Problem-formulation in a South African Organization

Executive Summary

Les Carlo

Warwick University

Engineering Doctorate

Submission No 6

8 June 2012

DECLARATION

The work contained in this Report, unless specifically referenced therein, has not been used previously, to the best of my knowledge. Unless referenced otherwise the Report is the sole product of the author.

ACKNOWLEDGEMENTS

I acknowledge with gratitude:

Mr. Paul Roberts (Warwick University) and Dr. Steve Lennon (Eskom Holdings Ltd), for their continued support as academic and industrial mentors respectively for this portfolio submission.

Eskom Holdings Ltd, for permission to use information obtained for this research project.

Mrs. Delene Slabbert, for assistance and support in editing and refining the format of this work.

The staff of Eskom Holdings Library for assistance in obtaining literature identified for use in this Executive Summary

Ms. Benny Kgati, Ms. Leanne Murphy and Ms. Seloacoe Pobe for their work in developing software related to the innovation developed in this Portfolio of Projects.

All those acknowledged in the Portfolio Project Reports referred to herein.

My wife, Mrs. Arnie Carlo, for her encouragement, forbearance, tolerance and understanding in travelling through the Engineering Doctorate journey with me.

ABSTRACT

Complex Problem Solving is an area of cognitive science that has received a good amount of attention, but theories in the field have not progressed accordingly. In general, research of problem solving has focussed on identifying preferable methods rather than on what happens when human beings confront problems in an organizational context

Queseda, Kirtsch and Gomez (2005)

Existing literature recognises that most organizational problems are ill-defined. Some problems can become well-defined whereas others are and remain ill-structured. For problems that can become well-defined, failure to pay attention to the area of problem definition has the potential to jeopardise the effectiveness of problem-formulation and thus the entire problem solving activity. Problem defining, a fundamental part of the problem-formulation process, is seen as the best defence against a Type III Error (trying to solve the wrong problem). Existing literature addresses possible processes for problem-formulation and recognises the importance of applying problem domain knowledge within them. However, inadequate attention is given to the possible circumstances that, within an organization, the participants do not know enough about the problem domain and do not recognise the importance of applying adequate problem domain knowledge or experience to the problem-formulation process. A case study is conducted into exactly these circumstances as they occurred and were successfully addressed within Eskom Holdings Ltd (Eskom), the national electricity utility in South Africa. The case study is a fundamental part of this research project, which explores the gap in the existing body of knowledge related to the circumstances described above and specifically to problems that can become well-defined, and provides the basis for the innovation developed herein that addresses that gap.

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

1. Introduction

This Engineering Doctorate research is made up of a Portfolio of Project Reports which documents the research conducted into the subject of Problem-Solving in a South African Organization. The South African Organization in question is Eskom Holdings Ltd (Eskom), South Africa's national electricity utility and the engineering business that the author works for. The Portfolio comprises nine reports, including this Executive Summary. The nine reports are listed below:

Portfolio Report 1: Portfolio Background and Research Question Definition
Portfolio Report 2: Literature Review
Portfolio Report 3: Pursuing Potential Innovation
Portfolio Report 4: Case Study: Contracting for Telecommunications Services in Eskom
Portfolio Report 5: Developed Innovation
Portfolio Report 6: Executive Summary
Portfolio Report 7: The Personal Profile
Portfolio Report 8: Review of Literature Related to Ill-Structured Problems
Portfolio Report 9: Codifying the Innovation

The innovation developed in this research project is specifically focussed on the application of problem domain knowledge or experience to the process of formulating problems that can become well-defined in an organization, in circumstances where the available domain knowledge or experience is inadequate for achieving an effective problem definition. The innovation addresses the formulation of the substantive aspects of problems excluding their behavioural aspects, and does not include the subsequent problem-solving processes. It excludes any application to structuring ill-structured, messy or wicked problems. The terms ill-structured, messy and wicked are used interchangeably in the literature, and this document will use the term that is used in the particular reference being cited.

The purpose of this Executive Summary is to present a concise picture of the entire Project Portfolio, demonstrating and justifying the area of innovation. It describes how, in the first three projects submitted to this Portfolio, the author chose and developed the subject for empirical research and a research strategy. This was done firstly through interrogating the author's own experience in Eskom in an area of concern to him, namely problem solving. This was the purpose of Portfolio Report 1, which developed the initial research question, "Why doesn't this

organization learn how to solve its problems?" The next step, which was the subject of Portfolio Report 2, was to take the initial research question, expand it and conduct a review of literature related to it. The reviews of literature provided the basis for the author to synthesize and create a comprehensive process of problem-formulation and, from that, conclude that there was potential for innovation to address the gaps exposed in existing literature. In the process of conducting the literature review, the author was involved in a real situation in Eskom, where an opportunity existed to conduct empirical research into at least one of the areas of potential innovation that were identified. Thereafter, the review of literature has been consistently updated throughout the production of the Portfolio. This led to the third step and the purpose of Portfolio Report 3, which was to describe Eskom where the research would be conducted, the significance of the research to the performance of Eskom's business, to make a final choice of a research question and to develop the research strategy. Portfolio Report 4 and Portfolio Report 5 describe empirical research in a single case study "Contracting for Telecommunications Services in Eskom" from which the two areas of innovation claimed in the Portfolio were created, developed into a practically applicable method and tested. Portfolio Report 9 establishes the relationship between the data obtained, in conducting the empirical research, and the areas of innovation. Portfolio Report 8 interrogates ways to treat problems with particular emphasis on ill-structured problems.

1.1. The context of the research project

The subject of this Engineering Doctorate project arose from an initial concern held by the author that within Eskom Holdings Ltd (Eskom) there was an increasing trend of difficulty in solving problems. Eskom is South Africa's national electricity supply utility, an engineering company that supplies the majority of electricity to South Africa, together with significant exports of electricity to neighbouring countries. Eskom is the primary source of, and is dependent on, knowledge and experience unique to the region's electricity supply industry.

The author has a particular skill, based on applying his knowledge and experience, in determining the nature of problems and solving them. He saw, in Eskom, that this was uncommon and that a trend was developing where such a skill was becoming increasingly scarce. The author held the view that the nature of problems to which this trend related, that were either unsuccessfully or only partly solved, was becoming more significant to Eskom's performance.

The author, in his early career working for an electricity utility in England, had been used to working with people who had sufficient knowledge of the problem subject-area (problem domain) to enable them to understand the nature of a problem and thus successfully go through a problem solving process. The author was concerned that in Eskom, from mid-1990 onwards as a consequence of implementing affirmative action, large numbers of people with extensive problem domain knowledge had left the company resulting in a loss of their tacit knowledge. In addition, Eskom was about to embark on a programme of building new power stations, at least a decade since the last one was built, without the benefit of having retained the people involved at that time. Circumstances of this nature, where skills loss in critical areas has occurred without adequate transfer of knowledge, can create risk to any company. In South Africa, a nation developing in its post-apartheid era with knowledge and skills shortages in the previously disadvantaged population, this risk is significant.

A review of a number of examples of problem solving in Eskom, based on the author's experience, led to the initial research question, "Why doesn't this organization learn how to solve its problems?" This question became the focus of the initial literature review, following which this research was focussed on how to successfully formulate problems that required domain knowledge or experience that did not exist within the area of the organization affected by them.

The empirical research demonstrated the development and application of innovation, resulting in the effective formulation and solution of a long-standing problem of significance to Eskom. The innovation has also been applied in an Eskom subsidiary company, in another African country and in a different engineering industry segment, resulting in the formulation of and solution to a problem of a strategic nature.

1.2. Research objectives

The objectives of this research project are to:

- Confirm that Eskom has difficulties solving problems.
- Identify possible causes for this.
- Create and apply a solution.

In conducting research, in order to achieve these objectives, it became clear that the ability to solve, resolve or dissolve a problem is influenced by a number of factors:

- The type of problem, e.g. a routine operational problem, a difficult operational problem or a strategic problem than can become well-defined, and a ill-structured problem.
- The domain knowledge and experience of the people engaged in solving the problem.
- The behaviour of the people engaged in solving the problem and related stakeholders.
- The problem solving process applied.

1.3. Assumptions

Assumptions are made related to the factors listed above:

- Relevant knowledge is essential to the effectiveness of treating problems.
- Problems that are formulated to become well-defined have the potential to be solved.
- In an organization the behaviour of the stakeholders to a problem, and the behaviour of the people affected by it, influences the effectiveness and efficiency of the problem solving process.

1.4. Scope of the research

Taking into account the above assumptions and the key findings from the literature reviewed, the scope of this research project is limited to address the impact of inadequate domain knowledge or experience on the formulation of problems that can become well-defined. It excludes ill-structured problems which are addressed through the application of Problem Structuring Methods. Messy problems are unstructured and cannot be well-defined; they are a mess which is conceptualized as a system of problems that cannot be solved by solving each of its component problems independently of the others (Ackoff, 1974; Lyles, 1981; Lyles, 1987).

In Portfolio Report 5 this research specifically separated the behavioural aspects of problem-formulation from those related to problem domain knowledge or experience. Refer to Section 4.2, page 59 for treatment of chance variables.

The scope of this research project is therefore bounded by the exclusion of the treatment of ill-structured problems, the behavioural aspects of problem-formulation, and the well documented processes of solving a problem once it has arrived at the stage of being well-defined problem. This

research project scope is therefore focussed on the substantive, domain-related aspects of formulating problems that can become well-defined.

1.5. The applicability of the innovation

The innovation is specifically focussed on the recognition of and addressing the circumstances of inadequate problem domain knowledge or experience to achieve the outcome of a well-defined problem from the process of problem-formulation. Within an organization this will apply to non-routine and more complex operational problems, because routine problems can be resolved through the use of procedures (Fontenot, 1993). It will also apply to those strategic problems that can become well-defined.

1.6. The research question and the research process

The research question and the high-level research process followed are shown in Figure 1.

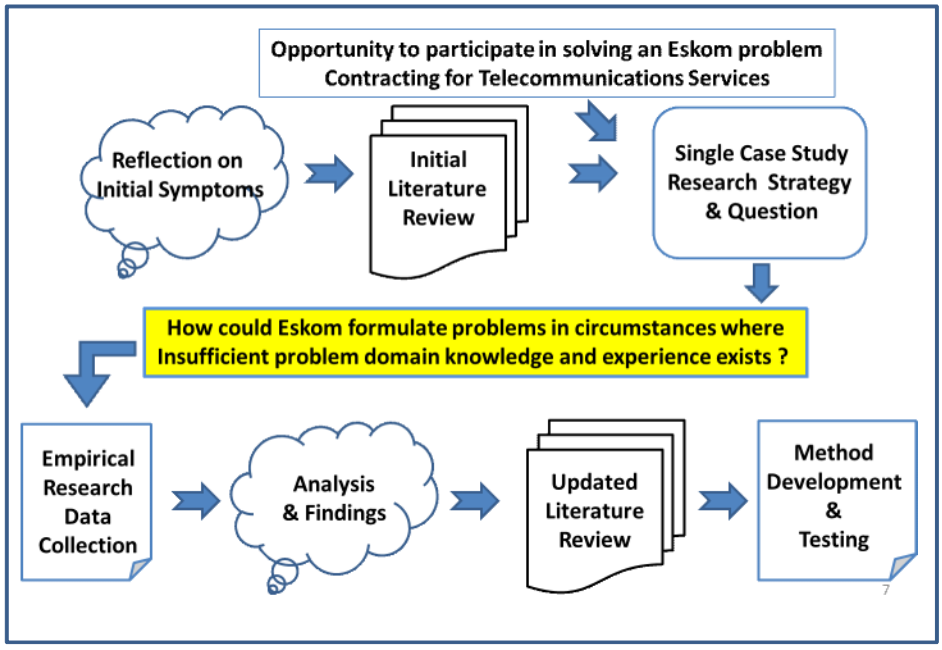

Figure 1. The research process.

1.7. Overview of the submissions

In Section 1.1 the way in which the research project developed is outlined. This section will outline the Portfolio Reports describing their objectives, scope and key achievements.

1.7.1. Portfolio Report 1: Portfolio background and research question definition

Objectives

The objective of Portfolio Report 1 was to provide background to the research project subject, that is, problem-solving in a South African Organization, to contextualize the need for research and to define a research question.

Scope

Portfolio Report 1 provides a description of how the first Portfolio Project drew on and analysed the author's own experience of problem-solving in two of the major business units of a South African electricity utility organization. This was done by analysing five examples of situations in which the author became involved in attempting to solve problems. The analysis was conducted against the criteria related to problem definition, and design and implementation of a solution.

Key achievements

The key achievement was the definition of the research question, "Why doesn't this organization learn to solve its problems?"

