffee sessions were used to inform users of this new system.



**Figure 4.20: Mean values for PEOU for Service Catalogue**

#### ***4.6.3.2 Perceived Usefulness (PU) of Service Catalogue System***

The usefulness of the Service Catalogue System was generally endorsed as average by the community of end users, with the mean value lying between the middle and upper quartile of the data set ( $M=3.29$ ) as illustrated in Figure 4.21. The Service Catalogue System automated a cumbersome and detailed manual application form used in SASOL. The manual form was very detail orientated and users generally had difficulty completing the application form. The Service Catalogue was marketed as an efficient, effective, paperless method of applying for services, incorporating automated approvals in the process. The perceived benefits and impact of the system were highlighted and communicated to the users.



**Figure 4.21: Mean values for PU for Service Catalogue**

#### ***4.6.3.3 Information Quality (IQ) of Service Catalogue System***

The quality of information delivered by the Service Catalogue System to the systems' end users is endorsed as acceptable ( $M = 3.28$ ), as reflected in Figure 4.22.

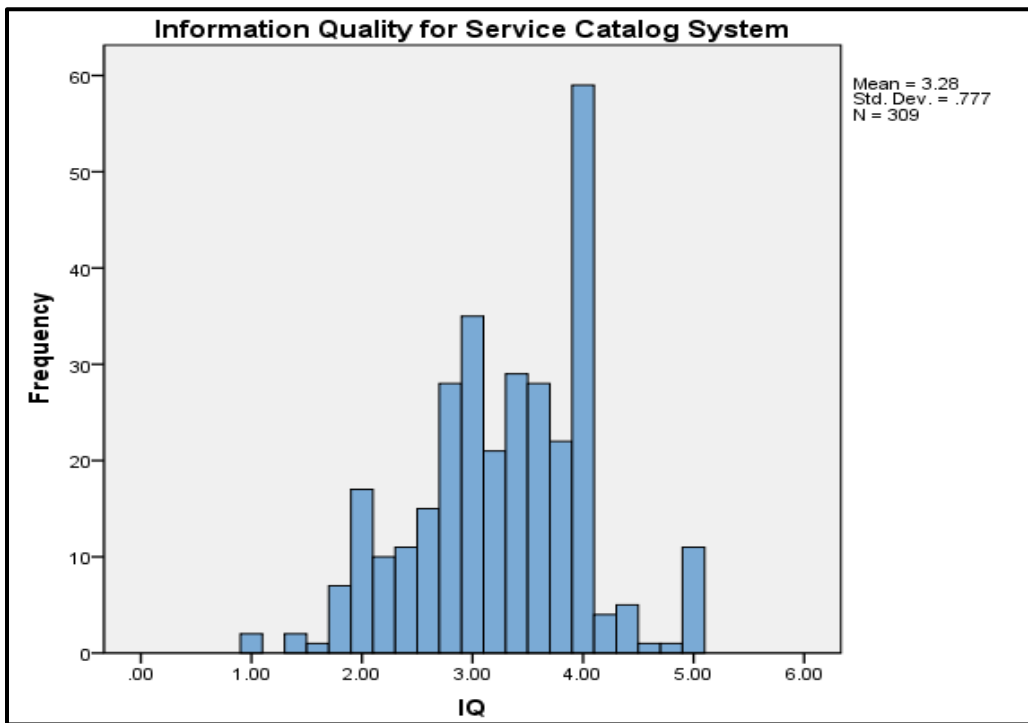


Figure 4.22: Mean values for IQ for Service Catalogue

#### 4.6.3.4 User involvement in the RE for the Service Catalogue

The level of user involvement in the RE phase of development of the Service Catalogue System is just below average and falls between the lower and middle quartile ( $M=2.79$  as illustrated in Figure 4.23).

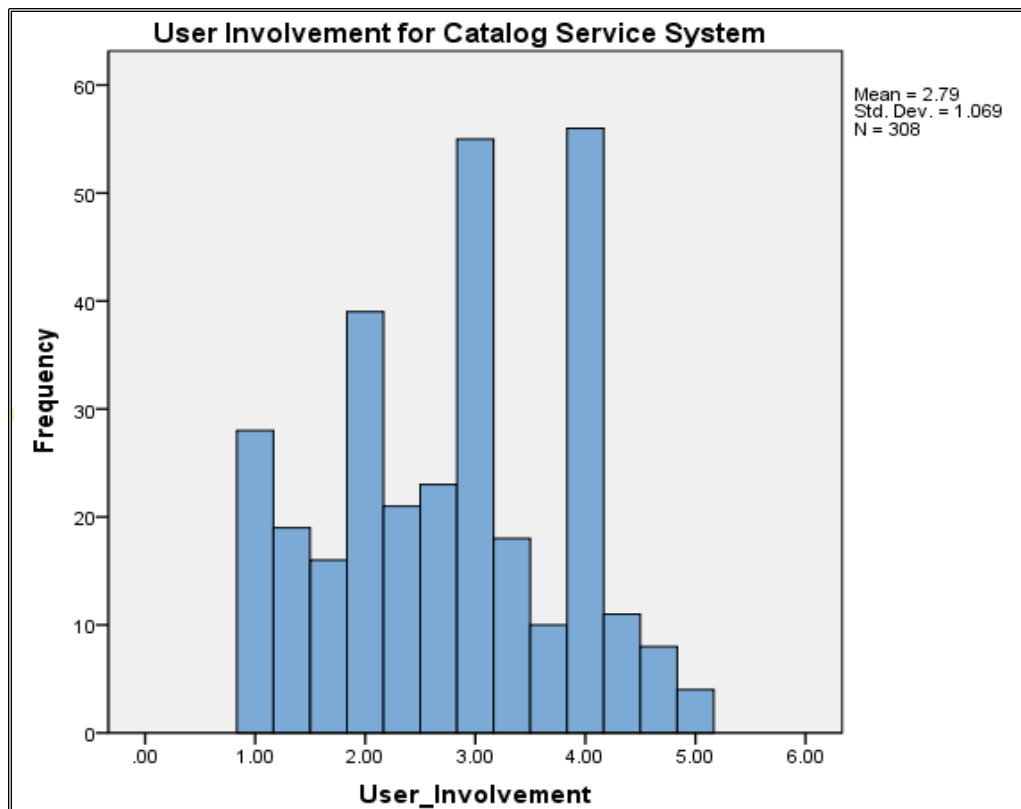


Figure 4.23: Mean values for user involvement for Service Catalogue System



**4.6.3.5 Correlations between PEOU, PU, IQ and user involvement for the Service Catalogue Systems (SCS)**

After computing a Pearson Correlation between the level of user involvement and the level of user acceptance of the system, it can be ascertained from Table 4.8 that there is a significant positive correlation between user involvement in the RE phase of development of the Service Catalogue System and the users' acceptance of the system (as indicated by the variables PEOU, PU & IQ).

**Table 4.8: Correlations between PEOU, PU, IQ and user involvement for the SCS**

		PEOU	PU	IQ	User_Involvement
PEOU	Pearson Correlation	1	.816**	.782**	.754**
	Sig. (2-tailed)		.000	.000	.000
	N	309	309	309	308
PU	Pearson Correlation	.816**	1	.811**	.758**
	Sig. (2-tailed)	.000		.000	.000
	N	309	309	309	308
IQ	Pearson Correlation	.782**	.811**	1	.804**
	Sig. (2-tailed)	.000	.000		.000
	N	309	309	309	308
User_Involvement	Pearson Correlation	.754**	.758**	.804**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	308	308	308	308

\*\* . Correlation is significant at the 0.01 level (2-tailed).

#### 4.6.4 Independent Sample t-test Between SAP RPM and ITMS

In Table 4.9 there is an observable difference between the factors that influence system acceptance for both systems. In all instances, the mean values reported for the ITMS (Sys\_No 1) showed a higher level of user acceptance. In order to determine whether these differences were significant, a null hypothesis was constructed stating that there is no difference between the mean values of the corresponding variables (PU, PEOU & IQ) for each system. An independent samples t-test was used to determine whether the null hypothesis may be rejected or accepted. In all instances, evaluation of the t-statistic revealed that the probability of the mean difference being due to chance was less than 0.05 ( $p=0.026$  for PEOU,  $p=0.00$  for PU and  $p=0.00$  for IQ). Hence the null hypothesis was rejected thereby affirming the difference between PU, PEOU, and IQ for each system as significant.

**Table 4.9: Group Statistics between SAP RPM and ITMS**

Group Statistics					
	Sys_NO	N	Mean	Std. Deviation	Std. Error Mean
PEOU	1 ITMS	381	2.8718	.55749	.02856
	2 SAP	36	2.6528	.60863	.10144
PU	1 ITMS	381	3.3438	.91760	.04701
	2 SAP	36	2.5069	1.15339	.19223
IQ	1 ITMS	381	3.5827	.71893	.03683
	2 SAP	36	2.9944	.57069	.09511

The t-test can only be conducted when comparing two groups or samples. To ensure that the significance of the results was applicable to all three information systems in this study, the ANOVA test was also completed to confirm the significance variable. Refer to Section 4.6.7 for details on the ANOVA test.

#### 4.6.5 Independent Sample t-test Between ITMS and the Service Catalogue System

In Table 4.10 there is an observable difference between the factors that influence system acceptance for both systems (Sys\_No 1 is a reference to ITMS and Sys\_No 3 is the Service Catalogue System).

However, the differences in the mean values are variable. The Service Catalogue System is better than ITMS with respect to PEOU. However, this observation is reversed for the IQ aspect with the ITMS slightly better than the Service Catalogue System.

**Table 4.10: Group Statistics between ITMS and the Service Catalogue System (SCS)**

Group Statistics					
	Sys_No	N	Mean	Std. Deviation	Std. Error Mean
PEOU	1 ITMS	381	2.8718	.55749	.02856
	3 SCS	309	3.2826	.75994	.04323
PU	1 ITMS	381	3.3438	.91760	.04701
	3 SCS	309	3.2937	.91353	.05197
IQ	1 ITMS	381	3.5827	.71893	.03683
	3 SCS	309	3.2790	.77709	.04421

While the differences between the two systems with respect to PEOU and IQ were statistically significant ( $p=0.00$  for both aspects), the difference in PU ( $p=0.475$  is greater than the threshold value of 0.05 at the 95% confidence level), is not statistically significant as shown in Table 4.11.

**Table 4.11: Group Statistics between ITMS and the Service Catalogue System**

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
PEOU	Equal variances assumed	43.446	.000	-8.181	688	.000	-.41080	.05021	-.50939	-.31221
	Equal variances not assumed			-7.928	550.531	.000	-.41080	.05181	-.51258	-.30903
PU	Equal variances assumed	.019	.891	.715	688	.475	.05014	.07011	-.08751	.18780
	Equal variances not assumed			.716	660.065	.475	.05014	.07008	-.08746	.18774
IQ	Equal variances assumed	3.973	.047	5.321	688	.000	.30371	.05708	.19165	.41578
	Equal variances not assumed			5.278	635.726	.000	.30371	.05754	.19072	.41670

#### 4.6.6 Independent Sample t-test Between SAP RPM System and the Service Catalogue System

In Table 4.12 there is an observable difference between the factors that influence system acceptance for both systems (Sys\_No 2 is a reference to SAP RPM System and Sys\_No 3 is a reference to the Service Catalogue System). However, the differences favour the Service Catalogue System. In each of the aspects under measurement, PEOU, PU and IQ, there is a significant difference ( $p=0.00$  for PEOU as well as PU while  $p=0.034$  for IQ, which is lower than the threshold value of 0.05 at the 95% confidence level) indicating a higher level of user acceptance of the Service Catalogue System than the SAP RPM system for all aspects under measurement.

**Table 4.12: Group Statistics between the SAP RPM and the Service Catalogue System**

Group Statistics					
	Sys_NO	N	Mean	Std. Deviation	Std. Error Mean
PEOU	2 SAPRPM	36	2.6528	.60863	.10144
	3 SCS	309	3.2826	.75994	.04323
PU	2 SAPRPM	36	2.5069	1.15339	.19223
	3 SCS	309	3.2937	.91353	.05197
IQ	2 SAPRPM	36	2.9944	.57069	.09511
	3 SCS	309	3.2790	.77709	.04421

#### 4.6.7. ANOVA Test

The ANOVA test in Table 4.13 and Table 4.14 represent the analysis of the variance for PEOU, PU and IQ for the three information systems. The results of the ANOVA test indicate that there is sufficient significance in comparison of the mean values of the sample set of the study, thereby providing sufficient support for the generalisation of these results to the entire population of the study. The ANOVA test represents the variance for the three systems in this survey indicating the results are acceptable and a true representation of the population.