1.7.2. Portfolio Report 2: Literature Review

Objectives

The objectives of the Literature Review were to:

- Expand the research question identified in Portfolio Report 1 to enable a precise basis for exploring the existing body of knowledge to be obtained.

- Conduct a review of existing literature to see if theory empirically tested or not, existed that addressed the research question.
- Identify opportunities for innovation, related to the research question that could be the subject of empirical research.

Scope

A review of literature was conducted. Details of the journal articles and books referred to are depicted in the references section of Portfolio Report 2, pages 96 to 104.

The review of literature was targeted on the research question identified in Portfolio Report 1 as expanded into the component questions shown below:

- How do organizations identify or define their problems?
- How do organizations ensure that people understand the nature of the problems that they will face?
- How do organizations ensure that problems are solved?
- How do organizations ensure that problem-related knowledge is created and made available to others?
- How do organizations ensure that people learn the technical and problem-solving skills needed to deal with the problems they will face?

(Portfolio Report 2, page 6)

Key achievements

Firstly, the author did not see definitions of an identified problem or a defined problem from the analysis conducted into existing literature that would enable him to further pursue research in this subject area with complete clarity. This issue was addressed by synthesizing definitions from existing literature and grounding them, for the purpose of this Research Project, for the terms:

- A problem.
- An identified problem.
- A defined problem.

A second achievement was that the author was able clearly to understand and present the concept of problem-formulation.

A third and major achievement was that the existing body of knowledge that answered the expanded research questions was quantified.

A fourth achievement was that a number of conclusions were drawn concerning the extent to which the existing body of knowledge provides answers to the expanded research question (Portfolio Report 2, pages 83 to 94).

Finally, the following gaps in existing literature related to the chosen research question were identified as areas for potential innovation:

- There is no evidence recorded in the literature of a complete, empirically tested process to identify and define organizational problems that embodies the capability to respond to specific organizational dynamics that includes methodology for ensuring the accuracy of a problem definition as it changes as the process of problem solving proceeds.
- Existing theory for identifying and defining problems does not address the possibility that the organization may not possess the skills or intuitive capability to recognise problem symptoms initially; or to evaluate and synthesize the cues as needed for effective problem definition.

(Portfolio Report 2, page 95)

This final achievement provided a basis from which to narrow down the scope of the research project and to determine the area of potential innovation to pursue through empirical research.

1.7.3. Portfolio Report 3: Pursuing potential innovation: the next steps

Objectives

The intent of Portfolio Report 3 was to build a bridge between the gaps in knowledge identified by the Literature Review (Portfolio Report 2) and choose a subject and strategy for empirical research. The purpose of Portfolio Report 3 was further to initiate the empirical research project into the subject of Contracting for Telecommunications Services in Eskom. The subject of the empirical research would be circumstances where the company did not possess the problem domain knowledge, skills or intuitive capability needed to adequately formulate the problem (Portfolio Report 3, pages 5 to 8).

Scope

Portfolio Report 3 has the following major areas of scope.

- The description of the business area researched to provide context concerning the area of empirical research, indicating its significance to an engineering business (Portfolio Report 3, pages 9 to 12).
- The description of the background to and significance of telecommunications to Eskom's core business (Portfolio Report 3, pages 13 to 24).
- The choice of the research question that would be the subject of the empirical research and the determination of the research paradigm that would be applied (Portfolio Report 3, pages 25 to 40).

Key achievements

The key achievement of Portfolio Report 3 was the determination of the research subject, question, paradigm and strategy. The research question determined is, "How could Eskom formulate problems in circumstances where insufficient problem area related skills or intuitive capability exists?" In addition the following was described:

- The circumstances in which Eskom has allowed experienced, knowledgeable and skilled staff to leave the company before their tacit knowledge was passed on (Portfolio Report 3, page 11).
- Eskom as South Africa's national electricity utility (Portfolio Report 3, page 9).
- The significance of telecommunications to Eskom's core business. (Portfolio Report 3, page 13).
- An explanation of why the contractual negotiations for telecommunications services in Eskom became a complex and significant problem (Portfolio Report 3, pages 15 to 19).

1.7.4. Portfolio Report 4: Case study-Contracting for telecommunications services in Eskom

Objectives

The purpose of this Portfolio Report was to use a case study to investigate the possibility of developing and testing innovative adaptations to the existing body of knowledge related to problem-formulation. Accordingly, one objective of Portfolio Project 4 was to conduct robust and rigorous empirical research exploring the potential for innovation related to the research question. A second objective was to develop and justify any areas of innovative adaptations to the existing body of knowledge related to problem-formulation. A third objective was to establish that the application of any identified areas of innovation enabled the resolution of a significant problem affecting the engineering business. Finally, a fourth objective was to identify any areas of potential further research.

Scope

Portfolio Report 4 has the following major areas of scope.

- The synthesis of the fragmented elements of problem-formulation knowledge obtained from the literature review into processes of problem-identification and problem-defining.
- The representation of the above synthesized problem-identification and problem-defining processes into an overall problem-solving process.
- The development and analysis of a case study addressing the subject of contracting for telecommunications in Eskom over the period 2000 to 2005. The case study was based on corroborated data sourced from 19 archive records, 103 documents, nine interviews and the author's participant observations.

Key achievements

The key achievements of Portfolio Project 4 are as follows.

- Creation of synthesized diagrams showing the key aspects of the existing body of knowledge that relate to problem-formulation in the context of the overall problem solving process, emphasizing gaps that exist in the literature (Portfolio Report 4, Figure 1.2 and Figure 1.3).

- The development and application of a rigorous case study design (Portfolio Report 4, Section 2, pages 7 to 32).
- The derivation, application, and presentation in written and diagram form of the areas of innovation (Portfolio Report 4, Section 4.4.2 pages 89 to 92; Portfolio Report 4, Figure 4.1 and Figure 4.2).
- The establishment of the relevance and significance of the case study in describing the solution of significant problem for Eskom, through the successful application of innovation (Portfolio Report 4, Section 4.4.5, pages 103 to 105).
- The identification of areas of potential further research (Portfolio Report 4, Section 4.5, pages 111 to 112).

1.7.5. Portfolio Report 5: Developed innovation

Objectives

The first objective of Portfolio Report 5 was to conduct a further literature review with particular emphasis on how inadequate domain knowledge or experience is addressed in the process of problem-formulation. The second objective was to develop and test a method that expands the innovation identified in Portfolio Report 4, separating the behavioural aspects of a problem from those that relate to the problem domain. The third objective was to establish the benefits of applying the innovation.

Scope

Portfolio Report 5 has the following major areas of scope:

- The further development of one of the areas of innovation related to circumstances in which the relevant people in the organization do not have adequate knowledge or experience in the subject area to successfully formulate the problem. The development took the form of a detailed method, or process model, supported by software.
- The testing of the detailed method.
- The determination of business benefits from applying the innovation.

Key achievements

The key achievements of Portfolio Report 5 are as follows:

- An updated review of relevant existing literature that validated Conclusion 1 of Portfolio Report 4, namely that it is not possible to correctly formulate a problem in circumstances when there is not sufficient knowledge of the subject matter to understand it (Portfolio Report 4, Section 4.5, page 110).
- Establishing that the possession of a large body of problem domain knowledge is central to expertise. Also, that solving complex problems may require additional knowledge to be acquired, together with the need for managers to decide how to access it from within or outside the organization (Portfolio Report 5, Section 2, page 15).
- The understanding that even recently published problem-solving processes do not help an organization to realise that there is insufficient problem domain knowledge to effectively define the problem or where to apply expert problem domain knowledge in the problem-solving process. (Portfolio Report 5, page 15).
- A workable method to analyse the adequacy of problem domain explicit and / or tacit knowledge, integrating the concepts described in existing literature.
- The validation of the workable method referred to above by testing against cases described in this Portfolio.
- The confirmation that applying the areas of innovation, developed in Portfolio Report 4 and further developed partly or in full, has solved two significant problems for Eskom.
- The quantification of the benefits (Portfolio Report 5, Section 4.3, pages 43 to 51).

1.7.6. Portfolio Report 8: Review of literature related to ill-structured problems

Objectives

The objective of Portfolio Report 8 was to review literature related to problems that cannot be well defined in order to understand such problems and how to treat them, if such treatment is different to formulating and solving problems that can become well-defined.

Scope

Portfolio Report 8 has the scope of a review of literature that covers the types of problems that affect organizations, with particular emphasis on the nature and treatment of ill-structured problems.

Key achievements

The key achievements of Portfolio Report 8 are as follows:

- A description of ill-structured problems and how, by applying a systems approach, they are treated by processes of resolution or dissolution through the application of Problem Structuring Methods (PSMs).
- Confirmation that ill-structured problems cannot be well-defined. Therefore, the problem-formulation process described in Portfolio Report 5 cannot be applied.
- The conclusion that without sufficient problem domain knowledge or experience the application of a PSM will result in inadequate success whether applied to ill-structured problems or to problems that can become well-defined.

1.7.7. Portfolio Report 9: Codifying the innovation

Objectives

The objective of Portfolio Report 9 was to enhance the validity of the empirical research process by documenting the robust relationship between the data obtained, in conducting the Case Study and the areas of innovation developed.

Scope

Portfolio Report 9 has the following scope:

- The application of a method that examines the relationship between the areas of innovation described in Portfolio Report 4 and the Case Study data.

- The creation of a clear and visible relationship between the case study interview data and the innovative process elements introduced into the problem-formulation process developed in Portfolio Report 4.

Key achievements

The validity of the empirical research has been reinforced by codification that demonstrates a robust relationship between the innovative process elements, as depicted in red in Figure 10 and Figure 11 herein, and the case study interview data as corroborated by data from other case study sources.

1.8. Order of reading of the submissions

The recommended order of reading the submissions, after reading this Executive Summary, is as follows:

- Portfolio Report 1 (Portfolio Background and Research Question Definition).
- Portfolio Report 2 (The initial Literature Review).
- Portfolio Report 3 (Pursuing Potential Innovation).
  An essential introduction to the empirical research, the subject of Portfolio Report 4.
- Portfolio Report 4 (Case Study: Contracting for Telecommunications Services in Eskom).
- Portfolio Report 9 (Codifying the Innovation).
- Portfolio Report 5 (Developed Innovation).
- Portfolio Report 8 (Review of Literature Related to Ill-Structured Problems).
- Portfolio Report 7 (The Personal Profile).

2. Literature Review

2.1. The literature reviewed – key issues

The review of literature has addressed matters relevant to the initial research question and issues arising as the research project progressed. The review of literature covers the topic listed below:

- The definition of a problem, identified problem, defined problem, problem-formulation and ill-structured problem.
- Types of problems that affect organizations.
- Ways of treating problems and messes.
- Processes to formulate problems that can be well-defined.
- Ensuring that well-structured problems are solved.
- Processes to address ill-structured problems.
- Ensuring that problem domain knowledge is created and made available to others in organizations.

2.1.1. Definitions

Definition of problem

A review of seven definitions of 'problem' by 11 authors revealed two main themes. The first theme is that of a problem being a significant, undesirable situation requiring a solution that is probably difficult to create, and includes the concept of something being wrong (Agre, 1982; Macdonald, 1981; Ohlmer, 1998; Smith, 1989b). The second theme characterizes a problem as a deviation from an expected standard of performance, that is, between a current state as compared to an expectation of a desired state (Ho & Cicmil, 1996; 1951; Kepner & Tregoe, 1965; Kilman and Mitroff, 1979; Pande, Neuman & Cavanagh, 2000; Pounds, 1969; Van Grundy, 1988; Zandi, 1999). In addition, a gap must be important and deserve to be of concern (Smith, 1989b), which supports the element of significance in the first theme described above.

For this research, a problem is defined as **a gap between a current state and a desired state that is significant and requires a solution**.

Definition of identified problem

Agre (1982) and Van Grundy (1988) argue that without being conscious of a problem, that is, without awareness that a gap exists, there is no problem. Lyles and Mitroff (1980) argue that the lack of recognition by a person or persons of the existence of a problem does not mean that a problem does not exist. Key to this argument is the definition of perception (that is, awareness (Hornby, 1995)). The inability of a person to recognise or acknowledge the existence of a problem could lead to it becoming more severe (Lyles and Mitroff, 1980). Smith (1989b) also stated that only conscious beings – humans not organizations – can believe that a problem exists, which indicates the importance of ensuring that within an organization the right people collectively perceive the existence of a problem.

For this research, an identified problem is defined as **a perception of a gap between a current state and a desired state that is significant and requires a solution.**

Definition of defined problem

The definition of a defined problem builds on the definition of a problem given above. To define means to determine with precision, to describe accurately, to state or describe the exact nature of (Macdonald, 1981; Hornby, 1995). A problem definition should be an exact statement of what the problem is and should not describe causes or prescribe solutions as this would pre-empt the problem-solving process (Kepner and Tregoe, 1965; Senge, Kleiner, Roberts, Ross & Smith, 1994). In the context of problem-solving, a problem can be considered to be defined if the solver is readily able to identify a promising solution strategy, or if it results in an explicit or implicit representation of the problem or set of problems to a point that enables specific further research action (Massey and O'Keefe, 1993; Smith, 1988; Smith, 1989a).

For this research, a defined problem is defined **as an accurately described gap between a current state and a desired state, that is significant, for which awareness exists, that contributes to a solution being found.**

Definition of problem-formulation

The literature on problem-formulation is homogeneous; it includes the perception that a problem exists (i.e. problem identification), together with inquiry into the nature of a problem and the definition and the representation of the problem (Lyles and Mitroff, 1980; Smith, 1989b).

Definition of a messy problem

Ackoff (1974) coined the term 'messes' in response to the arguments of William James and John Dewey that problematic states are extracted from unstructured states of confusion; where problems are elements of systems and a mess is a system of problems, a system of external conditions that produces dissatisfaction. From a system's perspective, actual and potential problems can be identified once symptoms (a deviation from a system's normal behaviour) have been identified (Ackoff, 1974). In the context of a mess a problem is a situation that satisfies three conditions: a decision-making individual or group has alternative courses of action available; the choice can have a significant effect; and the decision-maker has some doubt as to which alternative should be selected (Ackoff, 1981). A solution to a mess is not the simple sum of the solutions to problems that can be extracted from it (Ackoff, 1974).

2.1.2. Types of problems that affect organizations

The types of problems commonly referred to in management literature can be represented in two dimensions (1) an orientation that includes technical and human-relations problems, and (2) an organizational-level dimension that includes strategic and operating problems; the distinction frequently appears as task orientation versus people orientation (Cowan, 1991). In the organizational-level context, there are fundamentally four types of problems within two categories that affect organizations. The categories are well-structured problems and ill-structured problems. The types of problems are well-defined operational problems, ill-defined operational problems, well-defined strategic problems and ill-structured problems.

Ill-structured problems

Ill-structured problems are messy problems as described above, and are characterized by multiple actors, multiple perspectives, conflicting interests, important intangibles and key uncertainties; they are frequently more strategic than well-structured problems (Mingers and Rosenhead, 2004; Rosenhead, 2006). They are unique or novel, important and frequently ambiguous; they are more complex and ill-defined than other problems. They are distinguished by interlocking aspects and inter-connectedness to other problems, complexity, open-endedness, relentless, and uncertainty in a dynamic environment (Mintzberg, Raisinghani and Theoret, 1976; Lyles, 1987; Lyles and Thomas, 1988; Reynolds and Howell, pp4 to 5, 2010; Weber and Kaderman, 2008). They do not have a unique, universal formulation (Lyles, 1987). Formulating such problems in different ways

can result in different solutions to the same problem, and improved ways of solving problems do not assure improved methods of coping with messes (Ackoff, 1974; Ramaprasad and Mitroff, 1984).

Well-structured or well-defined problems

A well-structured problem will not just have unambiguous objectives, firm constraints, and established relationships between causes and effects (Rosenhead, 1989). Operational problems can be analysed to produce a clear understanding of what went wrong (Ramakrishna and Brightman, 1986). Such operational problems can be well-structured. There is also a type of strategic problem that can be well-defined; they are frequently imposed on the organization e.g. by government legislation or union contracts (Lyles, 1981; Lyles, 1987).

2.1.3. Ways of treating problems and messes

The ways of treating problems depend on the type of problem situation; namely, a problem that can become well-defined or a mess. Fontenot (1993) states that well-defined problems can be solved using standard operating procedures whereas, ill-defined problems require creative problem-solving skills. In the case of operational problems that fail to meet manager's expectations, causes of the deviation must be determined by a process of diagnosis. That is, by gaining a clear understanding of what went wrong. Examples of ways of treating such problems to the point of definition and cause analysis are Fishbone (Cause and Effect) Diagrams, the Kepner Tregoe Model, and the Fact-Net Model (Ramakrishina and Brightman, 1986). The Fact-Net Model is based on Churchman's mode of knowledge generation, specifically the Kantian mode of enquiry (ibid). In this mode, a problem-solver generates several possible theories about problem causality and then systematically seeks information to determine which theory, if any is correct (Ramakrishina and Brightman, 1986). The more appropriate methods of inquiry for ill-defined problems are the Kantian and Hegelian methods (Lyles and Mitroff, 1980). The Kantian method addresses several views about the problem and the Hegelian method has two diametrically opposed views of the problem (ibid). The most successful strategic problem-formulators should utilise a process that evokes debate among multiple representations of the nature of the problems, involving the balancing of alternative problem viewpoints and perspectives (Lyles and Thomas, 1988).

In the case of ill-structured problems corporate managers became aware of the need to adopt a systems approach, taking into account the purposes and interests of:

(1) The parts of the system they manage.

(2) The larger parts of the system that contained them.

(3) The purposes of the system they manage.

(Ackoff, 1974; Ackoff, 1998).

Ackoff (1994), states the following ways of treating problems or messes:

- **Absolution:** To ignore the problem or mess; to hope that it will take care of itself or go away.
- **Resolution:** To do something that yields an outcome that's good enough, that satisfices.
- **Solution:** To do something that yields or comes as close as possible to the best possible outcome, that optimizes.
- **Dissolution:** To redesign either the entity that has the problem or mess, or its environment, in such a way as to eliminate the problem or mess and enable the system involved to do better in the future than the best it can do today, in a word, to idealize.

In considering the way to treat a problem, it is important to distinguish between processes to formulate problems that can become well-defined and processes that will address ill-structured problems. In the case of problems that can become well-defined, a process of problem-formulation leading to solving the problem is followed. Ill-structured problems are treated as described in Section 2.1.6, page 31.

2.1.4. Processes to formulate problems that can be well-defined

For problems that can become well-defined, diagnosis and formulation is the critical first step in problem-solving (Ramakrishna and Brightman, 1986).

An overriding concern expressed in existing literature is that insufficient attention is paid to the problem-formulation stage of the problem solving process (Cowan, 1986; Lyles and Mitroff, 1980; Volkema, 1983). Problem-formulation is a complex process starting with cues being sensed by individuals (that is, the process of problem-identification), where the majority of the sensing of cues is based on informal indicators and can be interpreted as being intuitive (Lyles and Mitroff,

1980; Lyles and Thomas, 1988). Involving the right people in the problem-formulation process is essential from the perspectives of enhancing the probability of arriving at a good quality definition, together with managing the stakeholder relationships and political influences that are relevant in an organizational context (Haines, 2000; Yasin and Yavas, 2003).

Chae, Paradice, Courtney and Cagle (2005) quote Mitroff's (1997) five sources of Type III Errors to include phrasing a problem incorrectly, Dewey (1910) as saying that "A problem well stated is half solved" and Mitroff (1997) as saying that "The ability to spot the right problems and then formulate them correctly is the critical skill that all workers, managers and top executives must possess if they are to compete successfully in the 21st. Century". The term Type III Error or Error of the Third Kind reflects the practice of entertaining the wrong hypothesis; in a problem-solving context this means entertaining an ill-defined problem (e.g. trying to solve the wrong problem) (Butler, 1994; Ramaprasad and Mitroff, 1984: Volkema, 1983; Volkema, 1986; Volkema, 1997; Yadav and Korukonda, 1985).

Processes to identify problems

In terms of problem-identification, a concern is that individuals will interpret the same situation or environmental cues differently, and an individual's perception of a problem will be a function of his or her background, capabilities, cognitive style or experiences (Cowan, 1986; Lyles and Thomas, 1988; Smith, 1989b; Volkema, 1983). Identifying symptoms should trigger the analytical process that embodies steps that include problem-identification and exploratory investigation, after which actual problem definition occurs (Butler, 1994). Whilst organizations can become aware of problems emanating from their environment through more formal mechanisms (for example, environmental scanning, issue management, potential problem analysis, performance management), research has indicated that significant numbers of managers become aware of a problem through intuitive mechanisms. That is, recognising stimuli that the problem makes available, informal indicators or informal communication networks that they use to short circuit formal mechanisms. Some problems literally make themselves known (that is, by serendipity) or are identified automatically and for the most part as a result of prior experiences. Generalisation, situations where various stimuli contribute to problem awareness, is the most common way in which problems are identified (Kepner and Tregoe 1981; Lyles, 1987; Lyles and Mitroff, 1980; Ramaprasad and Mitroff, 1984; Smith 1989b).

Lyles and Mitroff (1980), in an empirical study of organizational problem solving, found that 90% of problems reported by managers fell within the ill-defined category and that managers become aware of significant problems through informal sensing mechanisms. Furthermore, it was identified that themes such as commitment, turnover, political manoeuvring, problem avoidance (that is, denial) recurred in the cases studied, and therefore need addressing.

Some elements of process exist that can identify problems, albeit fragmented and largely theoretical. Cowan (1986) postulated a three-stage model for the process of problem recognition by individuals involving: (a) gestation / latency, (b) categorisation, and (c) diagnosis. Pounds (1969) presents a problem-finding process model that includes comparing it to reality, identifying differences and selecting a difference. Kepner & Tregoe (1981) define the Situational Appraisal Model that facilitates problem awareness and prioritisation.

The effectiveness of problem-identification mechanisms applied in an organization will be influenced by the extent to which prior learning (e.g. experience, knowledge and skill) can be applied. The question, "How does one identify problems if the organization or person involved is not experienced, knowledgeable and skilled in areas in which the problem exists?" remains. In addition, the question exists, "Is there a sufficiently comprehensive process for problem identification that can be applied at managerial and non-managerial levels within an organization?" The key issues detailed above were synthesized and expanded into the process model depicted in black in Figure 2, with the literature sources marked. Figure 3 indicates the process model depicted in black and endorsed in blue to represent the gap in existing literature arising from the former of the two above questions.

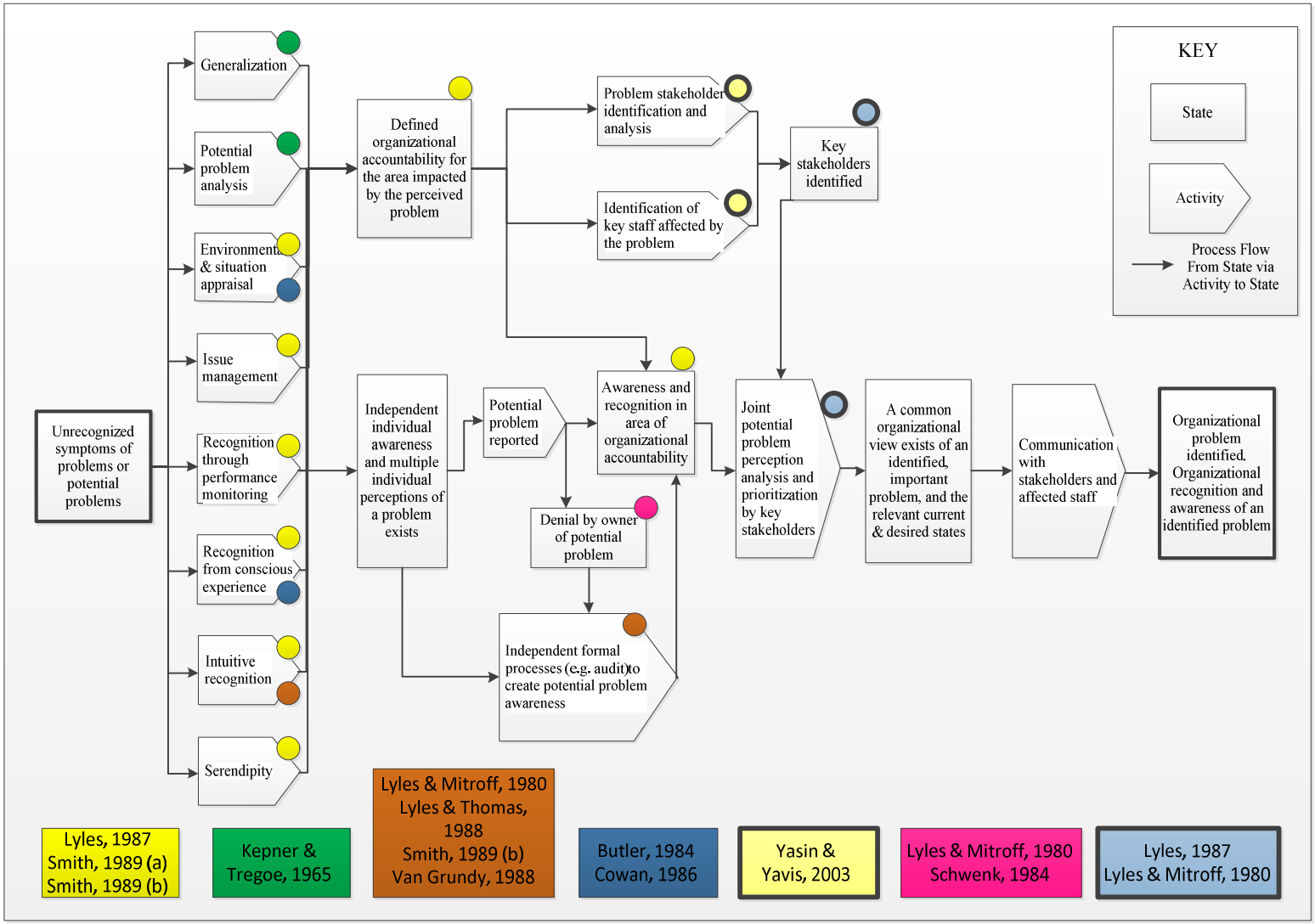

Figure 2. The problem identifying process developed by the author, literature sources marked