**Table 4.13: Comparing the three Mean Sample Values**

Descriptives									
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	
					Lower Bound	Upper Bound			
PEOU	1 <sup>a</sup>	381	2.8718	.55749	.02856	2.8157	2.9280	.83	4.17
	2 <sup>b</sup>	36	2.6528	.60863	.10144	2.4468	2.8587	1.50	3.67
	3 <sup>c</sup>	309	3.2826	.75994	.04323	3.1976	3.3677	1.00	5.00
	Total	726	3.0358	.68812	.02554	2.9857	3.0860	.83	5.00
PU	1 <sup>a</sup>	381	3.3438	.91760	.04701	3.2514	3.4363	1.00	5.00
	2 <sup>b</sup>	36	2.5069	1.15339	.19223	2.1167	2.8972	1.00	5.00
	3 <sup>c</sup>	309	3.2937	.91353	.05197	3.1914	3.3959	1.00	5.00
	Total	726	3.2810	.94444	.03505	3.2122	3.3498	1.00	5.00
IQ	1 <sup>a</sup>	381	3.5827	.71893	.03683	3.5103	3.6551	1.00	5.00
	2 <sup>b</sup>	36	2.9944	.57069	.09511	2.8014	3.1875	1.80	4.20
	3 <sup>c</sup>	309	3.2790	.77709	.04421	3.1920	3.3660	1.00	5.00
	Total	726	3.4242	.75798	.02813	3.3690	3.4795	1.00	5.00

a. ITMS  
b. SAPRPM  
c. SCS

**Table 4.14: ANOVA test**

<b>ANOVA</b>						
		Sum of Squares	df	Mean Square	F	Sig.
PEOU	Between Groups	34.351	2	17.176	40.196	.000
	Within Groups	308.940	723	.427		
	Total	343.291	725			
PU	Between Groups	23.124	2	11.562	13.406	.000
	Within Groups	623.554	723	.862		
	Total	646.678	725			
IQ	Between Groups	22.736	2	11.368	20.871	.000
	Within Groups	393.798	723	.545		
	Total	416.533	725			

## **4.7 Qualitative Component**

The incursion into the qualitative paradigm was necessitated by the inability of the main stakeholders (the PMs and BAs) to identify/acknowledge the use of a recognisable RE strategy/technique that underpinned the development of each system. The researcher realised that this information will have to be deduced by the researcher on the basis of evidence gathered from semi-structured interviews with the PMs and BAs. This observation created the opportunity to extend the dimensions of the current study from being exclusively positivistic in nature and to incorporate elements of an interpretive paradigm of research. According to Gable (1994), "...a synergistic interplay of interpretive and positivist perspectives" can only serve to add value to the understanding of the implementation of information technology from a business perspective. In order to incorporate more than one dimension to a study, Gable (1994) suggests that more than one method of data collection should be utilised. While the multiple case study approach would be ideal in exploring relationships between key variables quantitatively, qualitative data may be required to complement the quantitative dimension of the study.

Yin (2009) describes qualitative data as the descriptive/textual data gathered when the researcher asks a mix of broad questions as well as questions that have a pre-defined structure in order to better understand a phenomenon. Qualitative research methods can produce detailed information on particular case studies, and this method has a strong reliance upon interviews. While the qualitative aspect of any study enhances the researcher's insight into the socially oriented issues around a study (Leech and Onwuegbuzie, 2007),

the primary purpose of the qualitative dimension for the current study was to obtain information and insight regarding the RE adopted for each system. A secondary purpose was to obtain insight into the organisational constraints and business values that were influential aspects that underpinned the development of each system.

According to Burnard *et al.*(2008), the two fundamental approaches to analysing qualitative data is the deductive and inductive approaches. The inductive approach involves analysing the data gathered with little or no pre-determined theory, structure or framework. The data analysis involves comprehensive analysis techniques, such as content analysis, that culminates in the development of some theory. The deductive approach involves the use of some pre-determined structure or framework to analyse data and interpret that data relative to the pre-existing theory/framework. In terms of the primary purpose of the qualitative intervention, the deductive approach was deemed to be more appropriate.

#### **4.7.1 The Interview Component**

Semi-structured face to face interviews were conducted with the BA's and PMs for each system. The time frame for the interviews was set at one hour and held in the organisation's conference rooms. The interviewees received a meeting invite with a brief explanation on the nature of the study and the approval document from the organisation's Information Management Department granting approval to proceed with data collection. The information obtained from the interviewees offered insight into the RE techniques used and the level of user involvement in the software development process used in the organisation. The interviews also served the secondary purpose of establishing the objectives behind the development of each system as well as the business value obtained from each system. The strategy adopted for the interview was firstly to acquire as much information as possible so that a classification regarding the type of RE technique used could be made. Once this had been established, the remainder of the interview served as a platform to collect information regarding other aspects of system development such as the challenges (time, cost and expertise) that the developers faced with regards to systems development at the organisation. The opinions of the PMs and BAs regarding the RE process was also acquired. While this unstructured data may be used to corroborate parts of the quantitative data, the researcher used the second part of the mainly as part of a "back-up" data collection strategy in the event of low responses to the survey that was disseminated to the users of each system.

#### ***4.7.1.1 Pretesting of the interview***

Pretesting of the interviews was achieved with pilot studies held with three BAs from the organisation's information management department. The interview questions were tested for clarity and applicability to the nature of the study. The BAs who completed the pilot interviews were not involved in the three IS projects selected for this study. The BAs involved in the pilot did have experience and were knowledgeable on the development and execution of IS projects. Certain questions required clarification during the pretesting. These questions were edited to be clear and unambiguous, contributing to the quality of the final interview questions.

#### ***4.7.1.2 Interviews***

Interview sessions were scheduled in the interviewee's calendar on MS Outlook and conducted in closed conference rooms in the interviewee's office area. All interview sessions were accepted by the interviewees on the first meeting request. This was encouraging as it indicated willingness to share the lessons learnt and challenges with the respective projects and the RE techniques utilised. The interviews targeted the PMs of each system. However, the willingness of the BAs to participate in the interview sessions resulted in interviews with BAs for 2 of the 3 systems that formed the focus of the study. The interview was guided by a set of 13 questions (refer to Appendix B). During the first interview, the researcher took written notes as the interview progressed. The first interview was crucial in helping the researcher understand the culture of software development within the organisation and it also provided an opportunity to refine the questions for the surveys as well as preparation for the subsequent interviews. It was also established that RE is primarily based on the intuition of the PM and BA and usually consisted of a combination of strategies. The outcome of the first interview is aligned to the assertion by Sekaran and Bougie (2010) that face to face interviews offered the advantages of establishing a rapport with the interviewees so that instant clarification of any enquiries or concerns may be obtained. However, the potential disadvantages of this approach are that the interviews are time consuming, risk of interviewer bias, training may be required for interviewers, respondents may opt to terminate the interview at any time, and interviewees may be concerned about anonymity or confidentiality of the information provided (Sekaran and Bougie, 2010). All of these possible disadvantages did not pose much of a problem because the interviewers were assured of the anonymity of the data collection process. The interviewees were quite keen to contribute to this study because they felt that it would provide valuable information with regards to the type of optimal RE strategy for the organisation. The schedule of interviews conducted for each system is presented in Table 4.15.



**Table 4.15: Interview Schedule**

Information System	Personnel Interviewed	Notes
IS 1 ( ITMS)	1 PM; 1 BA	Both interviews completed in approximately 45 minutes
IS 2 (SAP RPM)	1 PM	Interview completed in approximately 30 minutes; The BAs were end users of the system – BA data was thus captured via the survey
IS 3 (Service Catalogue System)	1 PM; 1 BA	Both interviews completed in approximately 45 minutes

#### 4.7.2 Presentation of Qualitative Data

According to Pope and Mays (2008), qualitative data analysis involves the use of analytical categories to describe and explain phenomena. These categories may be obtained inductively by examining the data and identifying emerging themes or classifications. However, an alternate approach that is gaining widespread popularity is the deductive “framework approach” where the researcher starts with a guiding theory or framework and then classifies qualitative data according to the guiding framework. Gilgun (2005) posits that the guiding theory can range from “...a parsimonious theory to a rather loose set of ideas”. Gilgun provides an example of deductive qualitative analysis that involves delineating the phenomenon that is the focus of the study into specific categories and then analysing qualitative data according to these categories. Schadewitz and Jachna (2007) used a “mindmap” to explain and contextualise the invocation of deductive analysis as a technique for evaluating qualitative data.

In the current study, the guiding theory is based on the framework for classification of RE techniques suggested by Nuseibeh and Easterbrook (2000) and introduced in Chapter 3 of the study. This guiding framework was used to analyse the textual data provided by the PMs and BAs to make a classification regarding the type of RE technique employed in the development of each system.

During the pilot interview sessions with the BAs, it was established that while RE was an iterative process that involved a prototyping approach, once the system requirements were stabilised, the requirements were “signed off” and became the set of baseline requirements that were used to determine

whether the system had satisfied the set of user requirements. While this arrangement may be seen as a variant of the Waterfall methodology, the basic set of requirements were not “frozen”. It was merely used as a guide to ascertain the scope of the system. The development team was quite flexible and accommodated additional requirements in order to satisfy the client base. This approach may be seen as a mix of Waterfall and Agile software development methodologies.

#### **4.7.2.1 Type of RE Used in System Development**

A summarised presentation of the interview data is shown in Table 4.16. Two interview questions were used to establish the level of user involvement from the perspective of the PMs and BAs. These questions (Questions 7 and 8) were phrased as Likert scale type questions on a continuum from 1 to 5 where 1 represented a high level of end user involvement and 5 represented a low level of end user involvement. In order maintain consistency with the measurement scale used to establish the level of end user involvement in the quantitative component of the study, the responses were reverse coded and the mean value was computed so that a high value represented a high level of user involvement. In the case where there was more than one interviewee for each system, the mean of the 2 sets of responses were used in computing a quantified representation of end user involvement, as shown in Table 4.16.

**Table 4.16: Summary of Responses from Interviews**

Information System	Summary Responses to Question 1 – The type of RE strategy used	Number of RE Sessions (Question 6)	Level of User Involvement ( Mean value for Question 8 on a scale from 1 to 5)
IS 1 (ITMS)	A mix of different approaches – no specific technique; BAs asked for end user perspective; funding was provided to engage with at least 200 end users; we initially sent out questionnaires with the intent of establishing main user requirements; we conducted “meetings” where user requirements were refined; developers used a prototyping approach concurrently with the meetings so that each “meeting” was followed-up with a session where the users interacted with prototype system and provided feedback to the developers. System testing provided an opportunity to refine requirements identify new requirements that would complete the system. RE and system development occurred concurrently.	More than 4 – approximately 10 to 12 in total – incorporating “everything”	4.22
IS 2 (SAP RPM)	The BA commissioned the system; User requirements established with a single stakeholder; BA dictated what he would like to see in the system; A prototype was used for demonstration purposes; iterative approach until BA was satisfied; system subsequently installed	Approximately 5 to 6	3.12
IS 3 (Service Catalogue System)	A mix of questionnaires and interviews; Interviews conducted with BAs to establish initial set of user requirements; questionnaires sent to approximately 50 users; context of the system was	3 interview sessions with BAs; Questionnaire	3.78

	explained to the users and their suggestions and opinions were obtained; requirements were refined during testing as well as ad hoc meetings with end users.	feedback from users	
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In order to analyse the data presented in Table 4.16 and obtain a classification regarding the type of RE strategy used in the development of each system, a “mind map” of the processing as suggested in Schadewitz and Jachna (2007) is presented in Figure 4.24. Based on the processing logic illustrated in Figure 4.24, the RE technique, classified according to the model provided by (Nuseibeh and Easterbrook, 2000), used in the development of each system is presented in Table 4.17 below

**Table 4.17: Classification of RE strategy used for development of each Information System**

Information System No	Information System Name	Type of RE Strategy
IS 1	ISTMS	Group Elicitation
IS 2	SAP RPM	Cognitive & prototyping
IS 3	SCS	Traditional

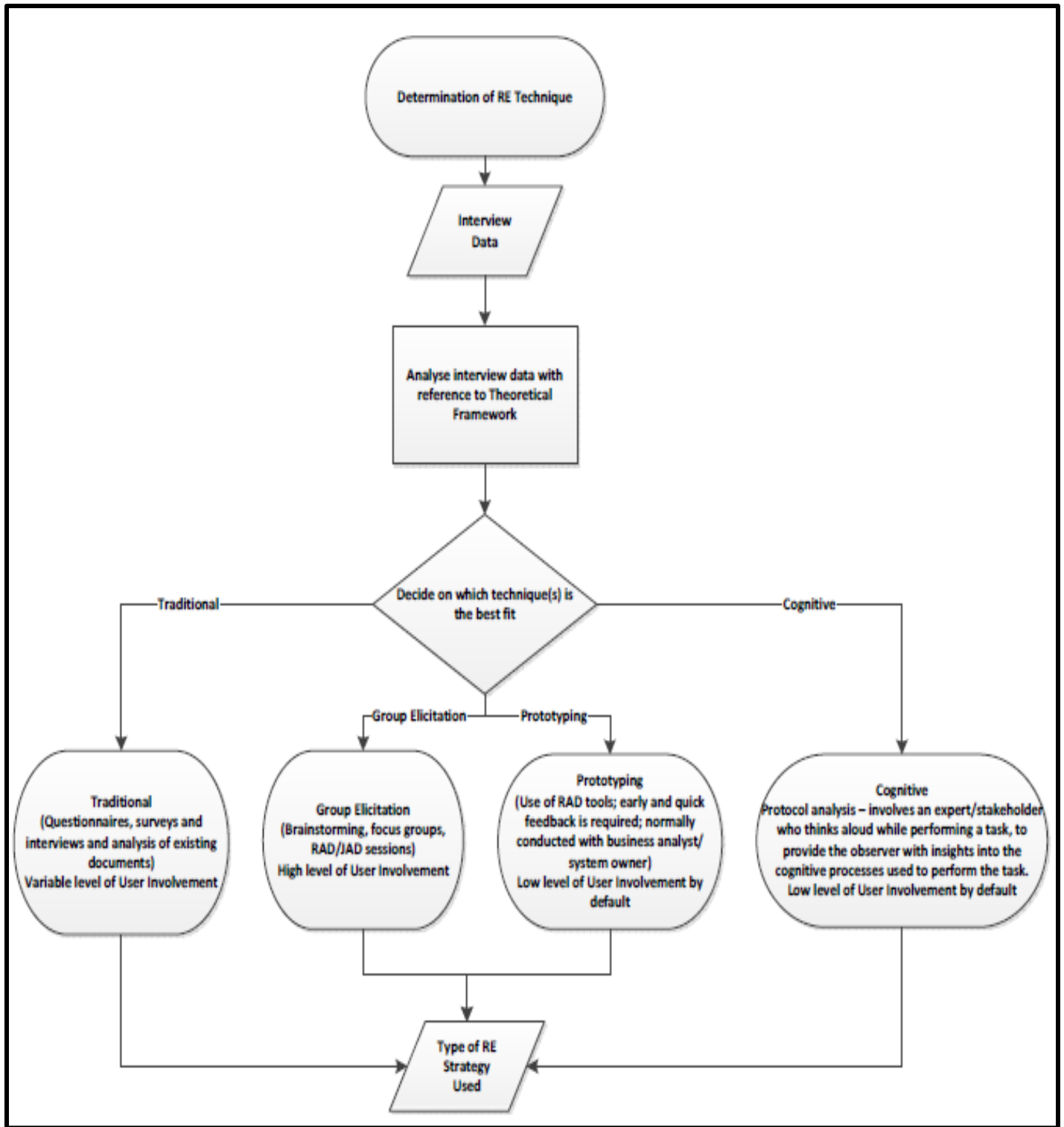


Figure 4.24: Mind map of processing for RE Classification

#### 4.7.2.2 Success Factors Influencing IS Development at SASOL

The culmination of the qualitative inquiry into software development at SASOL is represented by a summary presentation of the responses to the open ended question asked in the survey as well as a question alluding to success indicators for software development at Sasol emanating from the interview. Both these questions are presented in Table 4.18.