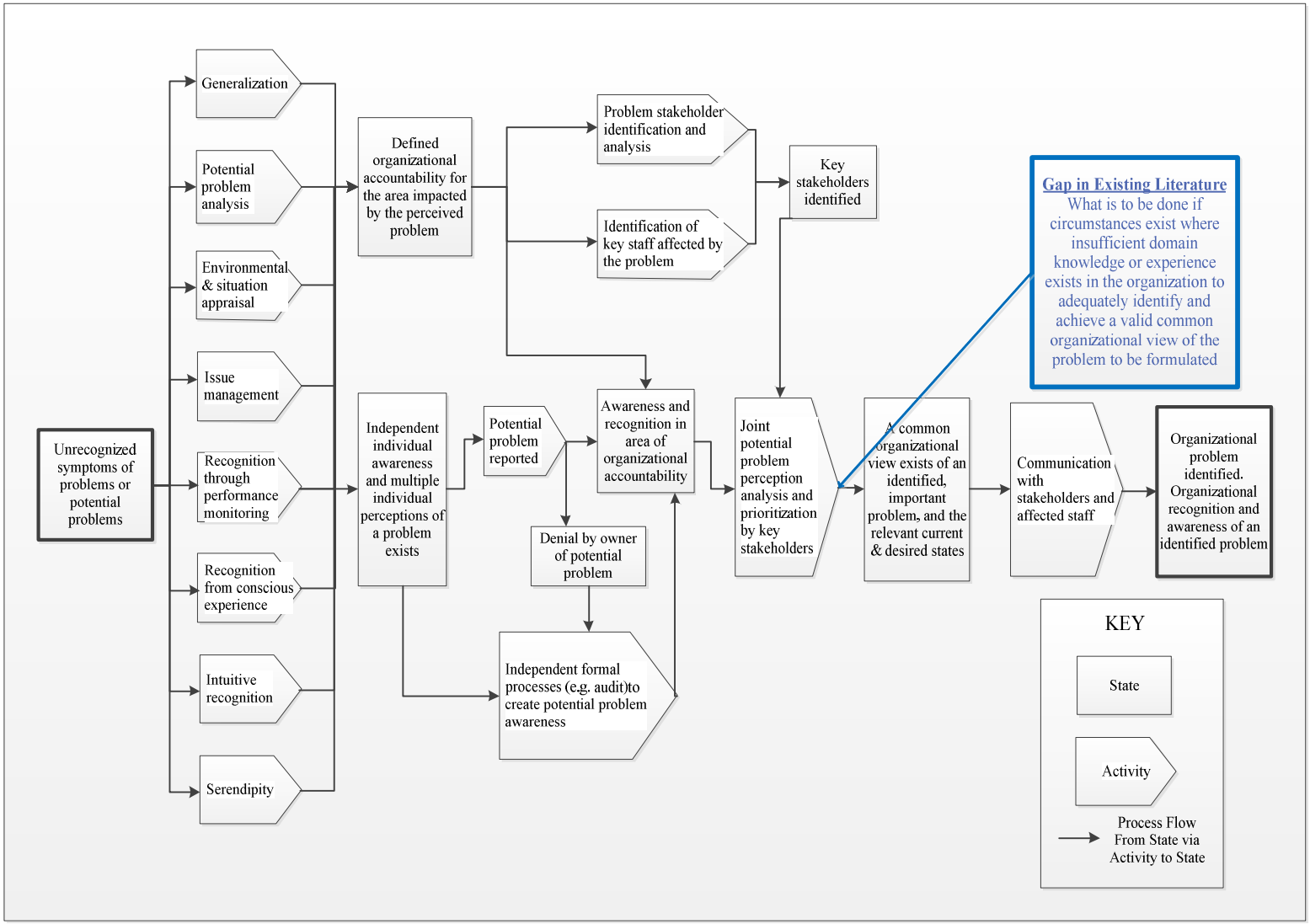

Figure 3: The problem identifying process, with gap in existing knowledge indicated

Processes to define problems

In the context of well-structured problems, most organizational problems originate as being ill-defined, for which a process of problem-formulation is critical (Cowan, 1986; Lyles and Mitroff, 1980; Reiter-Palmon and Illies, 2004). The way such a problem is stated will determine the quantity and quality of solutions produced, and careful planning and execution of the later steps (that is problem-solving) are irrelevant if the wrong problem-definition is developed (Kilman and Mitroff, 1979; Volkema, 1995). Problem-defining is seen as a cognitive activity that starts at the point of belief that a problem exists (that is, an identified problem) and is a process of conceptualization that results in explicit or implicit representation of a problem into a problem or set of problems, issues and questions defined sufficiently to enable further research. It determines the solution space or area in which focus will be given to determine a solution, and is seen as the best defence against a Type III Error. Therefore, failure to pay attention to the area of problem-definition has the potential of jeopardising the effectiveness of the entire problem-solving activity (Buyukdamgaci, 2003; Kilman and Mitroff, 1979; Massey and O'Keefe, 1993; Smith, 1989a; Smith, 1989b, Volkema, 1985).

A problem-definition should be an exact statement of what the problem is and should not describe causes or prescribe solutions (Kepner and Tregoe, 1965; Senge, Kleiner, Roberts, Ross and Smith, 1994). Too often we rush into generating alternatives, including the use of heuristics, developing or even implementing solutions without determining a good problem statement, or take the risk that, because of the influence of a problem-solver's capability and expertise, expected solutions will drive problem-definition (Basadur, Pringle, Speranzini & Bacot, 2000; Buyukdamgaci, 2003; Massey and O'Keefe, 1993; Smith, 1989a; Volkema, 1983; Volkema, 1995). Problem-defining, particularly for ill-defined and complex problems, is a critical part of the decision-making process. Problems are never self-defining; their definition depends on the perception of whoever defines the issues, which is influenced by factors including previous experience, and beliefs and values (Copland, 2000; Drummond, 1992; Kepner and Tregoe, 1965, Lyles, 1987; Lyles and Mitroff, 1980; Massey and O'Keefe, 1993).

Problem-defining in organizations, in comparison to problem-defining at an individual level, brings out the additional complexities of dealing with different viewpoints of a problem, leading to a preference towards a participative process. There is a need to deal with different coalitions that will be politically motivated and sometimes introduce risks of political manoeuvring that result in the problem not being resolved. These risks include:

(1) Fear of retaliation by powerful people.

(2) A desire for acquisition of resources and / or power.

(3) Different levels of interest / enthusiasm towards a problem.

(4) Credibility attached to individuals and their viewpoints based on experiences, skills, etc.

Also, the risk exists that certain cognitive simplification processes (for example, prior hypothesis or adjustment or anchoring) could result in the filtering or denial of information that could lead to impaired quality of problem-definition (Buyukdamgaci, 2003; Lyles and Mitroff, 1980; Lyles and Thomas, 1988; Schwenk, 1984).

The more complex the problem, the more time generally must be spent in formulation (Volkema, 1995). In the case of organizational problem-solving, it is recognised that both cognitive aspects and political interests are considered in diagnosing problems, and that this in turn is influenced by strategic issues such as the availability and / or consistency of information and time pressures to provide a solution (Buyukdamgaci, 2003; Dutton, Fahey & Narayanan, 1983; Etzioni, 1989; Lyles, 1987; Lyles and Mitroff, 1980). The political dimension of problem diagnosis is not the preserve of strategic management. In general there is need for definitions of an organizational problem that must not only be understood by all participants in the problem solving process, but also enjoy their support (Basadur et. al., 2000; Van Grundy, 1988).

The risks associated with emphasizing intuition in deriving a problem-definition are associated with tendencies towards a closed mind and or applying intuitive favour to a definition concept (Jones, 1995). Therefore, involving the right people in the problem-formulation process is essential from the perspectives of enhancing the probability of

arriving at a good quality definition, and managing the stakeholder relationships and political influences that are relevant in an organizational context.

The outcome of a problem-defining process is to an extent dependent on the histories and backgrounds of those responsible for defining the problem. Thus, the participants must be capable of evaluating and synthesizing the cues that relate to the problem (Lyles, 1987; Ramaprasad and Mitroff, 1984, Volkema, 1997). In terms of including people who can constructively participate in defining a problem, it will be useful to consider the problem from a systems theory perspective, noting that organizational barriers introduce risk of impeding the flow of information relevant to defining a problem. Therefore, a greater potential exists for taking into account the views of sometimes excluded participants (Haines, 2000; Thomas and Schwenk, 1983; Yasin and Yavis, 2003). Since humans experience real difficulty as they attempt to manipulate concepts and situations with which they lack familiarity or experience, the choice of whom to involve in the problem-solving process is important. The choice should include persons who are experiencing the problem, who have the expertise to define problems in various substantive domains, whose commitment to the problem-definition and resulting change program will be necessary and those who are expected to be affected by the outcomes of any change program attempting to solve the problem (Bennett, Wheatley, Maddox & Anthony, 1994; Kilman and Mitroff, 1979).

Methodology that enables the process of problem-definition is found in existing literature. Creative problem-definition and re-definition techniques include Brainstorming, Brainwriting, Boundary Examination, the Delphi Procedure, Goal Orientation, Mental Imagery, Metaphors, Nominal Group Technique combined with Snowballing, Object Stimulation, Progressive Abstraction, Rich Pictures, Scenario Construction, the Simplex Process, Synetics, the Why Method and Wishful Thinking (Basadur et. al., 2000; Bennet, Wheatley, Maddox & Anthony, 1994; Buyukdamgaci, 2003; Gupto and Labbert, 1994; McFadzean, 1998; Van Grundy, 1988).

The following ways of defining problems exist:

- Methodology proposed by Kilman and Mitroff (1979), aimed at introducing different individuals and consultants into the problem-defining process to

minimise the risk of a Type III Error. The theory postulated by Kilman and Mitroff is not empirically tested.

- A Prescriptive Framework for Problem Definition, proposed by Smith (1989a) that is not empirically tested.
- A Group Problem Definition Process Using Visual Representation, proposed by Massey and Wallace (1996) as a result of empirical research.
- Problem Expansion (PE) and Strategic Assumption Surfacing and Testing, theories summarised and empirically compared by Buyukdamgaci (2003).
- The PEplusSAST methodology proposed by Buyukdamgaci (2003) that is not empirically tested.

Kilman and Mitroff (1979) address the application of intervention theory and the consultation process to problem-defining in efforts to minimise Type III Errors, in the context of changing organizations. They define the Consulting / Intervention Process in the circular steps of: (1) sensing problems (2) defining problems (3) deriving solutions (4) implementing solutions and (5) evaluating outcomes. They state that while consultants realise that they are trying to solve or manage some organizational problem, they often are quite implicit as to what or who defines the problem to be addressed; they assume that the top manager or individual who has hired them knows what the problem is and why the particular consultant was contracted, and quite naturally perceive that the problem facing the organization is based on their area of expertise. A question tabled in this paper is "How do members of the organization, with or without the aid of a consultant, define what the basic problem is?" This is answered by the view that that more often than not, it seems that individuals (including consultants) assume that their view of the world (their speciality) defines the essence of the problem. Consultants are often contacted to solve already defined problems, and the later the consultant enters into the problem-solving process (that is, after problem-defining) the more likely that the organization and the consultant will commit a Type III Error. Kilman and Mitroff (1979) postulate that, given the current (1979) state of the art of problem-solving, the best that can be done in terms of methodology for problem definition is as follows:

- Formulate several different definitions of the problem situation.

- Debate these different definitions in order to examine critically their underlying assumptions, and possible consequences.
- Develop an integrated and synthesized problem definition by emphasizing the strengths or advantages of each problem definition while minimising the weaknesses or disadvantages.
- Include those persons in the above steps who are experiencing the problem, who have expertise to define problems in various substantive domains, whose commitment to the problem-definition and resulting change programme will be necessary for that programme to be implemented successfully, and who are expected to be affected by the outcomes of any change programme attempting to solve or manage the perceived problem.