**Table 4.18 Questions Alluding to Key Success Factors for IS Development**

Question No	Source	Question
24	Survey	Please provide any comments/opinions that may help towards the improvement of the quality of information systems developed within SASOL.
12	Interview	What do you consider to be the main factors contributing to the success of information systems? Why?

Based on the end users' experience in using and developing IS 1, IS 2 and IS 3, the comments that were received as a response to Question 24 of the survey alluded to the pivotal role played by end user involvement in systems development. These comments are presented thematically in Tables 4.19, Table 4.20 and Table 4.21 for IS1, IS2 and IS3 respectively.

**Table 4.19 End User Open Ended Survey Responses Regarding IS 1 (ITMS)**

Theme	Common Responses
End User Involvement	Increased user involvement will result in a more efficient system as demonstrated by the ITMS; Involvement of users during the RE Process should increase similar to ITMS
Success of the System	ITMS is successful because users were involved in the testing of the system; Implementing an error free system will increase confidence in using the system ( as shown by ITMS)

**Table 4.20 End User Open Ended Survey Responses Regarding IS 2 (SAP RPM)**

Theme	Common Responses
End User Involvement	It is not logical to develop a system for the users without consultation with the end users as was the case for the SAP RPM; Information Systems should be client driven and developed with client support, interaction and engagement. Systems, such as the SAP RPM appears to be designed to suit the needs and purposes of the project sponsor or system owner, and not the users.
Success of the System from a Usability Perspective	Information Systems should be user friendly and easy to use. Currently, The SAP RPM information systems is too complex and not user friendly; The information in the SAP RPM system must be applicable to users, easy to understand and not using technical jargon; Some users accounts were locked, some line managers were unable to retrieve and approve their subordinate’s documents on the SAP RPM; The search functionality on Information Systems is important and should function efficiently – however, this is not the case with the SAP RPM; Navigating through the Information Systems should be intuitive, but this is not so in the SAP RPM

**Table 4.21 End User Open Ended Survey Responses Regarding IS 3 (Service Catalogue System - SCS)**

Theme	Common Responses
End User Involvement	The questionnaires were effective in establishing user requirements; The interview sessions were useful in establishing what the users required for the SCS
Success of the System	The SCS worked reasonably well because users were given the chance to contribute to identifying requirements for the system; The system was not too complex to use

The primary purpose of the interview sessions with the business analysts (BAs) and the project managers (PMs) was to obtain detailed information regarding the requirements elicitation strategy and the level of user involvement in the development of the three systems. This opportunity was also used to obtain insight into the development process and to identify key issues that may have had an influence on the success of each of the three systems. Question 12 of the interview alluded to the success factors underpinning each system. Whilst a complete summary of the response to this question is provided in Appendix D, there was a significant amount of information regarding the success of each system that was obtained as part of the interview from a holistic perspective. The complete summary of these responses is provided in Appendix E. The information regarding factors that influenced the success of each system taken from Appendix D and Appendix E is thematically presented in Tables 4.22, 4.23 and 4.24 for IS 1, IS 2 and IS 3 respectively.



**Table 4.22 BAs and PMs Interview Response Regarding Success Factors for IS 1 (ITMS)**

Theme	Common Responses
End User Involvement	<p>A strong sponsor or project champion can have a significant impact on the success of an IS (as was the case for IS1). The role of the sponsor or champion is to harness support for the IS from managers who in turn filter the support to other users in the organisation. This is accomplished in a top down approach. Users see/acknowledge the support of the managers for the IS and this has a positive impact on user acceptance. If the executive committee of the organisation can offer support on IS Projects impacting the entire organisation, the buy in from lower levels will improve and user support for the system will increase. This will also alleviate the need for the project team to conduct detailed communication to all users. Communication will be covered during department coffee sessions, group meetings and road-shows.</p>
Success of the System	<p>This increased level of communication with users has a significant impact on the buy in from users in SASOL and positively influences the use of the IS. The prototyping approach incorporating user interactivity via JAD and brainstorming sessions has a positive influence on the system's success.</p> <p>The ITMS has very high level of usage, with minor instances of end user complaints about the system.</p>

**Table 4.23 End User Open Ended Survey Responses Regarding IS 2 (SAP RPM)**

Theme	Common Responses
End User Involvement	Stakeholders and users with relevant business knowledge is another important factor contributing to the success of Information Systems.
Success of the System	The skill set of the core project team is an important success factor. The project team, BA, PM and key stakeholders must have a clear understanding of the problem statement and the user requirements. This forms a solid basis and foundation from which to work from, and build an IS that addresses the need and the problem statement and attain eventual success. The SAP RPM has an adequate level of usage, but there have been many complaints about the complexity of the system and end user reluctance to engage with the system.

**Table 4.24 End User Open Ended Survey Responses Regarding IS3 (Service Catalogue System - SCS)**

Theme	Common Responses
End User Involvement	Eliciting valid requirements from the users and stakeholders of the proposed IS via interviews and questionnaires were difficult. Users cannot provide clear requirements during the first RE session with the project team. A number of refinements and review sessions are needed before clear and well defined requirements are elicited.
Success of the System	Pressure to deliver a working solution in a short frame of time was a significant challenge faced by two of the three BAs interviewed. The SCS would have been more successful if the developers were given more time and requirements were compiled iteratively, rather than once off. The SCS is reported to have a much higher level of successful end user usage with a relatively few instances of complaints against the system.

## 4.8 Summary of the chapter

This chapter discussed the research approach used for the study and established content validation of the questionnaire. A major focus of the chapter is on the data collection and analysis techniques used, pilot testing of the questionnaire and interview questions. The combination of qualitative and quantitative techniques used in the study was explained and implemented. SPSS was used to analyse the data. Factor analysis and Cronbach Alpha was used to establish construct validity and reliability of the data so that the discussion of the results is based on valid and reliable data. Survey data was analysed using Pearson correlations, t-tests and ANOVA testing so that significant correlations between the data sets for each of the three systems could be identified and contribute to the discussion of results. Survey data was presented graphically facilitating quick and easy interpretation of the results.

A deductive analytical approach was used to qualitatively determine the type of RE strategy used in the development of each system. The qualitative data served the primary purpose of ascertaining the type of RE technique used as well as the level of user involvement in the systems development process. Additional questions asked during the interview sessions helped the researcher gain a deeper insight into the organisational issues that influence the RE process. These questions alluded to the success of each system from the perspective of end user acceptance as well as the value that each of the systems brought to the end users by virtue of the influence that these systems had on job performance.

A discussion of the results in conjunction with the research questions asked in the study is now presented in Chapter 5.

## **Chapter 5 Conclusion and Recommendations**

### **5.1 Introduction**

The agenda for the current research effort has been prompted by the dearth of empirical evidence to justify the use of proper RE strategy in order to develop information systems that are perceived as successful by the information system's set of end users. Whilst there is an abundance of anecdotal evidence, mostly provided by the methodological experts, attesting to the need for proper RE strategy the current study is an attempt to provide empirical evidence to determine whether proper RE techniques would be effective in ensuring the development of a successful information system. The main challenge faced by the researcher was to operationalize the variables of the current study as well as elicit information regarding the type of RE strategy used by the PMs as well as the perceived success of the information system by the community of end users. The variables of the current study were operationalized via the academic framework underpinning the study while the data required to complete the study was obtained via interviews with the PMs as well as survey responses from the end users of the information systems that became the target of the study.

The study employed a combination of qualitative and quantitative techniques in achieving its objectives. The main objective of qualitative component of the study mainly was to provide an insight into the type of RE technique that was used by the PMs. The interview sessions were also used as an opportunity to get "behind the scenes" with respect to the development of the system by establishing contact with some of the PMs and BAs who either developed or commissioned the development of each system. The quantitative aspect of the study was more objective and an effort was made to obtain a statistically representative view from the sample of end users. A systematic randomised sampling technique was used coupled with parametric statistics tests to ensure that the results were a significant reflection of the population of end users.

The remainder of the current chapter is divided into sections addressing the main research problem and associated sub problems. Each section will discuss the general findings, a result and a final recommendation. In order to contextualise the discussion of results, a summarised view of the results presented in Chapter 4 is provided in Table 5.1.

**Table 5.1: Summary of Research Variables Mean Values**

System No	System Name	Interview		Questionnaire				
		Elicitation Strategy	Level of User Involvement	PEOU	PU	IQ	Level of User Involvement	Number of Respondents (n)
IS1	ITMS	Group	4.12	2.87	3.34	3.58	3.11	381
IS2	SAPRPM	Cognitive & Prototype	3.22	2.65	2.51	2.99	2.55	36
IS3	SCS	Traditional	3.78	3.28	3.29	3.28	2.79	309

## 5.2 Discussion of Key Research Questions

### 5.2.1 Main Research Problem: The Relationship between End User Involvement and User Acceptance of Information Systems Projects Implemented at SASOL

*What is the relationship between the level of end user involvement and user acceptance of information systems projects implemented at SASOL?*

The research problem was mainly addressed by results obtained from responses to the 15 questions in the survey and partially addressed by the 13 questions in the interview. The remaining 9 questions in the survey were merely used to obtain additional insight into end users perception of each system. It was envisaged that this information would be helpful in facilitating a more informed interpretation of the results.

The main outcome of the study indicates that the user- interactive, user intensive RE techniques, such as joint application development (JAD) sessions, focus groups, workshops and brainstorming sessions that require a high level of user involvement, were highly successful in terms of user acceptance of the

information system. This assertion is based on the characteristics of IS 1 (ITMS) where the level of user interaction was high and the success with respect to user acceptance was also high. The SAP RPM system (referred to as IS 2) did not implement a planned, user intensive RE strategy. This resulted in lower levels of satisfaction for this system. The Service Catalogue system (referred to as IS 3) involved less intensive user involvement at the RE phase than the ITMS system. The user acceptance and system success of the Service Catalogue system is slightly lower than the ITMS system but much higher than the SAP RPM system.

Hence, a major overarching relationship that emerges is that those RE strategies that are user intensive seem to enhance the prospect of information system success with regards to user acceptance of that system. The empirical evidence provided in the current study is commensurate with similar assertions made by Emam and Koru (2008), Kujala (2003), Kujala *et al.* (2005), Cheng and Atlee (2007), Connor *et al.* (2009) and Kaur and Sengupta (2013).

### **5.2.2 Sub Problem 1**

*To determine the level of user acceptance of information systems projects implemented at SASOL.*

The first sub problem aimed to determine the level of user acceptance of information systems projects at SASOL. This sub problem was addressed by Questions 1 to 15 of the questionnaire, where information was gathered on the user satisfaction and acceptance of the information system. The academic framework used for the study was pivotal in ensuring that appropriate data on the perceived ease of the system (PEOU), perceived usefulness (PU) and information quality (IQ) was obtained. These questions were formulated based on the variables and constructs in the Technology Acceptance Model (constructs used were PEOU and PU) as well as the Information System Success Model (construct used was IQ).

The objective of this question is to establish whether end users found the information systems at SASOL easy to use and also derived benefit from using these systems with respect to work productivity and the quality of information delivered by the systems. This information will be a reliable predictor of whether the end users have an intention to continue using these systems, thereby justifying investment in developing the systems.

The results indicate a varied response. With regards to IS 1 (ITMS) and IS 3 (Service Catalogue System), the behavioural intention to use these systems as gleaned from the mean values established for PEOU

(2.87 for IS 1 (48%) and 3.28 for IS 3 (55%)) and PU (3.34 (56%) for IS 1 and 3.29 (55%) for IS 3) is located at around the 52% mark for IS 1 and around the 55% mark for IS 3. Both these results are representative of a value that is slightly more positive than neutral. With regards to the mean values for IQ, IS 1 has an indicator value of 3.6, placing it around the 60% mark while IS 3 has a mean value 3.3, located at around the 55% mark. In terms of IS 2 (SAP RPM System), the indicators for end user acceptance, as dictated by the variables used in the study were much lower. The PEOU (mean value of 2.6) and the PU (mean value of 2.5) indicators were placed at the 42% mark indicating a much lower intention to use than IS 1 and IS 3. The IQ (mean value of 2.9) indicator is located at 48% mark. While this value is relatively higher than the indicators of behavioural intention to use (PEOU and PU), the objective behind the development of IS 3 was to produce business decision making reports. Hence, the output of the system may have been pivotal in ensuring a higher value.