Kilman and Mitroff (1979) highlight the risk of assuming that the individual or organization knows what the problem is and propose a methodology for including a consultant or team of consultants in the defining problem step. However, the paper does not adequately address the steps an organization must take to analyse the extent to which it has adequate problem domain knowledge, to search for external problem domain experts, and how and where to apply such experts in the problem-defining process.

The effectiveness of problem-defining mechanisms applied in an organization will be influenced by the extent to which prior learning (e.g. experience, knowledge and skill) can be applied. The question, "How does one define problems if the organization or person involved is not experienced, knowledgeable and skilled in areas in which the problem exists?" remains. In addition, the question exists, "Is there a sufficiently comprehensive process for problem-defining that can be applied at managerial and non-managerial levels within an organization?"

The key issues detailed above were synthesized and expanded into the process model depicted in black in Figure 4, with the literature sources marked.

Figure 5 indicates the process model depicted in black and endorsed in blue to represent the gap in existing literature arising from the former of the two above questions.

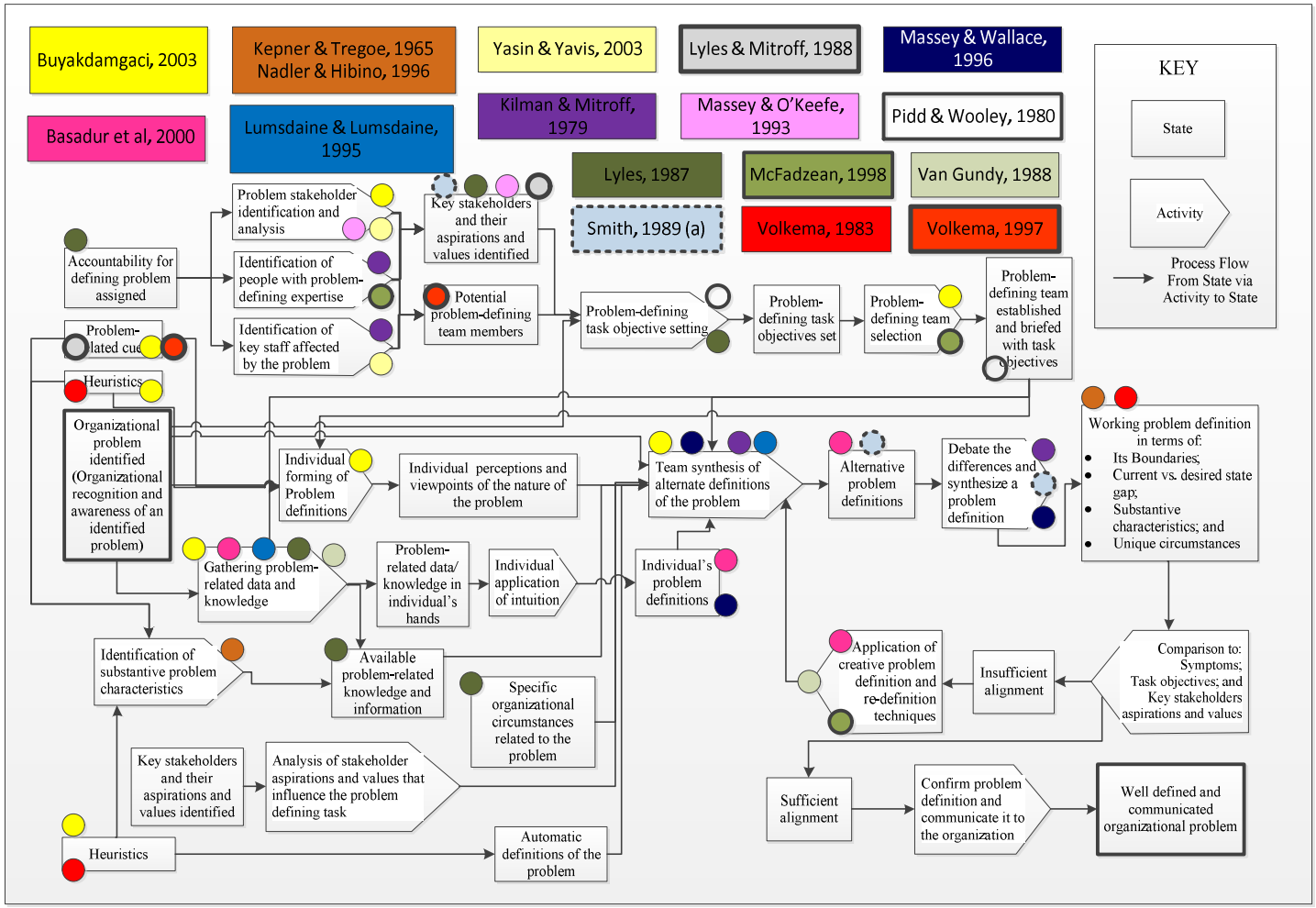

Figure 4. The problem-defining process developed by the author, literature sources marked

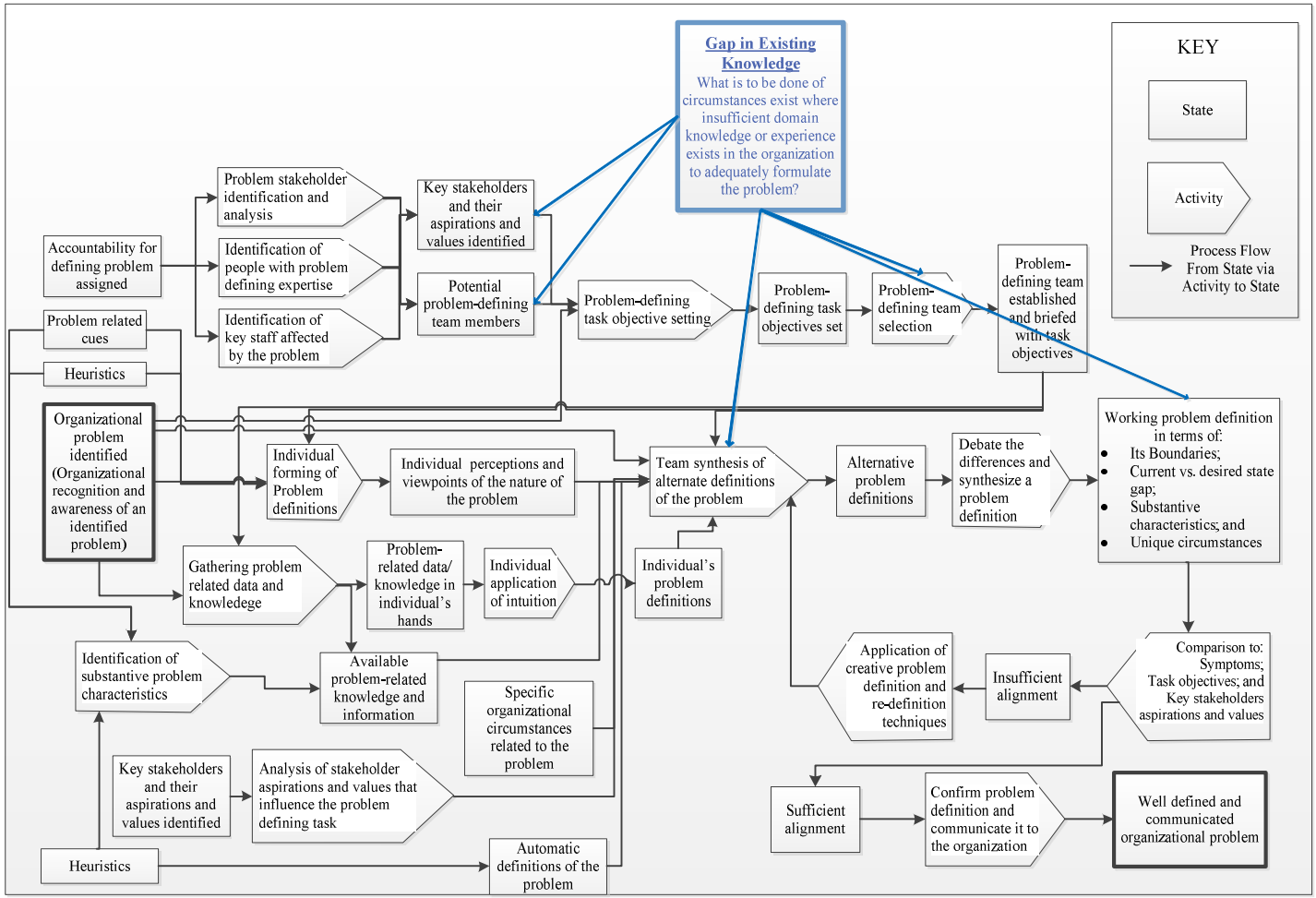

Figure 5: Problem-defining process, with gap in existing knowledge indicated

2.1.5. Ensuring that well-defined problems are solved

Portfolio Report 2, Section 4, pages 43-54 addresses processes for solving well-defined problems. This problem-solving process consists of problem-identification, problem-definition, the identification of likely causes and determination of the most likely causes, alternative solution generation, and choice of a solution, implementation and testing (Kepner and Tregoe, 1965; Massey and Wallace, 1996). Figure 6 shows a summary of the overall problem-solving process. Initially well-defined problems may be solved by using standard operating procedures, whereas ill-defined problems are characterized by multiple possible goals, and multiple possible and acceptable solutions requiring creative problem-solving skills, and reconciling these competing goals. Redefining the problem in a way that would take these competing goals into account will result in higher quality solutions (Fontenot, 1993; Reiter-Palmon and Illies, 2004).

2.1.6. Treating ill-structured problems

Portfolio Report 8 reviews literature related ill-structured problems, which required different approaches to those requiring and benefitting from more rational and optimal solutions. To treat such problems, a collection of Problem Structuring Methods (PSMs), which facilitate productivity of a group process emerged (Ackermann, 2011; Eden and Ackermann, 2006). PSMs include but are not limited to Soft Systems Methodology (SSM), Strategic Options Development and Analysis (SODA), Strategic Choice Approach (SCA), Strategic Assumption Surfacing and Testing, as well as Drama Theory, Decision Conferencing, Robustness Awareness and Viable Systems Model. SSM, SCA and SODA have the most extensive track record (Ackermann, 2011; Rosenhead, 1996; Mingers and Rosenhead, 2004; Reynolds and Holwell, 2010).

Portfolio Report 8 concludes that PSMs may be applied to problems that can become well-defined. However, without sufficient problem domain knowledge or experience the application of a PSM will result in inadequate success whether applied to ill-structured problems or to problems that can become well-defined.

It remains to be determined if the application of a PSM to a problem that can become well-defined will be as efficient as the processes of problem-formulation with innovation described in Portfolio Report 5. This is matter that requires further analysis, but it is not essential in addressing the research question.