As can be established by these results, there is a problem with end user acceptance of information systems at SASOL. While in one case, such as IS 2, the problem is more severe than in the other two cases thereby raising the issue of end user acceptance of information systems as an area that warrants further attention in order to justify investment in information systems development at SASOL. While the problem is not of a critical nature, the symptoms of a problem in end user acceptance as highlighted especially by IS 2 cannot be ignored.

### **5.2.3 Sub problem 2**

*To determine how user requirements are established for information systems projects implemented at SASOL*

The second sub problem aimed to determine how user requirements were established for medium to large scale projects at SASOL. This sub problem was addressed largely from the deductive analysis done on the interview data. One of the key aspects of RE that emerged from the interview transcripts is that there was no exclusive orientation towards a specific RE strategy. However, it was established that RE was regarded as an evolutionary process with user requirements being obtained iteratively, using a prototyping demeanour throughout the duration of the system's life-cycle. This observation is commensurate with the findings by Foster and Franz (1999) and Baroudi *et al.* (1986) in their observation of the development process underpinning IS projects. However, RE and user involvement activity is much greater during the analysis and design phases.

Table 4.16 in Chapter Four presents a summary of interview responses with the BAs and PMs regarding the RE strategies used to develop each of the information systems that forms the focus of the current study. From these responses it can be concluded that a combination of joint application development (JAD) sessions, focus interviews and brainstorming sessions formed the basis for the RE strategy used for the development of IS 1. On the basis of evidence from the interview transcripts, the intention of the PMs was to make use of a user intensive strategy to elicit user requirements for IS 1.

With regards to IS 2 (SAP RPM), the RE strategy could be classified as a prototyping technique where the system was quickly developed, informed by the intuitive insight of a BA who commissioned the system. It was also established that the BA who commissioned the development of IS 2, did consult with fellow BAs (who were the main users of the system) in order to present the PM with a representative view on behalf of the systems' users. The main strategy used for the development of IS 2 can be classified as prototyping, in the sense that the main stakeholder of the system was consulted regularly in order to provide guidance with the evolving system. However, the implementation of the prototyping strategy was not aligned with the norm of having adequate end user representation. Hence, whilst the literature attests to the effectiveness of prototyping ((Holbrook III, 1990), (Dieste et al., 2008) and (Hickey and Davis, 2003)) on establishing accurate user requirements, the minimalist approach towards ensuring adequate end user representation may be seen as an aspect of implementation that would compromise the benefits of using prototyping.

With regards to IS 3 (Service Catalogue System), the RE techniques incorporated a combination of questionnaires and interviews with selected end users. Due to time and cost constraints, the intention of the PMs was to establish user involvement with a limited group of system users. The main strategy of RE was interviews and questionnaires. As with IS 1, the end user base for IS 3 is in excess of 1000. The PMs and BAs were of the opinion that the survey data would provide adequate user oriented insight into requirements for the system.

From the overview perspective of providing an answer to this sub-question, it can be ascertained that all 3 information systems had been subjected to varying categories of RE strategies. In the case of IS 1 and IS 3 where the user base was in excess of 1000 end users, an effort was made to obtain end user perspective as part of the RE strategy of the evolving system. However, there was a higher level of user consultation in the development of IS 1 that involved frequent JAD and brainstorming sessions throughout the entire development life-cycle of the system. The RE strategy used followed an agile like demeanour where RE



was iterative as opposed to being part of a specific phase of development. This model of RE was also followed to a lesser extent for the development of IS 3. User involvement was predominantly constrained to responses from questionnaires and interviews. However, users were consulted in an ad hoc manner to ascertain whether the requirements identified earlier were accurately embedded in system functionality. Users were also allowed to identify new requirements that would complete the system. Hence, whilst there was an intensive requirements gathering phase during the earlier stages of system development, RE was also conducted in an iterative manner throughout the development of the system. During the development of IS 1 and IS 3, the testing phase was also strategically used to obtain more accurate requirements. Hence, testing became an integral part of the RE strategy used for the development of IS 1 and IS 3. The end user base for IS 2 involved approximately 50 users. Whilst there was a greater opportunity for end user involvement as part of the RE strategy, this opportunity was not used optimally. The RE effort was driven by the BA who commissioned the development of the system with minimal input from the set of intended end users. Hence, IS 2 was representative of a RE effort that may be classified as a flawed implementation of the prototyping strategy.

From a more formalised perspective, the RE techniques employed at SASOL for the development of IS1, IS 2 and IS 3 is classified according to the Nuseibeh and Easterbrook (2000) framework as group elicitation (IS 1), traditional (IS 3), and a combination of cognitive and prototyping (IS 2).

### **5.2.4 Sub problem 3**

*To determine a possible relationship between the level of user acceptance and the level of user involvement during the development of information systems projects at SASOL.*

The third sub-problem can be viewed as the core of the current study. User acceptance of the information has been operationalized, via the academic framework of the study, to be the dependant variables PEOU, PU and IQ. The independent variable is the level of user involvement employed in the development of each system. The independent variable has also been linked to the RE strategy via the Nuseibeh and Easterbrook (2000) classification provided in Chapter Four. This classification will be used in conjunction with the main variables of the study in order to present a discussion of the answer to sub-problem 3. It should be noted that the results presented in Chapter 4 have a 95% significance level and are statistically representative of the population of end users identified in the study. In order to contextualise the discussion around the current sub problem, the Pearson Correlation data presented in Chapter 4 is holistically presented in Table 5.2 for ease of reference.

**Table 5.2: Pearson Correlation between User Involvement and User Acceptance**

System No	System Name	Level of User Involvement (UI) Mean Values	User Acceptance Mean Values (Pearson Correlation (r) vs UI)			Number of Respondents (n)
			PEOU	PU	IQ	
IS 1	ITMS	3.11	2.87 ( r=0.60)	3.34 ( r=0.72)	3.58 ( r=0.70)	381
IS 2	SAP RPM	2.55	2.65 ( r=0.57)	2.51 ( r=0.76)	2.99 ( r=0.79)	36
IS 3	SCS	2.79	3.28 ( r=0.75)	3.29 ( r=0.76)	3.28 ( r=0.80)	309

#### 5.2.4.1 Perceived Ease of Use (PEOU)

The results of the data analysis presented in Chapter 4 indicate that the PEOU of IS 3 was the highest with a mean value of 3.3, followed by IS 1 mean value of 2.9 with IS 2 showing a mean value of 2.7. The poor rating attached to IS 2 is commensurate with a RE strategy that entailed a low level of end user involvement in the development of the system. This relationship is also confirmed in similar studies by Kujala (2003), Kujala *et al.*, (2005) and Emam and Koru (2008). However, the higher rating attached to IS 3 in comparison to IS 1 was somewhat surprising as IS 1 had a higher level of end user involvement than IS 3. It should be noted that whilst the Pearson Correlation between PEOU and user involvement is a positive one, the relatively low (in comparison to PU and IQ) co-efficient value for IS 1 and IS 2 indicates that in the current study, the relationship between PEOU and the level of end user involvement, from the perspectives of IS 1 and IS 2, is not a strong relationship. These values are similar to the results (r= 0.55.and 0.51) reported by Foster and Franz (1999) where they investigated the relationship between user involvement and indicators of user acceptance of an information system. The commonly perceived notion that intensive user involvement in RE would guarantee the development of a system that was easier to use is dispelled by Terry (2008) who surveyed 44 project leaders on the value of end user involvement in improving the usability of a system. Only 3 of the 44 project leaders were of the opinion that end users added significant value to the usability of a system. The unconvincing influence of end

user involvement on the PEOU of an information system is also reported in Gefen and Straub (2000), Lee *et al.* (2003) and to a lesser extent by Turner *et al.* (2010) and Legris *et al.* (2003).

However, the strong positive relationship between PEOU and end user involvement evident from the correlation statistic for IS 3 ( $r=0.75$ ) presents a conflicting outcome in comparison with IS 1 and IS 2. This type of relationship is however commensurate with the outcome of similar empirical studies conducted by Calisir and Calisir (2004) and Lin *et al.* (1997). According to Terry (2008) conflicting empirical reports of the value of end user involvement should not be seen as an anomaly because many experienced developers have become quite knowledgeable about the usability requirements of end users. Coupled with this observation is the possibility that a large cohort of end users may not be familiar with the capacity of technology to enhance the usability of a system. A plausible conclusion from this inquiry is that the academic community ((Terry, 2008); (Calisir and Calisir, 2004) and (Lin *et al.*, 1997)) have identified the value of end user involvement in improving system usability as a viable area of further study.

#### **5.2.4.2 Perceived Usefulness (PU)**

The results of the PU of the three systems under review are marginally different from the discussion of results with respect to PEOU. The mean PU values obtained for IS 1 and IS 3 were 3.34 and 3.29 respectively. IS 2 obtained the lowest rating with a mean value of 2.5. The mean levels of end user involvement for IS 1 and IS 3 were 3.11 and 2.79 respectively. However, the mean value obtained for the level of end user involvement for IS 2 is 2.55. The higher Pearson correlation co-efficient (0.719, 0.758 and 0.758 for IS 1, IS 2 and IS 3 respectively) between PU and the level of user involvement for each of the three systems is an indicator that the level of end user involvement is a more reliable predictor of PU of an information system.

The strong relationship between PU and the level of user involvement reported in this study is also confirmed in Rouibah *et al.* (2009), Amoako-Gyampah (2007), Calisir and Calisir (2004), Lin *et al.* (1997) and Barki and Hartwick (1994). Whilst the correlation between PU and the level of user involvement does not imply causality (Rouibah *et al.*, 2009) the amount of user involvement that will contribute to system usefulness and usage of an information system is an area for further study. The relevance of such studies is explained by Calisir and Calisir (2004) who claim that users who perceive an IS as being useful by obtaining value and competitive advantage in the workplace are more likely to be satisfied with the IS thereby enhancing the prospect of system acceptance and system usage. The

significance of this claim is further elaborated by Amoako-Gyampah (2007) who asserts that a manager's ultimate goal of implementing an IS to achieve the intended level of usage because system usage is a reflection of system acceptance.

#### **5.2.4.3 Information Quality (IQ)**

The results with regards to IQ of the three systems under review are similar to the results discussed with respect to PU. The mean IQ values obtained for IS 1 and IS 3 were 3.58 and 3.28 respectively. IS 2 obtained the lowest rating with a mean value of 2.99. The mean levels of end user involvement for IS1 and IS3 were 3.11 and 2.79 respectively. However, the mean value obtained for the level of end user involvement for IS 2 is 2.55. The high Pearson correlation co-efficient (0.70, 0.79 and 0.80 for IS 1, IS 2 and IS 3 respectively) between IQ and the level of user involvement for each of the three systems is an indicator that the level IQ of an information system.

Information quality is a reference to IS characteristics such as accuracy, timeliness, completeness, relevance, and consistency (Delone, 2003). These characteristics of an IS contribute towards an overall perception of end user satisfaction. In a comprehensive meta-analysis of 45 studies in the domain of end user involvement and end user satisfaction with an IS, Mahmood *et al.* (2000) confirm the strong correlation between end user involvement, information quality and overall end user satisfaction with an IS. The positive correlation between end user involvement and IQ is also reported in Rouibah *et al.* (2009) , Lin *et al.* (1997) and Foster and Franz (1999).

Based on the above discussion, it can be seen that level of user involvement is a significant indicator of user acceptance of an information system. Although there are conflicting reports of the influence of end user involvement on the PEOU of a system, the strong positive correlation between end user involvement to PU and IQ suggests that overall user satisfaction with an information system is strongly influenced by the RE technique adopted. The current study provides empirical evidence that those RE techniques that involve a high level of user involvement have a greater chance of obtaining acceptance by the end user community.

#### 5.2.5 Sub Problem 4

*To determine the main success factors of information systems developed at SASOL*

The success of an information system is invariably linked to the accuracy and comprehensiveness of the RE strategy underpinning the development of that system (Birks *et al.*, 2003; Sumner, 1999; Hsu *et al.*, 2012; Ives and Olson, 1984). This is confirmed in the current study where the PU and IQ of IS 1, which involved the highest level of user involvement in RE, was recorded as the highest of the three systems under review. In this regard, the level of user involvement may be viewed as a critical success factor in information system development. This outcome regarding main success factors underlying information system development is also endorsed by Al-Ahmad *et al.*(2009), Sumner (1999) and Appan and Browne (2012).

From a qualitative perspective, this research problem was addressed by Question 24 of the questionnaire directed at end users as well as Question 12 of the interview with BAs. These were open-ended questions that required a response regarding suggestions in improving the quality and success of information system development at SASOL. Details of the responses to these questions are provided in Appendix F of this document. However, from a summary perspective, there was strong focus on the following aspects of system development that impacted on the success of the system.

A clear need for more intensive user involvement, communication with prospective end users and adequate training on new systems were identified. From a system development perspective, there was a strong request to have end user involvement in the RE as well as the testing phase of new systems. This will also provide end users with an opportunity to take ownership of the system, thereby reducing the notion that the system is imposed on them.

The interview based responses from the 3 PMs alluded to the typically large end user base at SASOL that presents logistical difficulties in terms of obtaining a representative sample of interviews. The typically large end user base at SASOL presents logistical difficulties in terms of obtaining a representative sample of interviews. Also, the time taken to analyse the interviews compromises the development time allocated to the system. There is also the intangible nature of software requirements (Faulk, 1995) that may not be established during interview sessions. SAP and financial information systems may be typical examples. There is also the possibility of misinformation (Appan and Browne, 2012) obscuring the

accuracy of interview sessions. However, the use of workshops, in tandem with interviews allows users to engage with the project team, and clarify any concerns or misunderstandings users may have regarding the proposed system requirements. In such an instance, the interview is not merely a “once-off” event. The use of JAD sessions and prototypes result in the main system requirements being implemented in a basic small version of the proposed system. This allows users to view the user interface design, thereby reducing the abstractionism of the system facilitating the identification of system requirements more accurately. While prototypes are suggested as an effective RE strategy, informed by the analysis of IS 2, the prototype approach only seems to work well if it is included as part of RE strategy that involves high levels of user involvement.

A significant theme emanating from the interviews was that if there is strong management support for a system, the development team were quite willing to make the effort and use resources in order to obtain clear end user requirements. The RE sessions that were iterative and spanned the entire duration of the development life-cycle yielded more success in terms of system usage and end user acceptance of the system.

Hence, a viable response to the question posed regarding success factors of IS implementation at SASOL, is that strong management support coupled with a RE effort that involved iterative techniques comprising of user involvement in all aspects of systems development, would be a reliable predictor of information system success.

### 5.3 Summary of the study

The challenges with the implementation of successful information systems are deeply rooted in the literature (Legris et al., 2003, Cooke-Davies, 2002, Coughlan et al., 2003, Davey and Cope, 2008). The high rate of failed, cancelled or unsuccessful IS projects has been linked to unclear user requirements. Al-Ahmad *et al.*, (2009) observed that in a ranked list of 53 information system risk factors obtained from three panels of IT experts, misunderstanding user requirements was ranked second and inadequate user involvement was ranked fifth. This observation can be aligned to the assertion by Legris *et al.*, (2003) that an emphasis on the RE phase of software development will enhance the prospect of user acceptance and success of the software system. Having established an adequate rationale for the domain area of the study, the researcher decided to delve into the RE process in order to better understand the effectiveness of different RE techniques.

The study itself required a measure of quantification of information system success. However, the amorphous nature of success in an IT intensive environment is well documented (Hwang and Thorn, 1999). Quantifying information system success presented quite a challenge. The strategy adopted in the study was to make use of TAM's variables of PEOU and PU in order to quantify user acceptance of an information system in conjunction with IQ from the ISSM to jointly achieve a measure of information system success. The research design entailed a multiple case study involving three information systems. The study adopted a primarily quantitative approach where the focus was to achieve a quantified measure of information system success for each of the three systems being investigated. A qualitative component was used to establish the type of RE strategy that was used in obtaining requirements for each of the systems. The framework proposed by Nuseibeh and Easterbrook (2000) was used to deductively analyse interview data from the PMs and BAs of each system in order to classify the RE strategy used in the development of each system.

The study established that RE strategies that entailed a higher intensity of user involvement, necessitating a planned and co-ordinated approach to RE, resulted in higher levels of user acceptance the system, thereby classifying the system as successful. These strategies could be listed as JAD sessions, focus group interviews, workshops and to a lesser extent interviews. The study also established that RE strategies that involved a few users over a short period of time did not achieve high levels of user acceptance, thereby rendering these systems as moderately successful. The RE strategy that fell into this category is rapid prototyping. Interviews, classified as a traditional RE strategy, can contribute

significantly to the success of an information system provided it is used in conjunction with group elicitation techniques that are not just a “once-off” event, but occurred consistently during all phases of development.

## **5.4 Conclusion**

From a theoretical perspective, quantification of information system success is not easy to achieve. In this regard, acceptance models such as TAM do serve a purpose. However, the call to extend the dimensions to the TAM model is being made by the research community (Benbasat and Barki, 2007). In this regard the current study made use of a combination of TAM and the ISSM to achieve a quantified measure of information system success. The variables underpinning the model exhibited sufficient content and construct validity to warrant further testing of the model in other studies with a similar agenda.

From a problem domain perspective, the influence of the RE strategy to elicit user requirements in the development of an information system has been the subject of discussion by methodology experts on the basis of intuition and experience. There is a dearth of empirical information that can attest to this claim. This study has made an endeavour to address this problem by providing empirical evidence that the RE strategy used in the development of an information system is pivotal in ensuring user acceptance of that system and overall success of the system. This study has also revealed that group intensive sessions employing a combination of RE techniques would be an ideal recommendation to ensure information system success from the perspective of user acceptance. The significance of this outcome is that the conclusion has been reached on the basis of empirical evidence that has been presented in this study, something severely lacking due to the difficulties attached to conducting research on RE (Cheng and Atlee, 2007). The qualitative data obtained by virtue of the interviews and open ended questions alluded to the need to have more involvement of super-users and key stakeholders such as line managers during the RE process. There was also a strong focus on the need for training sessions as well as better communication regarding the objectives of each system. The impact and influence of users on an IS should not be underestimated, as these are the domain knowledge experts.

An effective way of involving the domain knowledge experts is by engaging them as part of the RE process in JAD sessions, focus group sessions and workshops. Interviews and prototypes lose their effectiveness if not implemented as part of an intensive user involvement strategy. As a concluding



remark, the relevance of RE and user involvement in the software development process is now regaining impetus under the framework of Agile software development methodology. The Agile methodology is constructed around the principle of JAD and prototypes and consists mainly of group elicitation techniques, an approach aligned strongly to the outcome of this study.

## **5.5 Limitations and Recommendations for Future Work**

The lack of proper analysis of the interview data obtained from the BAs and PMs would be regarded as a limitation of the study. However, the comprehensive quantitative analysis detracted and compromised the researcher's efforts with regards to the qualitative aspect of the study. Whilst it would have been ideal to establish a link between the RE strategy and the business value obtained by the BAs, this did not form part of the main essence of this study.

Another limitation is that the multiple case study approach would have been ideal if all 3 systems were identical in nature, thereby resembling an experimental research design. However, the logistical impediments that would be encountered did not make it feasible. Also, the voluntariness of system usage could have had an impact on the outcome of the study and this aspect could be factored into future studies with a similar agenda.

Whilst it is acknowledged that the study has limitations with respect to the handling of the many variables that could add complexity to the problem domain, it is envisaged that this research effort will serve as a catalyst for future research efforts in the domain of RE thereby "covering the gaps" left by the limitations of the current study.

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## Appendix A: The Research Questionnaire

### INFORMED CONSENT DOCUMENT

#### Dear Participant

My name is Vedantha Kundalram and I am a Service Delivery Manager in the Information Management Department. I am currently working on a research project that aims to investigate the effectiveness of the RE strategies used on the success of information system projects implemented at SASOL.

RE involves the process of obtaining requirements for a new system from a select group of stakeholders. These requirements are obtained during various group sessions and meetings with the main stakeholders involved in the new system.

Participation in this study is voluntary. Your participation however would be appreciated, as your input will contribute and add value to the proposed research. All information will be kept confidential and any comments and suggestions made by you will remain anonymous.

Completed questionnaires will either be collected by myself or can be emailed to [vedantha.kundalram@SASOL.com](mailto:vedantha.kundalram@SASOL.com)

Kind Regards

Vedantha Kundalram

Office: +27 11 344 3610

Fax +27 11 219 2814

Mobile +27 82 805 5219

Email [vedantha.kundalram@SASOL.com](mailto:vedantha.kundalram@SASOL.com)

**General Instructions**

Please read and complete the following questionnaire. Please note answers to this questionnaire will be kept anonymous. In those sections where options are provided, please indicate your response by making a cross (X) in the boxes provided.

**PART 1: Demographic Details**

<b>Job Title/Position</b>		
<b>Department</b>		
<b>Gender</b>	MALE	FEMALE
<b>Age</b>		

**PART 2 (Perceived Ease of Use of the System, Attitude towards System Usage Intention to use the System):**

*In this section, please provide your response with respect to the following statements concerning usage of the information system.*

1. It is easy to learn how to use the system.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

2. It is easy to become proficient in using the system.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

3. It is easy for me to recover if I make a mistake whilst working with the system.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

4. I am able to understand the functionality of the menu options available.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

5. The system responds in a timely manner to my processing requests.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

6. The system is error prone.

Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
-------------------	----------	---------	-------	----------------

7. The system increases my work productivity.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

8. The system improves the quality of my work.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

9. I enjoy using the system.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

10. I intend to use the system regularly at work.

**PART 3 (Information Quality):**

*In this section, please provide your response with respect to the following statements concerning the quality of the information obtained from the system.*

11. The system provides meaningful output.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

12. The system supplies accurate information.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

13. The information supplied by the system is relevant and necessary for my work requirements.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

14. The system is able to present information in different formats.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

15. The system can exchange information easily with other systems.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

**PART 4 (Information System Development & Installation):**

*In this section, please provide your response with respect to the following statements concerning the development and installation of the information system*

16. How would you rate your involvement in identifying requirements for the information system?

Excellent	Good	Satisfactory	Fair	Unsatisfactory
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17. How would you rate your involvement in testing of the information system?

Excellent	Good	Satisfactory	Fair	Unsatisfactory
-----------	------	--------------	------	----------------

18. How would you rate the options available so that you could provide feedback regarding your interaction with the system?

Excellent	Good	Satisfactory	Fair	Unsatisfactory
-----------	------	--------------	------	----------------

19. How would you rate the training that you received on using the system?

Excellent	Good	Satisfactory	Fair	Unsatisfactory
-----------	------	--------------	------	----------------

20. How would you rate the support that you receive in using the information system?

Excellent	Good	Satisfactory	Fair	Unsatisfactory
-----------	------	--------------	------	----------------

**PART 5:** *The following questions are aimed at obtaining your opinion on the **general use of information systems** in your daily work routine.*

21. I am generally happy with the information systems that I use.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------



22. I think that the information system quality will improve if there is more user involvement in the development of the system.

Strongly agree	Agree	Neutral	Disagree	Strongly disagree
----------------	-------	---------	----------	-------------------

23. Rank the following aspects of information system quality that you would prioritise. You should rank the most important item as 1, the next in importance as 2, and so on, until you have ranked each item 1,2,3,4, or 5. *Please refrain from duplicate ranking i.e. do not use the same number more than once to rank an item.*

Aspect	Ranking (1,2,3,4, or 5)
The system provides quick responses	
The system provides correct responses	
The system is easy to use/user friendly	
The system makes aspects of my job easier to do	
The system is not error prone	

24. Please provide any comments/opinions that may help towards the improvement of the quality of information systems developed within SASOL.


*Thank You for Your Participation*

## **Appendix B: The Interview Questions**

### **INFORMED CONSENT DOCUMENT**

#### **Dear Participant**

My name is Vedantha Kundalram and I am a Service Delivery Manager in the Information Management Department. I am currently working on a research project that aims to investigate the effectiveness of the requirement elicitation strategies used, on the success of information system projects implemented at SASOL.

Requirement elicitation involves the process of obtaining requirements for a new system from a select group of stakeholders. These requirements are obtained during various group sessions and meetings with the main stakeholders involved in the new system.

Participation in this study is voluntary and you are free to withdraw from the study at any stage for any reason. Your participation however would be appreciated, as your input will contribute and add value to the proposed research. All information will be kept confidential and any comments and suggestions made by you will remain anonymous.

Kind Regards

Vedantha Kundalram

Office: +27 11 344 3610

Fax +27 11 219 2814

Mobile +27 82 805 5219

Email [vedantha.kundalram@SASOL.com](mailto:vedantha.kundalram@SASOL.com)

**General Instructions**

Please note your responses during this interview will be kept anonymous. You may request clarification or repletion of the question during the interview. There is no time limit set for answering a particular question or for the duration of the interview session. It is advisable to complete the interview in a single sitting.

**PART 1: Demographic Details**

- State your name, title and position within the company.
- Please confirm the project you were the Business Analyst / Project Manager for.

**PART 2:** *General feedback on the requirement elicitation techniques used during the project.*

1. Which methods were used to elicit the requirements for the new system?

	Prototypes
	Questionnaires
	Use Cases
	Interviews
	Other. Please specify.

2. Is there a certain technique favoured for requirement elicitation exercises?
3. Why is this technique favoured?
4. Rate the level of problems or challenges experienced with the elicitation of requirements.

High	1	2	3	4	5	Low
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5. Describe these challenges or problems.

6. How many requirements gathering sessions did you have before the requirements were fully elicited, understood and signed off?

One Session	Two Sessions	Three Sessions	Four Sessions	More than Four Sessions
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7. Rate the level of involvement of the stakeholders during the project.

High Involved	1	2	3	4	5	Not Involved
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8. Rate the level of involvement of the users in the requirement elicitation session.

High Involved	1	2	3	4	5	Not Involved
---------------	---	---	---	---	---	--------------

9. Rate the level of communication to the users during the development of the system.

High	1	2	3	4	5	Low
------	---	---	---	---	---	-----

10. Rate the importance of communication to users during the SDLC of the project.

Very Important	1	2	3	4	5	Not Important
----------------	---	---	---	---	---	---------------

11. Rate the importance of user training during the implementation of the project.

Very Important	1	2	3	4	5	Not Important
----------------	---	---	---	---	---	---------------

**PART 3:** The following questions are aimed at obtaining your opinion on various techniques and factors relating to the SDLC of information systems. Please respond to them as honestly as possible.