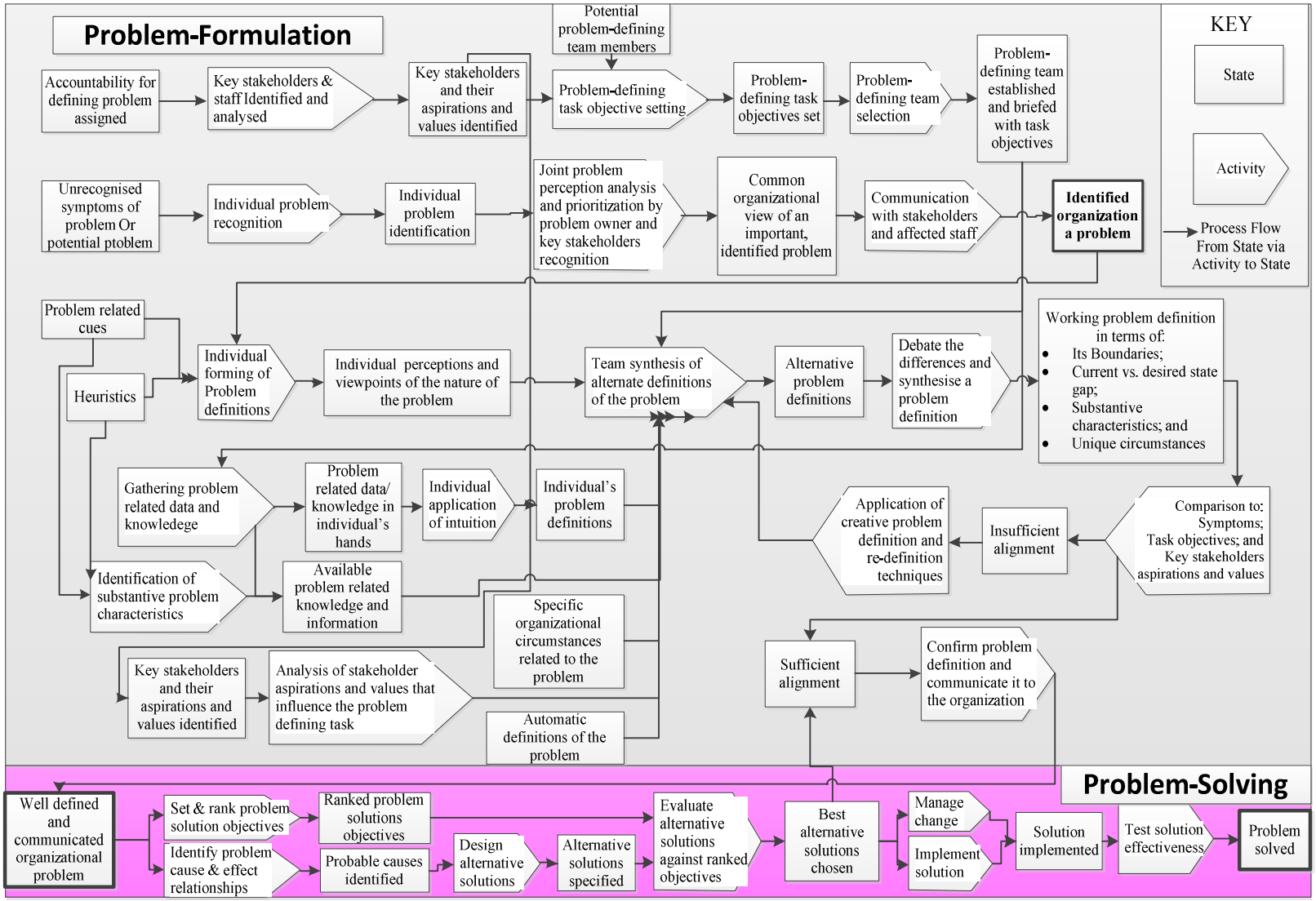

Figure 6. The overall problem-solving process developed by the author

2.1.7. Ensuring that problem domain knowledge is created and made available to others in organizations

Section 2.1.4, page 24 raises the question, "How does one define problems if the organization or person involved is not experienced, knowledgeable and skilled in areas in which the problem exists?" In addressing the question, the meanings of the experience, knowledge and skill in the context of the problem domain need to be developed further.

Knowledge

Knowledge is possessed by individuals and exists in the human brain or it is outside them in the organization itself; it is that which is known, concepts, contextual information, expert insight, facts, interpretations, justified true beliefs, what is learned from experience, principles, understanding and skills that a person has acquired through experience or education; the theoretical or practical understanding of a subject (Alavi and Leidner, 2001; Bennet and Bennet, 2008: Hornby, 1995: 656; Lang, 2001; Lok and Mofulatis, 2003; Macdonald, 1981:729; Malhotra, 2002; Nonaka and Takeuchi, 1995; O'Dell and Grayson, 1998; Ortenblad, 2001; Schulz, 2003: Stevenson, 2010:976; Stonehouse and Pemberton, 1999). Notwithstanding the various terms used above, a compelling meaning of knowledge is that it is a justified belief or commitment that increases an entity's capacity for effective action (Alavi and Leidner, 2001; Nonaka and Takeuchi 1995).

Experience

Experience is the process of gaining knowledge or skill over a period of time through trial or practical contact with, and observation of, events; seeing or doing things rather than through studying (Hornby, 1995: 404; Macdonald, 1981: 460; Stevenson, 2010: 615). Experience in a domain leads to well-developed knowledge structures that have a major impact on problem representation quality (Vera-Munoz, Kinney Jr, and Bonner, 2001).

Skill is the ability to do something well, a particular ability, expertise, expertness (Hornby, 1995: 1109; Macdonald, 1981: 1266; Stevenson, 2010: 1671).

Domain

A domain is a specified sphere or field of activity or knowledge or activity (Hornby, 1995: 344; Macdonald, 1981: 384; Stevenson, 2010: 519).

Problem domain knowledge

Problem domain knowledge is the part of knowledge that is related to the problem and is essential for problem-solving; it includes both explicit and tacit knowledge (Yang, Zheng and Bo, 2008).

Problem domain experience

Vera-Munoz, Kinney Jr, and Bonner (2001) state that domain experience consists of encounters related to a particular discipline that provides the opportunity for acquiring knowledge about that discipline. This reinforces the conclusion that problem domain experience will therefore be knowledge of the domain that is limited to that gained through trial, practical contact with or observation of rather than being gained by studying.

Domain knowledge and domain experience in the context of problem-solving

It is important to establish the relevance of problem domain knowledge and experience to problem-solving. Knowledge is a broader concept than experience or skill alone. Knowledge can be acquired through education or experience. Organizational knowledge is the learning that occurs at a group or divisional level in an organization (O'Dell and Grayson, 1998).

The problem domain can be classified in terms of size, complexity, and degree of structure (Kim and Courtney, 1988). Knowledge of the problem domain is important; it has long been recognised as a major component of decision-making and expertise constitutes a large body of domain knowledge. The experience and knowledge brought to the problem-solving process determine the quality of representation of the problem; and whether and how a solution will be reached. A novice in the problem domain may not be able to complete later steps in the problem-solving process due to a lack of knowledge (Chi and Glaser, 1985; Devine and Kozlowski, 1995; Eirman and Philip, 2003; Glaser, 1984; Wiley, 1998; Yang, Zheng and Bo, 2008). Thus, a person without experience will be equipped only with available explicit knowledge. Knowing how to solve problems begins with understanding that the problem-solver needs resources that include time,

money and knowledge. Therefore, knowledge is fundamental to the problem's representation and a firm's ability to solve problems. Solving complex problems in particular may require additional knowledge to be acquired through internal or external networks; managers must decide how to access relevant knowledge either within or outside the firm (Bowman, 2008; Chi and Glaser, 1985; Nickerson and Zenger, 2004; Woiceshyn and Falkenberg, 2008). Also, Kuo (1998) indicates that intuition requires knowledge, is domain specific and enables individuals to grasp the meaning, significance and structure of a problem. These themes recognise the importance of problem domain knowledge to problem-solving as did Kilman and Mitroff (1979) in proposing the Consulting / Intervention Process. However, a fundamental limitation prevails. That is, adequately addressing the steps that an organization must take to analyse the extent to which it has adequate problem domain knowledge; to search for external problem domain experts and how and where to apply such experts and / or their knowledge in the problem-defining process.

Organizational knowledge creation involves developing new content or replacing existing content with the organization's tacit and explicit knowledge; it evolves through interactions between new knowledge and prior, related knowledge; where prior knowledge can aid the recognition and establishment of connections to new knowledge (Alavi and Leidner, 2001; Gay, 2001; Schulz, 2003). Knowledge can exist in an explicit form (structured in words and/or visual representations in electronic or paper), or in an implicit form (being stored in an individual's memory), or in a tacit form (being unstructured and residing in the human mind). Knowledge for problem-solving includes prior experiences with similar projects or processes, involvement with professional societies, and prior education. Without management, knowledge is largely tacit in nature (Bennet and Bennet, 2008: Lok and Mofulatsi, 2003; Minkler, 1993; Nonaka and Takeuchi, 1995; Radding, 1998; Stonehouse and Pemberton, 1999). Tacit knowledge is highly personal and hard to formalise; it includes insights, and intuition and is deeply rooted in an individual's action and experience, as well as in the ideals, values, or emotions he or she embraces (Nonaka and Takeuchi, 1995). Tacit knowledge contains a cognitive dimension that is important to the processes of problem-solving; it reflects our image of reality and our vision of the future (Nonaka and Takeuchi, 1995). Four modes of knowledge creation have been identified: socialization, externalization, internalization, and combination. Socialization refers to the conversion of tacit knowledge to new tacit knowledge. Externalization refers to the conversion of tacit knowledge to new explicit knowledge. Internalization refers to the creation of new tacit knowledge from explicit knowledge. Combination refers to the creation of new explicit knowledge by merging, categorising, reclassifying and synthesizing existing explicit knowledge (Alavi and Leidner, 2001;

Nonaka and Takeuchi, 1995; Radding, 1998). Of particular interest in the context of problem-solving is the process of socialisation, since it entails transferring tacit knowledge from the mind of one person to create tacit knowledge in the mind of another person (Alavi and Leidner, 2001; Nonaka and Takeuchi, 1995; van Zolingen, Streumer & Stooker, 2001).

Making domain knowledge available

Making knowledge available to others in the organization is addressed by the concept of knowledge management. A theoretical model exists that categorises knowledge management practices according to their contribution to the problem-solving process, as shown in Figure 7.

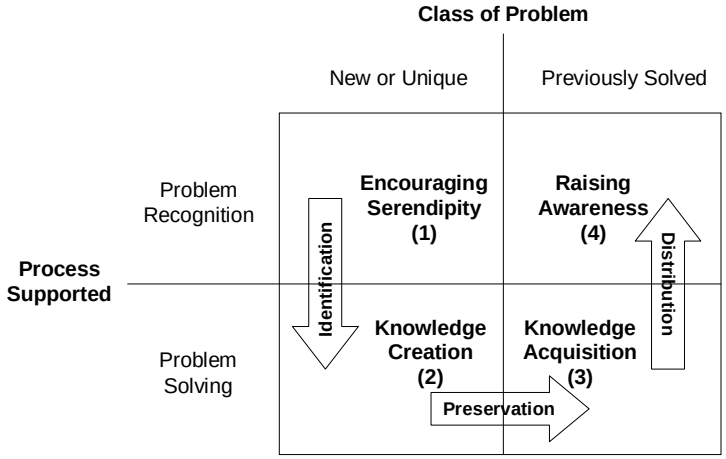

Figure 7: A framework for knowledge management practices (Source: Gay, 2001)

Cell 1 represents knowledge management practices that relate to the discovery of new problems. In Cell 2, organizations support the creation of knowledge by employees, aware of a new problem, who are developing new solutions. In Cell 3, organizations engage in practices that capture and retain knowledge, making it available to others seeking solutions to previously solved problems. In Cell 4, organizations undertake activities designed to help employees realise that they may be facing problems previously addressed and for which solutions have been developed (Gay, 2001).

The concepts of problem domain knowledge and problem domain experience should be separated. Explicit knowledge can be obtained by searching for it in a documented form either inside or outside the organization. On the other hand, if the necessary knowledge is not available in explicit form and the problem-solving team lacks experience in the problem domain, experts'

tacit knowledge must be sought. This requires searching for problem domain experts with whom the process of socialisation and / or externalisation may be applied.

In summary, problem domain knowledge in an explicit form can be created and shared in an organization through enquiry into documented explicit knowledge and applying the processes of internalisation and combination. Problem domain experience is often in the form of implicit or tacit knowledge that must be made available through the processes of socialisation and externalisation. Where implicit or tacit knowledge does not exist in an organization, it must be obtained externally from domain experts, from whom their informal knowledge (based on problem domain related experiences) can be sourced. It is therefore important to see the difference in the ways of sourcing problem domain knowledge in an explicit form from that which exists in the form of experience (i.e. undocumented tacit knowledge).

Apart from the knowledge management process outlined, there remains a need to introduce problem domain knowledge into problem-solving. Three ways, found in the literature, were considered as a means to introduce problem domain knowledge into the process of problem-formulation and are explored further in Section 2.1.8.

2.1.8. Ways to introduce knowledge into the process of problem-formulation

The ways to introduce problem domain knowledge into the process of problem-formulation are through Action Research, Creative problem Solving and Collective Creativity. These are expanded on as follows.

Action research

Action research is a cyclical process that involves diagnosing a problem situation, planning action steps, implementing and evaluating outcomes, that produces a different kind of knowledge, a knowledge which is contingent on a particular situation, and which improves the capacity of members of the organization to solve their own problem. Action research is a way in which the combined expertise of skilled authors and skilled practitioners are involved in problem-formulation (Afify, 2007; Marsick, Gephart and Huber, 2003; Mullen, 2002). Action research is distinguished by the involvement of the researcher, taking a role such as facilitator or consultant with expertise in the particular industry, having some influence on choices and accepting the accountability that this implies (Nord, Ed., excerpt by Eden and Huxman, 2006, pages 388 to 408).

Although Afify (2007) goes on to describe methods of action research, neither he nor Mullen address the point at which an organization realises that there is insufficient problem domain knowledge to effectively define the problem or where to apply consultant- or author-sourced knowledge in the problem-solving process.

Creative problem solving

The Creative Problem Solving Profile is a four-quadrant process of generating, conceptualizing, optimizing and implementing. It embodies the concept developed by Guilford (1967) for gaining knowledge through cognition (by experience, recognition) or through convergent production (generation from information given) (Basadeur and Gelade, 2003). This approach does not address the possibility that an individual or an organization may not possess sufficient problem domain knowledge or where to apply gained knowledge in the problem-solving process.

Collective creativity

The Collective Creativity approach is based on the concepts of help seeking, help giving, reflective framing and reinforcing that recognise the issue of insufficient problem domain knowledge where help is derived from entities such as management consultants, internal consulting groups and product design groups (Hargadon and Bechly, 2006). This approach, however, does not address the matter of what stimulates the search for knowledge or where to apply gained knowledge in the problem-solving process.

Addressing inadequate domain knowledge

Fundamental to ensuring that adequate problem domain knowledge is created and made available to the organization is the recognition that it is possible that inadequate problem domain knowledge exists to enable the process of problem-solving to be successful. The only reference in literature to identifying a state of inadequate knowledge in the context of problem-solving is in the work of H. William Dettmer.

Dettmer (2007a, 2007b, 2008) expands on Eliyahu Goldratt's approach to continuous improvement based on the Theory of Constraints, including the Logical Thinking Process. Dettmer (2007a, page 164) states in addressing the impact of hidden conflict that, "*Maybe the only*

reason we can't resolve our problem is that we just don't have enough intuitive knowledge to work it out – and if we did, we would. If inadequate knowledge was really the roadblock, good minds and better intentions should have overcome this obstacle already. The only way to know for sure whether the problem is perpetuated by a conflict or inadequate knowledge is to try to build an Evaporating Cloud (EC). If a conflict is really present, it will show up in the EC." Whilst Dettmer provides a method to identify if conflict or inadequate knowledge impedes the solving of a problem, he does not address ways to proactively recognise or address circumstances of inadequate knowledge in the problem-formulation process.

It is possible to conclude that theoretically, for problems that are recurrent and are of a similar nature, an organization could make available to others relevant problem domain knowledge. However, two issues of concern surrounding the existing body of knowledge remained, as expressed in the questions:

- How does the availability of problem domain knowledge affect the process of defining ill-structured problems?
- Can organizations ensure sufficient conversion of tacit knowledge to explicit knowledge, the dissemination thereof, and the internalisation of knowledge (in the persons engaged in problem solving) to ensure the availability of problem domain knowledge to support the solving of problems?

A fundamental limitation therefore prevails. That is, adequately addressing the steps that an organization must take to analyse the extent to which it has adequate problem domain knowledge; to search for external problem domain experts and how and where to apply such experts and / or their knowledge in the problem-formulation process.

2.2. Conclusions reached from the review of literature

Two types of problems affect organizations, namely messy problems and problems that are, or can become, well-defined. Messy problems are typically of a strategic nature. Messy problems have no single best way of being formulated and cannot be solved by solving each of their component problems They are treated by being resolved or dissolved by applying PSMs.

Operational problems and some strategic problems can become well-defined, through a process of problem-formulation. The ways of treating such problems is by processes of resolution (providing

an outcome that satisfices) or solution (providing the best possible outcome). With respect to such problems, the following applies:

- Problem-identification, followed by problem-definition.
- Ensuring accuracy in the definition of a problem is essential. The action of producing a well-defined problem reduces the risk of solving the wrong problem.
- Problem-defining methodologies and techniques that exist are yet to be documented as having been tested empirically, but could enable the process of problem-definition.
- There is not a single comprehensive problem-formulation process.
- None of the existing processes of problem-formulation adequately addresses the possibility that an organization does not have the required domain knowledge or experience.
- Methodology and techniques exist for developing, evaluating and selecting solutions to problems, and for implementing problem solutions.

Knowledge of the problem domain is important; it is fundamental to the problem's representation and a firm's ability to solve problems.

- In the case of problems that can become well-defined, the experience and knowledge brought to the problem-solving process determine the quality of the representation and whether and how a solution will be reached.
- In the case of messy problems, there is need to draw on a broad knowledge base and share usable new knowledge applicable to that problem to enable long-term dissolving capability.

Knowledge is a broader concept than experience or skill alone. Knowledge can be acquired through education or experience; it exists in three forms, explicit, implicit and tacit, the transfer of which occurs through socialization, externalization, internalization and combination. Three ways exist in which problem domain knowledge can be introduced into the process of problem-formulation, namely through action research, creative problem solving and collective creativity.

Fundamental to ensuring that adequate problem domain knowledge is created and made available to the organization is the recognition that inadequate problem domain knowledge exists. Existing literature does not address ways to proactively recognise circumstances of inadequate domain knowledge in the problem-solving process, or adequately deal with introducing the domain knowledge needed therein.

3. The empirical research

In 2004, a situation occurred which could provide a valuable contribution to the research. At that time the author had recently been requested by Eskom Enterprises (Pty) Ltd (Eskom Enterprises) to participate in difficult negotiations for intra-company contracts for the provision of telecommunications services. The negotiations, which had been on-going and largely failing since 2000, were heading for a breakdown. They were characterized by ill-informed bargaining, dysfunctional behaviour, and intra-company politics and not the substantive matters that should underpin a successful outcome. The author recognised the possibility that within Eskom there was not enough domain knowledge or experience to enable successful negotiations to be concluded.

The operation of a telecommunications system, with levels of availability and reliability that often exceed commercially available telecommunications services, is a crucial factor in determining the performance of Eskom's electricity network (therefore also of its core business). Consequently, the matter of Contracting for Telecommunications Services in Eskom has industrial relevance and is significant in the performance of Eskom. A unique opportunity was thus presented for the author to obtain access to a significant problem situation in Eskom, and observe and participate in the process of problem-formulation. Having obtained authorisation, the author during 2004 and 2005 participated in and observed the events that led to a successful conclusion of contracts for telecommunications services for Eskom.

3.1. Research methods

3.1.1. Research paradigm

The choice of research paradigm is dealt with in Portfolio Report 3, Section 4, pages 25 to 26. The factors that influenced the choice are as follows:

(a) The author wished to study in-depth situations relevant to the subject of the research and, if possible, use it as part of the basis for answering the research question.

(b) The possibility existed of being able to adapt existing knowledge and explore if it could be applied in a way that would contribute significantly to Eskom.

(c) The preference existed for obtaining, analysing and understanding meaning derived from data concerning the subject of this research.

Table 1 subjectively compares factors (a), (b), and (c) to features that describe the positivist and phenomenological research paradigms (Hussey and Hussey, 1997, pages 52 to 53; Remenyi, Williams, Money and Swartz, 1998, pages 33 to 34; Welman, Kruger and Mitchell, 2005, page 6). Based on this comparison a phenomenological research paradigm is chosen for this research.

Table 1: A subjective analysis of issues concerning the nature of the research project

Positivistic Paradigm	**2**	**1**	**0**	**1**	**2**	**Phenomenological Paradigm**
Author independent of the subject of the research; and objective observer / analyst of social reality					(a)	Author not independent of social reality
Study to be conducted in terms of objective observations and measurements					(a)	Study focussed on the meaning, rather that measurement of social phenomena
Quantifiable observations and statistical analysis, leading to laws explaining objectively observed and measured behaviour			(b)		(c)	Qualitative approach which stresses the subjective aspects of human behaviour, that can be modelled (but not necessarily mathematically)

3.1.2. The research approach: Action research vs. participant observations

Fundamental to the choice of a research strategy is the question of the extent to which the author intends to influence or manipulate the subject of the research, or to use the role of participant as a basis for making observations. In other words, is the research strategy based on an Action Research approach or is it another form of empirical research including participant observations as

a source of data? The comparison of an action research approach to that of participant observation is explored below.

Action research

Action research has a number of characteristics that are relevant to the question concerning the research approach. These are listed below.

- It always involves two goals: to solve a problem for the client and contribute to science.
- It is distinguished by an involvement by the researcher with members of organizations over matters of genuine concern over which they intend to take action; where the members of the organization participate actively in the design, data gathering and analysis of the research.
- It demands an integral involvement by the researcher to plan and achieve change for the organization. It must be concerned with intervening in action; it is not enough for the researcher simply to study the action of others.
- The researcher is visible and is aware of the impact that his or her presence has on the organization, and the researcher is expected to have an impact.
- There is collaboration between the researcher and the researched that is seen to be part of the change; where the researcher takes the role of facilitator or and expert consultant to the client.
- It involves taking a static picture of the organization from which a hypothesis is formulated, manipulation of variables being controlled by the researcher, taking and evaluating second and subsequent pictures of the organization.
- It must have some implications beyond those required for action or generation of knowledge in the domain of the project.

(Afify, 2007; Easterby-Smith, Thorpe and Lowe, 2000, page 8 and page 33; Hussey and Hussey, 1997, pages 64 to 65; Marsick, Gephart and Huber, 2003; Nord (Ed.), 2006; Partington (Ed.), 2002, pages 255 to 257; Remenyi, Williams, Money and Swartz, 1998, pages 49 to 50).

From the above list the only criteria that are applicable to the intended research approach are the first and last bullet points. The intent was to find a different way of doing things, solving the problems leading to the failed negotiations for contracting for telecommunications services in Eskom, potentially enhancing the probability of success by the introduction of increased domain knowledge and experience. In doing this, as well as solving a significant problem for Eskom, the

intent was to obtain data from which new knowledge could be generated and applied to the gap in literature as expressed in the research question.

Participant observation

The different types of roles that a researcher can play in observation are depicted in Table 2.

Table 2: Summary of participant observation roles (Source: Remenyi, Williams, Money and Swartz, 1998, p111)

Role of Researcher	**Degree of Involvement**	**Potential Problems**
Type 1	Complete participant as a normal member of the organization	Pretence problem – how normal is the behaviour of the setting
Type 2	Participant as observer- researcher and organization members aware of the author's status	Researcher 'going native'
Type 3	Observer as participant	Limited involvement of the researcher
Type 4	Complete observer	Limited usefulness – mainly for reconnaissance

In the role of a complete or non-participant observer, the researcher simply collects data and has no involvement with the participants (Hussey and Hussey, 1997). This role is not applicable to the opportunity described above. The circumstances presented align more closely to the author becoming a 'complete participant as a normal member of the organization', having been requested by Eskom Enterprises in 2004 to become involved in negotiations with Eskom on this matter. Certainly, in this case the author was neither 'going native' nor was the involvement expected to be of a limited nature. Therefore, the role of the author in the empirical research is that of Type 1 as described in Table 2. In this role, participant-observation is a method of collecting data where the author is fully involved with the participants (Hussey and Hussy, 1997; Partington (Ed.) (2002), in an excerpt by Singh and Dickson (pages 121 to 122); Yin, 2003).

The research approach chosen

In evaluating the merits of an action research versus a participant observation approach, the author did not influence events, in the mode of action research. There was no intent, from a research perspective, to manipulate variables that could be controlled by the author. Rather, having

achieved access to the problem situation, the author then participated as part of the normal organization and collected data relevant to the research question through participant observations.

3.2. The research strategy

The development of the research strategy chosen is addressed in Portfolio Report 3, Section 6, pages 33 to 37. This report established that the purpose of research into "Contracting for Telecommunications Services in Eskom" is exploratory and descriptive, to which a case study strategy would be appropriate (Marshall and Rossman, as quoted by Remenyi, Williams, Money and Swartz, 1998; Yin, 2003, page 3).

The choice of a case study strategy is reinforced by considering the suggestion of Yin (2003, page 5) that three conditions linked to the form of the research question distinguish alternative research strategies, namely (a) the type of research question posed, (b) the extent of control an investigator has over actual behavioural events, and (c) the degree of focus on contemporary as opposed to historical events. This relationship is shown in Table 3.

Table 3: Relevant situations for different resarch strategies (Source: COSMOS Corp., cited in Yin, 2003, p3)

Strategy	Form of Research Question	Requires Control of Behavioural Events	Focuses on Contemporary Events
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/No
History	How, why?	No	No
Case Study	How, why?	No	Yes

Considering the research question depicted in Section 1.7.3, Table 3 shows that it is closest to a "How" question and that the research will be based on contemporary and / or recent historical events. The conclusion that the appropriate research strategy is a case study is affirmed.

3.2.1. A single case study or multiple case studies

Yin (2003, pages 39 to 42) establishes criteria upon which a single case study is justified.

- A single case study is appropriate if it is a critical case in testing a well-known theory, which in terms of this research is not the primary purpose.
- In circumstances where the case represents a unique case which this is. The case study is unique in as much as this was a single opportunity for the author, at the time, to explore sources of rich data, to observe the application of certain aspects of the body of knowledge, and to participate in and observe a situation of potential innovation applied to such knowledge. Also, the author was in the situation of having unique access for research into to this problem situation in Eskom.
- The case represents circumstances where the case study is a representative or typical case which is not determined definitively.
- Circumstances exist where the case study is revelatory or where the opportunity exists to observe and analyse phenomena previously inaccessible to scientific investigation which is valid for this research. Circumstances existed at the time, in Eskom, of potentially inadequate levels of domain knowledge or experience to adequately formulate a problem, and failure to recognise the inadequacy of such knowledge. This was a situation that to the author's knowledge had not been the subject of prior research.
- The case study is longitudinal in that it studies the same case over two or more different periods of time, which in terms of this research is not the case.