12. What do you consider to be the main factors contributing to the success of information systems?  
Why?

13. What techniques do you find more effective for requirement elicitation, when in challenging or difficult requirement elicitation sessions?  
Why?

*Thank You for Your Participation*

## Appendix C: Approval from SASOL Information Management

August 2012

Dear Heather,

### **Request for IM approval to proceed with research survey.**

I am currently registered for a MComm in Information Technology at the University of KwaZulu-Natal. My research project aims to investigate the effectiveness of the requirement elicitation strategies used, on the success of information system projects implemented at SASOL. Questionnaires and interviews will be issued to obtain the required information from company employees. The questionnaires and interview questions will be reviewed by the Ethical Committee at UKZN to ensure the questions are fair and do not compromise the integrity of SASOL or the respondents.

Kindly approve request to proceed with the proposed research study and distribution of surveys to employees in SASOL. The IP Group has advised that Level 3 approval is required for research studies.

The final research report and research findings will be submitted to the Information Management department and the Intellectual Property Department at SASOL for review prior to final submission to UKZN.

IM Approval



16 AUG 2012

Heather Fuller

Date

General Manager IM: Services

Functional Core Division IM Group Services

+27 11 344 3264

[heather.fuller@SASOL.com](mailto:heather.fuller@SASOL.com)

17/01/2013

Dear Heather Fuller,

**Request for IM approval for Vedantha Kundalram to proceed with submission and publication of research findings from case study on Sasol IS Projects.**

Thank you for your approval granted on the 16<sup>th</sup> August 2012 to proceed with data collection for a postgraduate research study. The study entitled “*Requirement Elicitation as a predictor of the success of IS Projects,*” examined the requirement elicitation strategies used for IS Projects implemented at Sasol as well as the users feedback on the components of the particular information system. The data has been analysed and included in the research report. The final research report is now ready for submission to the University of Kwa-Zulu Natal for a master’s degree.

As per discussions with Senior Chief IP Technical Advisor Luis Dancaurt (082 804 0245) from Sastech Intellectual Property Group, a level 3’s approval is required to submit the research report to the university. Once your approval has been received, the IP Group will review the research report ensuring that no Sasol IP is being published in the report.

Kindly review and or approve request to proceed with the submission of the research report to the IP Group, and UKZN.

IM Approval



21/01/2013

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Heather Fuller

Date

General Manager [IM:Services](#)

Functional Core Division – IM Group Services

+27 11 344 3264

[Heather.Fuller@sasol.com](mailto:Heather.Fuller@sasol.com)

## **Appendix D: Main success factors of IS**

### **(Question 24 of the questionnaire and Question 12 of the interview)**

#### **From the perspective of users of the information systems:**

The results of the open ended Question 24 of the survey to determine the main success factors of information systems developed at SASOL, from the perspective of users, is summarised below. This information is derived from the actual users of the 3 Information Systems (ITMS, SAP RPM and Service Catalogue).

- Increased support to contact IT personnel when a problem or error is encountered on an IS.
- Regular training sessions, if required by users. Once off training sessions may not be sufficient to get users comfortable using a new system. Training programmes should be improved and more hands on than a presentation.
- Include internal personnel in the training sessions, and not just external consultants. Users may feel less like it is a system imposed on them if the facilitators are internal employees.
- Obtain more user inputs during software development. Increased user involvement will result in a more efficient system. Involvement of users during the RE Process should increase. User involvement in the development of the information system is critical. It is not logical to develop a system for the users without consultation with the end users.
- Information System should be user friendly and easy to use. Currently information systems are too complex and not user friendly. The inclusion of usability heuristics could improve the way IS are designed.
- Implementing an error free system will impact on the success of the IS. Sufficient testing should be completed to implement a bug free system.
- Information Systems should be client driven and developed with client support, interaction and engagement. Systems appear to be designed to suit the needs and purposes of the project sponsor or system owner, and not the users.
- The information in the IS must be applicable to users, easy to understand and not using technical jargon.
- Significant comments were received regarding errors with the system. Some users accounts were locked, some line managers were unable to retrieve and arove their subordinate's documents on the system. Errors have to be reported and are only resolved a few days later. If users experience



any errors on the system, they are required to report the error in an email to a support team. A contact line with support staff manning the telephones and offering immediate support to users would have been more beneficial.

- The search functionality on Information Systems is important and should function efficiently.
- Navigating through the Information Systems should be intuitive.

**From the perspective of business analysts and project managers:**

The results to the interview Question 12 to determine the main success factors of information systems developed at SASOL, is discussed below:

- A strong sponsor or project champion can have a significant impact on the success of an IS. The role of the sponsor or champion is to harness support for the IS from managers who in turn filter the support to other users in the organisation. This is accomplished in a top down approach. Users see the support of the managers for the IS and user acceptance improves. If the executive committee of the organisation can offer support on IS Projects impacting the entire organisation, the buy in from lower levels will improve and user support for the system will increase. This will also alleviate the need for the project team to conduct detailed communication to all users. Communication will be covered during department coffee sessions, group meetings and road-shows. This has a significant impact on the buy in from users in SASOL and directly affects the use of the IS.
- Stakeholders and users with relevant business knowledge is another important factor contributing to the success of Information Systems. User acceptance is critical to the success of IS implementation as highlighted by two of the three project members interviewed.
- Fit for purpose is a critical ingredient for IS success. This includes the integration of the end to end value chain which the new IS is commissioned to support and or automate. An integrated process offers greater advantages and has a higher chance of integration in the gap areas identified. The processes and supporting processes need to be defined and automated, as reliance on human intervention adds to the complexity and subjectivity of the process. This is especially critical in HR matters and talent management of employees.
- The rollout of the IS is important. Awareness on the IS Project should increase towards to end of the software development and commencement of the implementation phase. Communication is critical via email, posters, road shows, newsletters and departmental meetings. One of the IS Projects was HR related and impacted a significant number of users in the organisation. Each department in SASOL has a human resource consultant (HRC), and communications on the IS

Project was delivered through the HRC's in the organisation. This ensures communication is filtered down to even those users who do not have access to emails. Short information sessions can also aid in raising awareness on the IS project as well as message pop ups on the PC's.

- An interesting success factor was openness on the part of managers and their willingness to explore different options and innovative ways of addressing requirements and solving problems.
- Enterprise Architecture was deemed a critical success factor to IS Projects. The enterprise and infrastructure in SASOL needs to be designed and maintained in order to support the IS systems during software development, testing, implementation and operations.
- The skill set of the core project team is an important success factor. The project team, BA, PM and key stakeholders must have a clear understanding of the problem statement and the user requirements. This forms a solid basis and foundation from which to work from, and build an IS that addresses the need and the problem statement.
- Communication was highlighted by all PMs and Bas as a critical success factor in an information system project. Communication needs to be amongst the project team, key stakeholders, business managers and the end users. Communication needs to be tailored to the target group. For example communication updates to the managers and end users will be high level overviews, whilst communication amongst the project team will be detailed. Communication is important to ensure individuals are aligned with the purpose of the project, the requirements the system will address and the progress on the development of the system; amongst others.
- Training on the IS is important to get users comfortable with using the IS, especially if the application is slightly complex. Training manuals and contact numbers for user support should be made available to the users.
- Buy in and support from end users and stakeholders is critical to the success of IS projects and the implementation thereof.

## **Appendix E: General feedback on RE techniques used (Questions 1, 4, 5 and 6 of the interview)**

The feedback received from the BA's and PM's on the RE techniques used during the projects is listed below.

Question 1 of the interview examined which methods were used to elicit the requirements for the new information system. Interviewees could choose between prototypes, questionnaires, use cases, interview and specify any other technique. The following responses were obtained:

- Interviews were commonly used to elicit requirements during the RE process for IS projects implemented at SASOL. Workshops and scenarios were also utilised during RE. Scenarios were useful when the system required technical details for example SAP applications. Requirements were obtained from users, and gaps in the requirements were also identified during RE. This improved the users, stakeholders and BAs understanding of the requirements and which areas required further workshops to confirm and validate the requirement gaps. Workshops worked well for stakeholder engagement with the project team and developers.
- Brainstorming sessions were also used to gather requirements. After the brainstorming session, workshops were used to elicit requirements per process/stream identified. Requirements identified as “quick –wins” was also used to deliver urgent systems in a shorter development time.

Question 4 of the interview required interviewees to rate the level of problems or challenges experienced with the elicitation of requirements. Ratings ranged from 1 to 5 with 1 being “high” and 5 being “low”. Question 5 required the interviewees to describe these challenges or problems. The following responses were obtained for Question 4 and 5:

- The challenges and problems experienced with eliciting requirements were rated as medium to high. The BAs and PMs experienced challenges engaging with the service providers to the organisation. Eliciting valid requirements from the users and stakeholders of the proposed IS was difficult. Users cannot provide clear requirements during the first RE session with the project team. A number of refinements and review sessions are needed before clear and well defined requirements are elicited. Consensus amongst the users and stakeholders on the requirements can

also be a challenge. This could be the main reason for having a smaller core project team consisting of limited users and stakeholders. The more individuals involved in the project, the greater the effort on validating and verifying requirements, and reaching consensus amongst the group.

- Steering committees were highlighted as a critical component in IS projects. These committees assist in review sessions, signoff sessions, provide support for the project and assist in creating alignment amongst all the stakeholders.
- The challenges with eliciting requirements increased with the complexity of the requirements and proposed system. The IS implemented using SAP experienced very high level of challenges due to the number of users impacted by the IS, the complexity of consolidating 23 payroll and HR systems into one application, business culture and political climate in the organisation. Visible upper management support or a champion for the IS was highlighted as an important component to drive the project and gather acceptance and support on the project from business. Certain IS projects are dependent on the delivery and implementation of other projects running in the environment. One of the IS projects this survey was based on, experienced a crisis when a supporting project whose successful implementation impacted this IS project, was placed on hold due to complexity and resource constraints. Project dependence on other projects for successful implementation should be highlighted as a risk and managed accordingly. If risks increase during the SDLC, mitigation factors should be executed.
- Stability of the IT infrastructure and data integrity of information in the data warehouses is important for IS projects. The IT infrastructure and data integrity are critical components that feed into the IS and support the applications and servers upon which these IS's reside. It is important to focus on the project and successful delivery thereof. The BA and PM need to be aware of the other factors that can potentially impact the IS. Unique applications, scientific application and manufacturing execution systems (MES) used in the production environment introduce complexity into the project. These applications are non-standard and have to be clearly defined.
- Pressure to deliver a working solution in a short frame of time was a significant challenge faced by two of the three BAs interviewed.
- Problems were experienced with change management. Change management was considered a critical component impacting the success of IS projects from the BAs and PMs perspectives and experience with IS project at SASOL.

- Politics was introduced as a challenge in the RE process at SASOL. SASOL is a very structured organisation with a top down management approach. Approval is required from various areas and departments before projects can be initiated and execute the SDLC process. SASOL is a large corporate organisation positioned globally. There is a Project Management Office (PMO) Centre of Excellence (COE) created to manage projects in the environment. The IM department also manages projects and the engineering fraternity as well. Two or more projects of a similar nature may be executing concurrently, but the requirements may be for totally different departments and politics may arise due to this. For example the one IS project in the research study was commissioned to cater for resource and portfolio management of BAs in the IM fraternity. A similar project was running in SASOL to create a project management system, incorporating reporting and resource portfolio management for engineering and scientific projects. The requirements are similar but the areas in which the system will be implemented are vastly different. Politics impacted the projects in terms of whether the IM RPM project should continue or be cancelled and accommodated as part of the other project.
- Integration issues with applications in the environment was raised as a challenge in the RE process. SASOL has adopted a motto of “One SASOL Way” to create consistency in the organisation. Such an approach reduces integration issues as all development follows a single standard. Systems can easily be interchanged or integrated due to standard development and compatibility across the organisation.

Question 6 of the interview investigated the number of requirement gathering sessions the BA’s conducted before the requirements were fully elicited, understood and signed off. The responses below were received for Question 6:

- A number of RE sessions are conducted before requirements are clearly understood and well defined. Steering committees and prototypes are often used to clarify requirements and reach consensus amongst the stakeholders and project team. The number of RE sessions depended on the complexity of the system. The HR system implemented on SAP and catering for all users in the organisation went through a lengthy RE Phase. Initial RE sessions were held with the users and stakeholders. RE sessions were then held for each process identified in the proposed system. Sessions were held to validate the requirements over a period of three to five days, per module to be implemented for the proposed IS. The RE phase of one IS Project lasted between five to six weeks due to the complexity of the proposed system. It is encouraging to note, the RE phase was

so lengthy and not shortened to deliver a solution faster. The project team emphasised the importance of correct, clear and well defined requirements.

- The second IS Project investigated had a number of iterations of the RE process. More than four sessions were used to gather requirements. The initial requirements gathered formed part of the general requirements, followed by detailed requirements and finally technical requirements. Such an approach ensured clear understanding of the requirements by all stakeholders.
- The third IS Project investigated in this research study conducted more than four sessions to gather the requirements. The proposed IS increased in complexity as more RE sessions were conducted. With each RE session, the understanding of the different processes and the relationships thereof improved. Gaps in the requirements and subsequent processes were identified through the detailed emphasis on the RE process. The amount of time invested in RE for all three IS projects were significant. This implies that the petrochemical companies IS projects are aligned with the findings and recommendations in literature on the SDLC.
- An interesting technique found to be effective for RE in challenging situations, as per feedback from the BAs, was empathy. Users respond much better if they feel IM or IT is one their side and has the user's best interests at heart. Consequence management is another effective technique in challenging RE situations. Stakeholders, users and sponsors need to realise the consequences of their actions on the project scope and delivery of the IS. The longer users and stakeholders take to sign off on the requirements documents, the longer the SLDC will take resulting in a longer waiting period before the final system is implemented.
- Prototyping was identified as effective for RE when in challenging RE sessions. Prototypes assist users, stakeholders and the requirements engineers understand the requirements of the proposed system as the prototype is a conceptual model of the requirements of the envisaged system. Frequent face to face engagement sessions with stakeholders and the project team can also aid in resolving challenging RE sessions. Discussion forums with the process owners and end users can improve understanding and facilitate communication amongst the project team and end users.
- A BA commented that users can no longer be considered IT illiterate. Technology has become a part of daily operations in one's work, private, social and family life. The previous conception was IT is understood by IT people and end users are not IT experts. This preconception has changed. Users are now becoming subject matter experts of systems, regardless of an IT background or not. For a BA to be an IT generalist, is no longer adding as much value to business as before. All users are becoming IT generalists, and the BAs and project members need to

improve their skills to become IT specialists or experts, else business will not see the need or value in having an IM department with IT generalists.

- Simplifying requirements can assist in aligning users and stakeholders on the requirements. Reviewing and testing requirements is critical to ensure the correct requirements are being addressed; the requirements scope of the information systems is clear and well defined.
- Agreeing on a problem statement was highlighted as an effective way of handling challenging RE sessions. A problem statement is a concise brief statement on the nature of problem and highlighting the need for the IS.

## **Appendix F: General feedback user involvement in IS Projects**

### **(Questions 7 - 11 of the interview)**

This section provides the feedback on the users involvement in IS projects. The questions can be found in Appendix B. The results to the five interview questions to determine a possible relationship between user acceptance and the RE strategy used for software development is summarised below:

- The stakeholder and user involvement in two of the three IS Projects was rated as low to medium. This was attributed to availability of the stakeholders and users. Stakeholders include the project sponsor and or project champion. These individuals are generally high level managers in the organisation and are not easily available. The one IS Project investigated had requested additional users to include in the project. User's availability was also problematic. Users are more likely to be involved in the user acceptance testing (UAT) of the IS.
- One IS Project rated the involvement of stakeholders during the SDLC as highly involved. However the end users had low involvement in the RE sessions for the IS Project. This project was an initiative from the companies Information Management (IM) Manager, designed to automate and consolidate the process of ordering IT services and hardware for all users in the organisation. The users involved in the RE process included largely IM users and not corporate end users. Communication to the users during this project was very high. Banners, posters and emails were used to inform users of the project.
- The level of communication to the users during the development of the system was low during the development of the SAP RPM System. Business consultants and managers were included in the communication, but not the core end users. This approach was followed until the IS Project neared deployment. Communication to the end users increased towards implementation of the IS.
- The project to develop the ITMS System rated the level of communication to users during the as very high. The information was filtered in a top down approach with managers required to distribute information to the users. There was an instance of one department which refused to filter information to the users. The department did not want to be accountable and responsible for the communications and the IS Project. The department did not want to take accountability for possible delayed implementation of the project or problems with the system.



- The importance of communication to users during the SDLC of the project was rated as medium in two of the three IS Projects. BAs and PMs felt it was important not to over communicate to users as users can tire of the relentless communication and not take heed of critical updates. The approach is to communicate to users when needed at a high level. It is also important not to commence communication too early in the project as the project may be delayed, the scope may change or the project may be halted due to constraints (time, resources and subject matter expert's).
- The third IS Project rated the importance of communication to users during the SDLC as very important. Communication to the end users' needs to be constant, understandable and issued regularly during the SDLC. Communication is critical to the success of an IS and to obtain user acceptance of the system. The frequency of communication will intensify as the project progresses to implementation. Different means of communication on different levels should be considered such as high level feedback to managers or detailed communications on the use of the system to the end users. Emails, posters, visual presentations, and road shows can be used as forms of communication. In all methods of communication there are email and telephone contacts for users to contact the project should users have any enquiries. This facilitates two way communications.
- The communication to the end users should identify the problems and inefficiencies with the previous process and highlight the positive aspects of the new IS system designed to resolve the problems and inefficiencies identified.
- The importance of user training during the implementation of the project was rated as very important in all three IS Projects. Users need to be comfortable using the system and should complete actions on the IS efficiently and effectively. Training will depend on the nature of the application. The ITMS System was aimed at the Performance Appraisal documents for employees. Training and communication to users on the automation of the process was critical. Training sessions were conducted in small groups consisting of 12 to 15 users.
- Due to the sheer volume of users to be trained, the Service Catalogue Project utilised online training, self-service, and training with the relevant IM / IT personnel included in the process. The training sessions were demonstrated to the IM Managers for their inputs prior to training being rolled out to all employees.
- King III specifies user training as critical in the SDLC. Training can be facilitated via online guides, training manuals, competitions and awareness sessions. The Service Catalogue System designed to automate the ordering of IT services and equipment included the installation of a

shortcut to the IS on every users desktop in the organisation. The icon for the system was a green shopping trolley and symbolised users purchasing new IT Services. Users will only make use of the system if they require an IT service.

## **Appendix G: Interview feedback on effective RE strategies (Questions 2-3 of the interview)**

Questions 2 and 3 of the interview were designed to elicit information on the effective RE strategies and techniques used during the SDLC. Question 2 of the interview examined if there is a certain technique favoured for requirement elicitation exercises. Question 3 of the interview examined why the technique, mentioned in Question 2, is favoured.

The results obtained for Questions 2 and 3, is summarised below:

- SASOL's Business Development and Integration (BD&I) Model developed, patented and designed to be adaptable to any project from GTL, CTL, engineering, chemical, construction to IS, was closely adhered to. This model defines most of SASOL's critical projects and incorporates lessons learnt, best practices and mandatory documents during each phase of the project.
- Prototypes were used in 2 of the 3 IS Projects investigated in this research project. Prototypes proved valuable in complex projects such as SAP applications, involving the integration of a number of models and applications. The remaining IS Project followed the traditional SDLC of requirements, functional specification document and feasibility assessments of various applications before the solution moved into basic development, execution and implementation.
- The BAs met with stakeholders and matched requirements to technical functionality of shortlisted applications. RICEFW was used in the ITMS Project and is a consolidated requirements list. RICEFW represents Reports Interfaces, Customization Enhanced Forms and Workflows. This list was used throughout the project to track and manage requirements. This list allowed for business processes to be validated against requirements and functionality.
- Workshops were identified as a technique favoured for RE in two of the three IS Projects (Service Catalogue and SAP RPM). Small, frequent workshops are valuable in obtaining and clarifying requirements. One of the lessons learnt from one IS project was to include more users in the RE process. These users should represent the actual users of the proposed systems, as the end users and business owners have different perceptions and viewpoints on processes and the integration thereof. Process maturity was highlighted as a critical success factor in projects. Processes need to be well defined, clearly mapped and well documented. Projects may rely on existing processes in the organisation, only to discover later in the project the processes are not as clearly defined and implemented as initially thought.

- The BA on the ITMS Project emphasized the importance of different RE techniques being suitable in different environments. Users at SASOL include blue collared and white collared workers, ranging from coal miner to post-doctoral scientists. It is crucial to understand the user base, the department or business unit within which the system will be implemented the culture that exists with the users and the skills level of the workers. Different RE techniques will be used depending on the factors above. A workshop may be useful to elicit requirements from knowledge workers in the office environment, whilst coffee sessions will facilitate discussions with miners on what functionality they would require from a new IS.
- SASOL has a motto of “One SASOL way” which aims to guide the organisation to a single, shared standard way of developing systems and processes. This aims to allow SASOL to leverage of its current applications for similar requirements or processes, reducing development costs in the organisation.

## Appendix H: Screen shots of the three information systems

- Information System (IS) 1 – Integrated Talent Management System (ITMS)

The screenshot displays the SASOL Integrated Talent Management System (ITMS) portal. The browser address bar shows the URL <http://gep.sasol.com/rij/portal>. The page features a header with the SASOL logo and the slogan "better together...one team, One Sasol". A navigation menu includes "Home", "Employee Services", "Governance", "Functional Cluster", "Energy Cluster", "Communities", and "SAP Systems". The "Employee Services" menu is expanded, showing options like "ess", "mss", "Sasol Functional Catalogue", "Sasol Green", "Generic Services", "HR Employee movements", "M Services", "Travel Management", and "Sasotech".

The main content area is titled "performance management" and includes a "Close" button. Below this, there is a "Status Overview" section with tabs for "In Preparation (0)", "In Planning (0)", "In Review (0)", "In Process (0)", and "Completed (2)". A "Show Quick Criteria Maintenance" button is also present. The main table displays appraisal documents with the following data:

View	Status	Substatus	Appraisee Name	Appraisal Document Name	Period	To	Offline Info	App.Document Type
	Completed		Poppy Julia Mathibela	<a href="#">02 Manage Self Technical Professional</a>	01.07.2012	30.06.2013	<a href="#">Download</a>	Appraisal Document
			Revesh Deepraj	<a href="#">01 Manage Self Operational</a>	01.07.2012	30.06.2013	<a href="#">Download</a>	Appraisal Document

(SASOL, 2012a)

- Information System (IS) 2 – SAP RPM System

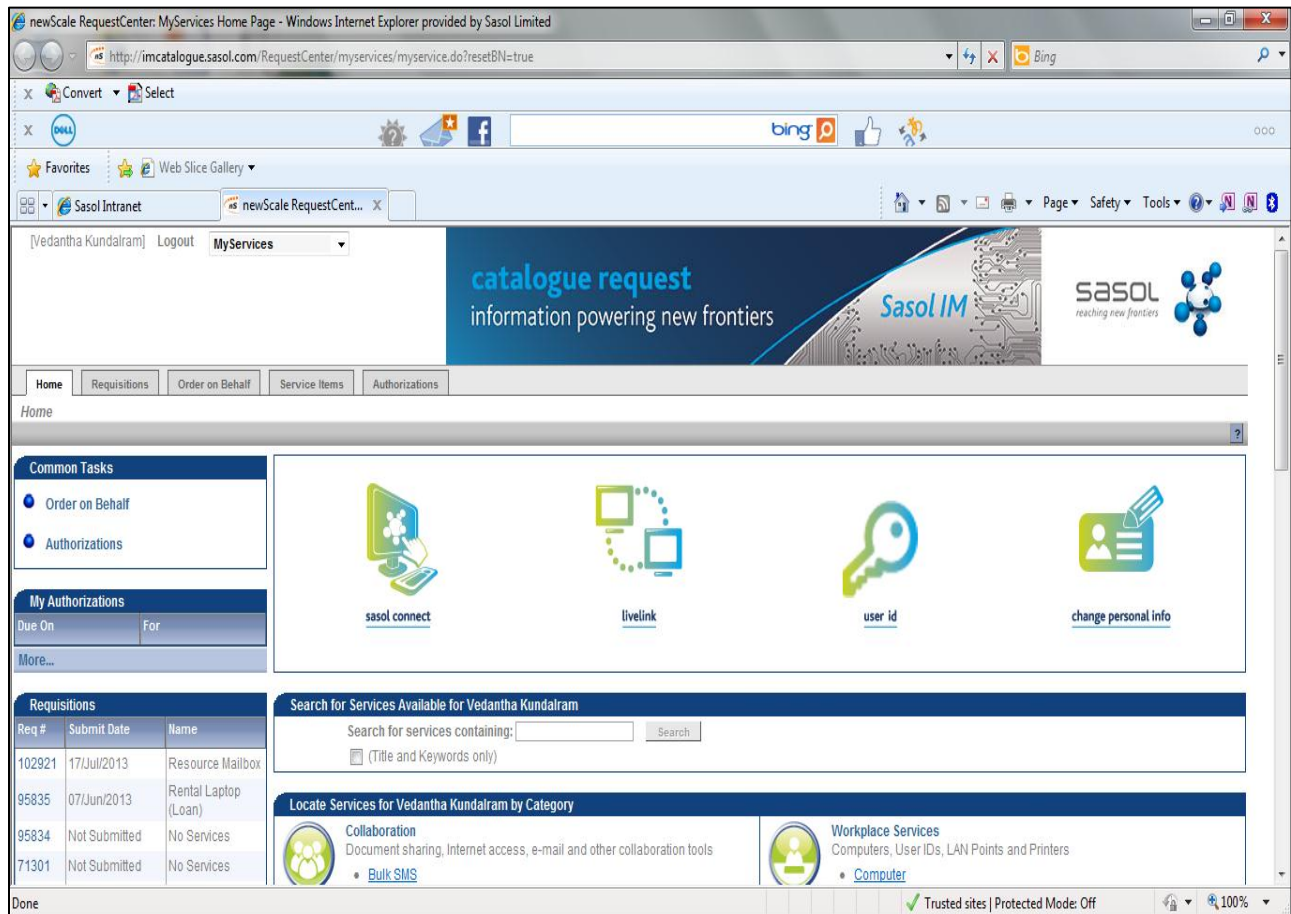
The screenshot displays the SASOL SAP RPM System interface. At the top, there is a header with the SASOL logo and the slogan "innovation for people". Below the header, there is a navigation bar with tabs for "Portfolio Management", "Business Context Viewer", "Sasol RPM Ranking Scoreboard", and "RPM Toolset". The main content area shows a "Portfolio Sasol Portfolio" view with a table of initiatives. The table includes columns for Bucket Name, ID, Name, Status, Net Present Value, Next Project Gate, Planned Start, Planned Finish, Phase Name, Portfolio Data Quality, and Planned Cost. The table is filtered by "Dawie's BU view" and shows 10 rows of data. A sidebar on the left contains navigation options like "Detailed Navigation", "Portfolio Structure", "Classification Hierarchies", "Portfolio Items", "Portfolio Initiatives", "Reviews", "Collections", "Services", "User Settings", "Search", "Substitutes", and "Portal Favorites".

Bucket Name	ID	Name	Status	Net Present Value	Next Project Gate	Planned Start	Planned Finish	Phase Name	Portfolio Data Quality	Planned Cost
Sasol Infr...	002622	Ammonia...	REL	7.270.289,00	Gate 5	01.08.2012	27.07.2013	Execution ...	Green	2.500.000,00
Informatio...	003433	Int Blueco...	ECNL	0,00	Gate 3	01.01.2013	28.06.2013	Feasibility	Red	750.000,00
DMAIC's C...	000706	LDV dame...	REL	0,00	G7	13.04.2010	30.06.2012	Evaluation 1	Red	0,00
IM Archive	002298	MULTIMED...	CNCL	0,00	Gate 0	01.06.2012	24.08.2012	FEL Phase	Red	0,00
COMPLET...	001280	Provide e...	REL	0,00	G7			Evaluation 1	Red	0,00
MB_OE	000333	Reduce lo...	REL	0,00		31.05.2010	25.06.2010	Clarification	Red	0,00
COMPLET...	000603	Remote FIL...	REL	0,00		15.06.2010	30.06.2012	Evaluation 1	Red	0,00
Sasol Gas	003590	1 Custom...	PROP	0,00	Gate 2	01.04.2013	31.03.2014	Front End ...	Yellow	0,00
Sasol Gas	002530	1 Master ...	PROP	0,00	Gate 2	01.01.2013	30.06.2014	FEL Phase	Yellow	15.000.00...
Sasol Gas	003275	1 Project ...	PROP	0,00	Gate 0	12.11.2012	31.10.2014	Feasibility	Yellow	18.000.00...

Last Refresh: 22.07.2013 08:01:40 CET Refresh

(SASOL, 2009)

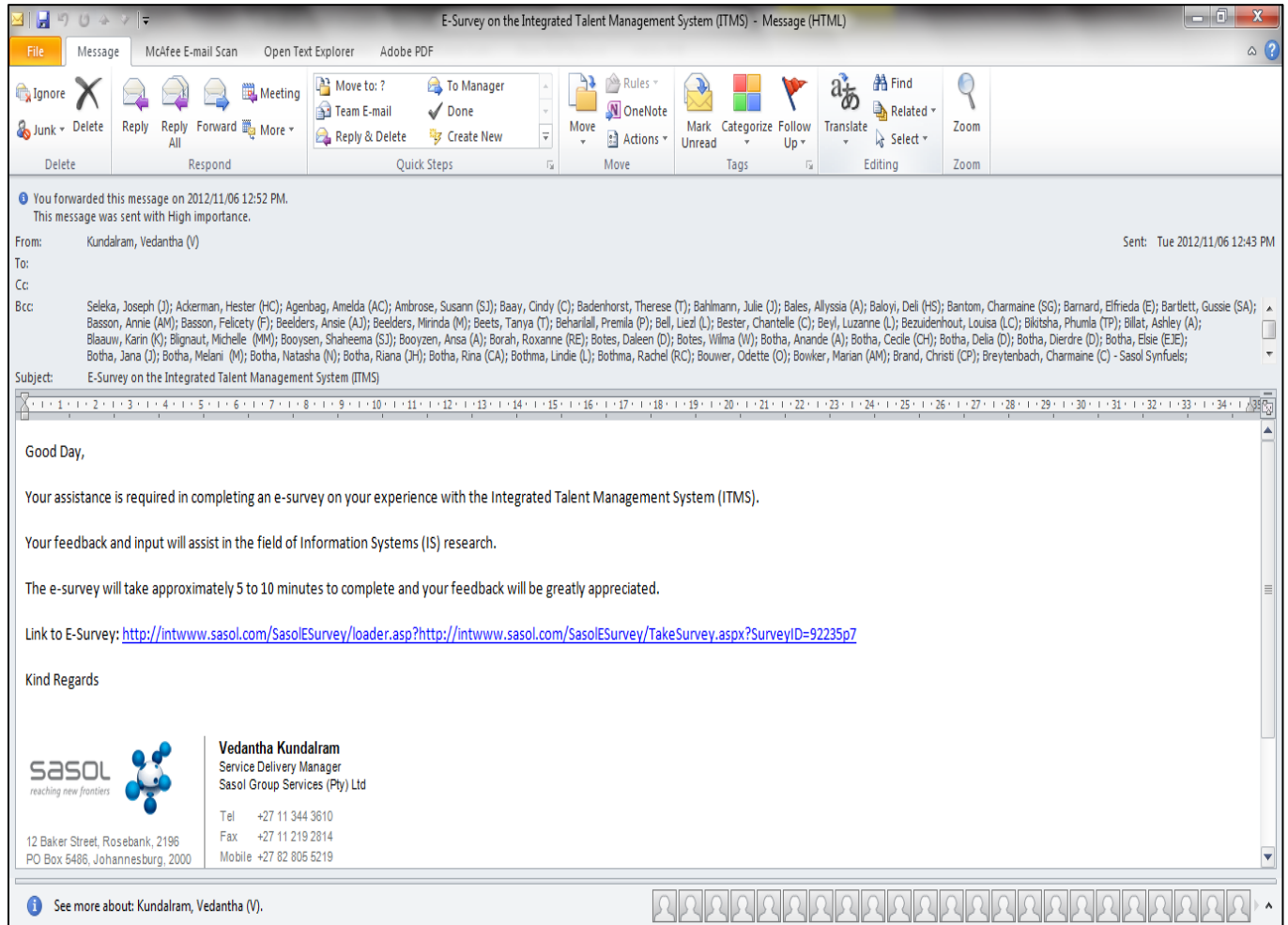
- **Information System (IS) 3 – Service Catalogue System**



(SASOL, 2012b)

# Appendix I: Screen shots of the emails issued to users to complete questionnaire

- Information System (IS) 1 – Integrated Talent Management System (ITMS)





- Information System (IS) 2 – SAP RPM System

E-Survey on SAP RPM - Message (HTML)

You forwarded this message on 2012/10/29 12:05 PM.

From: Kundalram, Vedantha (V) Sent: Mon 2012/10/29 12:04 PM

To:

Cc:

Bcc: Alberts, Andre (A); Barkhuysen, Mina (JE); Birkenstock, Dittmar (DC); Botes, Wilma (W); Bal, Jane (JB); Otto, Marjke (M); Dally, Claire-Ann (C); Dursen, Nishal (N); Evans, Nicky (N); Kumardew, Navin (N); Tiya, Nolundi (N); Clegg, Lindsey (L); Coetzee, Francois (FW); Jagath, Praveesh (PJ); Karani, Muhammed (MA); Kassen, Tyrone (TD); Kelly, Neville (NI); Leach, Stuart (S); Letape, Tshego (T); Maharaj, Nadia (N); Manganyi, Mpho Landa(MI); Mzi, Theodora (T); Naidoo, Glen (G); Nannoolal, Arkash (A); Oosthuizen, Etenne (E); Pienaar, Leon (L); Pillay, Ronal (RL); Pule, Kgomotso (KS); Ramaisa, Joseph (JM); Narainsamy, Jennysha (J); Mayet, Ihsaan (I); Pienaar, Leon (L); Smith, Morne (M); Steyn, CJ (CJ); Wagener, Natascha (NR); Van Antwerpen, Gauchet (GJ); Van Driel, Pieter (PA); de Kock, Lukas (LJ); Duba, Langi (MJT); Steinhobel, Gail (SG); du Toit, Gail (G); Pohl, Glazelle (G); Sehalele, Mofih (ME); Khumalo, Trevor (ST); Lottering, Roy (R); Pienaar, Dawie (DJ); Mohapi, Paeete (PA)

Subject: E-Survey on SAP RPM

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Dear Colleagues,


Your assistance is required in completing a survey on your experience with the SAP RPM System.

Your feedback and input will greatly assist in the field of Information Systems (IS) research.

The e-survey will take approximately 5 to 10 minutes to complete.

Link to E-Survey: <http://intwww.sasol.com/SasolESurvey/loader.asp?http://intwww.sasol.com/SasolESurvey/TakeSurvey.aspx?SurveyID=92238p7>

Kind Regards



12 Baker Street, Rosebank, 2196  
PO Box 5486, Johannesburg, 2000  
[www.sasol.com](http://www.sasol.com)

**Vedantha Kundalram**  
Service Delivery Manager  
Sasol Group Services (Pty) Ltd

Tel +27 11 344 3610  
Fax +27 11 219 2814  
Mobile +27 82 805 5219  
E-mail [Vedantha.Kundalram@sasol.com](mailto:Vedantha.Kundalram@sasol.com)

See more about: Kundalram, Vedantha (V).

- Information System (IS) 3 – Service Catalogue System

The screenshot shows an email client window titled "E-Survey on the IM Service Catalogue - Message (HTML)". The email is from Kundalram, Vedantha (V) and was sent on Thursday, 11/08/2012 at 03:27 PM. The subject is "E-Survey on the IM Service Catalogue".

The email content is as follows:

You forwarded this message on 2012/11/08 03:32 PM.

From: Kundalram, Vedantha (V) Sent: Thu 12/11/08 03:27 PM

To:

Cc:

Bcc: Almia, Omid (OJ); Babulali, Mandakini (M); Badal, Nehal (PolymersPolythene); Baratta, Antonio (A); Barnard, Anro (A); Barnard, Rudolf (RR); Becker, Joe (J) (Sasol Technology); Beneke, Daniel (DA); Bengu, Ntsika (NH); Bester, Tom (TJ); Beukman, Marnus (MT); Bhoola, Deepak (DB); Booyens, Sharon (S); Botes, Karen (K); Botha, Ignatius (I); Botha, Laetitia (L); Botha, Natascha (N); Bredell, Carl (C); Breedts, Annalze (AE); Breedts, Beatrice (B); Bringham, Natasha (N); Britz, Rudey (R); Bryssinck, Dirk (DFA); Bux, Marsh (M); Cawood, Shaun (S); Chan, Ivan (HTJ); Chanderman, Anveer (A); Chetty, Lavashkar (L); Chikwanda, Johnstone (J); Cilliers, Johan (JC); Claassens, Vanessa (V) - Sasol Technology; Cloete, Jez (J); Wedemeyer, Noline (N); Coetzee, Esca (E); Coetzee, Willie (W); Garner, Karen (KS); Conradie, Esmi (EE); Cooks, Johan (J); Corver, Pieter (PV); Cronje, Pauline (PE); Cullen, Adam (A); Da Silva, Jaco (J); De Beer, Jacobie (J); de Figueiredo, Ivone (IMT); De Villiers, Div (D); De Villiers, Riaan (AJ);

Subject: E-Survey on the IM Service Catalogue

Dear Colleagues,

Your assistance is required in completing an e-survey on your experience with the IM Service Catalogue. All IM requests for services, hardware and applications are currently logged on the Service Catalogue. The system is accessible via the green shopping trolley icon on your desktop.


*If you have already completed the survey, please ignore this email.*

Your feedback and input will assist in the field of Information Systems (IS) research.

The e-survey will take approximately 5 to 10 minutes to complete.

Link to E-Survey: <http://intwww.sasol.com/SasolESurvey/loader.asp?http://intwww.sasol.com/SasolESurvey/TakeSurvey.aspx?SurveyID=92237p7>

Kind Regards

 **Vedantha Kundalram**  
Sasol Group Services (Pty) Ltd  
Tel +27 11 344 3610  
Fax +27 11 344 3611

See more about: Kundalram, Vedantha (V).

## Appendix J: Ethical Clearance Letter



17 September 2013

Mrs V Kundalram (993216160)  
School of Management, IT & Governance  
Pietermaritzburg Campus

Protocol reference number: HSS/0945/012M  
New project title: **The relationship between User involvement In Information System Development and User acceptance of the Information System: A case study at SASOL**

Dear Mrs Kundalram

### Approval - Change of project title

I wish to confirm that your application in connection with the above mentioned project has been approved.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach/Methods must be reviewed and approved through an amendment /modification prior to its Implementation. In case you have further queries, please quote the above reference number. Please note: Research data should be securely stored in the discipline/department for a period of 5 years.

Best wishes for the successful completion of your research protocol.

Yours faithfully

Dr S Singh (Chair)

/ms

cc Supervisor: Mr Sanjay Ranjeeth  
cc Academic leader: Professor Brian McArthur  
cc School Admin. Ms B Cunyngnam

Humanities & Social Sciences Research Ethics Committee  
Dr Shanuka Singh (Acting Chair)  
Westville Campus, Govan Mbeki Building  
Postal Address: Private Bag X34007, Durban, 4010, South Africa  
Telephone: +27 (0)31 260 3567/8350/4567 Facsimile: 27 (0)31 260 4669 Email: shi.bap@suk27.ac.za / shynuka.m@ukm.ac.za / mshunup@ukm.ac.za  
Website: www.ukm.ac.za

Founding Campuses: ■ Edgewood ■ Howard College ■ Medical School ■ Pietermaritzburg ■ Westville