Having analysed this research it terms of the above criteria it is concluded that the second and fourth criteria mentioned above apply and thus a single case study method is appropriate. Notwithstanding this conclusion, it remains imperative to provide proof of careful triangulation of the evidence collected (Remenyi et al, 1998, page 179).

Normally, a pilot study would be conducted to establish the case study constructs. However, in this case, quick and decisive action to address the problem was needed because the situation had become urgent. This case provided a unique opportunity for participant observation. Thus, a prior pilot study was not feasible.

3.3. The single case study research design

Yin (2003, p19) states that a research design is the logic that links the data to be collected to the initial questions of the study. In addition, the development of the case study needs to maximise four conditions related to design quality: (a) construct validity, (b) internal validity (for explanatory and causal case studies only), (c) external validity, and (d) reliability.

The case study work breakdown structure as shown in Figure 8 was applied, incorporating the above aspects of research design.

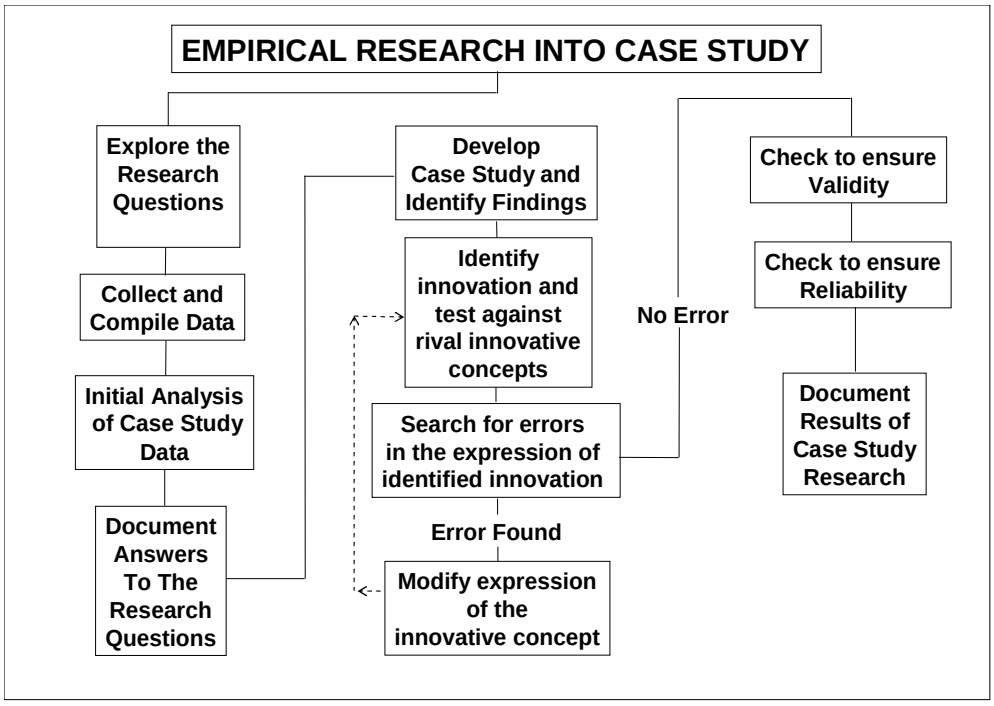

Figure 8: Outline work breakdown of case study

In considering theoretical options for a suitable work breakdown, the approaches contained in Hussey and Hussey (1997), Welman, Kruger and Mitchell (2005), Remenyi et al (1998) and Yin (2003) were reviewed and none found to be totally appropriate to the type of case study envisaged, the closest being as depicted by Yin (2003, page 50). In order, therefore, to ensure a well-planned method that addressed the need to find and test innovative concepts, the work breakdown shown in Figure 8 was developed and applied.

3.4. The quality of the research design

The work breakdown shown in Figure 8 makes reference to tests for validity and reliability. The typical tests that are applicable in whole or part to this research project are shown in Table 4.

Table 4. Case study tactics for four design tests. (Source: COSMOS Corporation as cited in Yin, 2003: page 34).

Tests	Case Study Tactic	Phase of Research in which Tactic Occurs
Construct validity	Use multiple sources of evidence	Data collection
	Establish chains of evidence	Data collection
	Have key informants review draft case study report	Data collection
Internal validity	Do pattern-matching	Data analysis
	Do explanation building	Data analysis
	Address rival explanations	Data analysis
	Use logic models	Data analysis
External validity	Use theory in single-case studies	Research design
	Use replication logic in multiple-case studies	Research design
Reliability	Use case study protocol	Data collection
	Develop case study database	Data collection

- *Construct Validity or Objectivity/Conformability* relates to ensuring that the correct operational procedures are in place and sufficiently detailed to provide an audit trail of data collection.
- *Internal Validity* relates to establishing whether the findings of the study make sense; establishing causal relationships, whereby certain conditions are shown to lead to other conditions, as distinguished from spurious relationships.
- *External Validity* relates to the establishment of the domain in which the case study's findings can be generalised.
- *Reliability* relates to the consistency of the process of the study, being able to demonstrate that the operations of the study can be repeated, with the same results, within the limits of experimental error (Yin, 2003: pages 33-39).

3.4.1. Construct Validity

In terms of the Table 4 above, the following is relevant concerning construct validity.

Multiple sources of evidence

The sources of evidence most commonly used in doing case studies are interviews, documentation, archival records, direct observations, participant-observation and physical artefacts (Partington, 2002, page 164 and page 172; Remenyi et al, 1998, page 110; Yin, 2003, page 85). The benefits from these sources of evidence can be maximised by following the principles of multiple sources of evidence, creating a case study data base and maintaining a chain of evidence (Yin, 2003, page 105). The use of multiple sources of evidence in case studies allows the investigator to address a broader range of historical, attitudinal, and behavioural issues; developing converging lines of inquiry by applying a process of triangulation (Yin, 2003, page 98).

Portfolio Report 4, Section 2.11.2 Evidence Data Base addresses multiple sources of evidence. Multiple sources of documented evidence have been used and are recorded in an Evidence Data base in Portfolio Report 4 Appendix 2. They comprise 9 Interviews, 19 Archive Records and 103 Documents. In addition, the participant observations of the author are recorded in Portfolio Report 4, Appendix 4. In the case of interviews, only data from at least two corroborated interview sources has been used. Data from the all sources has been triangulated to produce the basis for the case study findings, often from three or all of the four sources. Portfolio Report 9, which codifies the innovation, establishes interview data as the primary source of data, corroborated as appropriate, by data from documents and participant observations.

Nine interviews were conducted with persons who had significant involvement in the processes of negotiating for telecommunications services in Eskom during the period 2000 to 2005. The interviewees were representative of negotiation participants including externally-sourced experts. The interviews were based on the research question expanded into thirty eight sub-questions and addressed the units of analysis and variables (including chance variables) as described in Section 3.4.4., page 53, and categorised as shown in Table 5, page 50. The interviews were recorded and transcribed; interview data analysis is contained in Appendix 7 of Portfolio Report 4.

Portfolio Report 9 (Codifying the Innovation) demonstrates the use of interview data as a primary source in establishing a robust relationship between the data obtained and the areas of innovation. An example of codifying the data, extracted from Portfolio Report 9, is shown in Table 6, page 51, in which the highlighted words show the connections between the empirical data, the

interpretation of that data and the innovative process element. This example represents one of fourteen case study questions and sub-questions used to codify the innovative process elements shown in red in

Figure 10 and
Figure 11.

Table 5: Research question categories

SUBJECT OF THE CASE QUESTION	QUESTION NUMBERS	SUBJECT OF THE CASE QUESTION	QUESTION NUMBERS
Background	1 to 3	Types of people involved in establishing Telecoms SLAs, including their problem area related skills / intuitive capability	12 to 16
Meeting of objectives for negotiating Telecoms SLAs	4	Degree of effectiveness of processes to establish Telecoms SLAs - 2000 to April 2004	17 to 23
Impact of motivation on Telecoms SLA negotiations	5 to 6	Parties involved in change of approach to negotiating Telecoms SLAs in April 2004	24 to 25
Impact of agendas on Telecoms SLA negotiations	7 to 8	Changes to and degree of effectiveness of processes to establish Telecoms SLAs – April 2004 to 2005	26 to 33
Impact of people's behaviour on Telecom's SLA negotiations	9 to 10	Degree of alignment of processes to establish Telecoms SLAs, in or after April 2004, to the existing body of knowledge	34 to 38
Extend to which problem solving skills were applied	11		

Table 6: Example of codifying the innovation

Case Study Question Reference	Interview Data	Additional Data	Interpretation of Data	INNOVATIVE PROCESS ELEMENT
Question 14 What was done to increase the level of knowledge of subject areas significant to the Telecommunications SLA negotiations over the period 2000 to 2005? Question 26 From April 2004 to 2005, what processes were followed to establish Telecommunications SLAs?	Appendix 8 Q 14: In the Eyethu process the consultant (Gemini) injected knowledge and best practice at Pricing Steering Committee and Working Group level (i.e. domain experts as an intrinsic part of the team). As shortcomings were identified, Gemini did research and brought back knowledge to the process. Appendix 8 Q 26: A review of the full Interview data shows that an iterative problem-formulation / solving process where Gemini (Domain experts) acted in expert capacity to address shortcomings.	Appendix 8 Q 14: Participant observations show that in 2004: • The Eyethu Pricing Steering Committee introduced expertise accessed by Gemini • Telecoms. Working Group brought together key negotiators with Eskom's and Gemini's experts Appendix 8 Q26: Participant observations show that Gemini, from May to August 2004, through and with the Telecoms. Working Group together (i.e. as an intrinsic part) worked extensively on key issues.	The data responding to the state external domain experts found above confirms that Gemini Consulting (Gemini) were found as domain experts. Data from Questions 14, 26, 29 and 31 is also considered, as follows. Extensive interview data establishes that Gemini were included as an intrinsic part of the iterative Telecoms. SLAs problem-formulation and solving process. As such domain experts were included as an intrinsic part of the problem defining team. This is supported by participant observation data and data from documents.	Domain experts included as an intrinsic part of the problem-defining team (Activity) See this and the next two page table elements.

Establishing Chains of Evidence

A chain of evidence has been established corresponding to the model depicted in Figure 9 below.

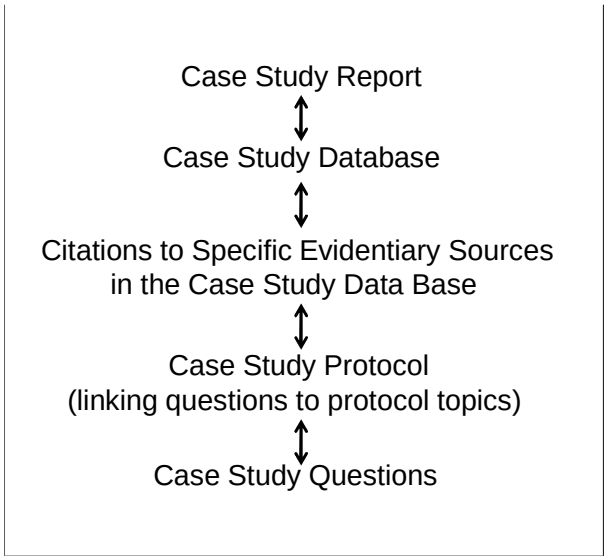

Figure 9: Maintaining a chain of evidence (Source: COSMOS Corporation as cited in Yin, 2003: page 106).

Having key informants review the draft case study report

The industrial mentor for this research project has regularly critically reviewed all draft Portfolio Project Reports related to the case study and approved submission into the Research Portfolio.

3.4.2. Internal validity

In terms of the Table 4, page 48, the following is relevant concerning internal validity:

Data analysis strategy

Three alternative strategies for data analysis were considered as follows.

- Relying on theoretical propositions.
- Considering rival explanations.
- Developing a case description.

(Yin, 2003, pages 111 to 114)

Although Yin (2003) indicates a preference for relying on the theoretical propositions that led to the case study, in this case it is not an appropriate strategy. This is because the purpose of the case study was to develop and test theories to address the gaps in existing knowledge. The strategy selected and built into the case study work breakdown is that of considering rival explanations.

The data analysis techniques that proved to be most valuable were explanation building and comparative analysis and logic models (Yin, 2003, pages 120 to 127) and Portfolio Report 4, Section 2.5.

3.4.3. External validity

In terms of Table 4 above, the following is relevant concerning external validity:

Use of theory

The issue to be addressed here is the extent to which the innovation can be generalised. This is a single case-study portfolio project. A tactic relevant for ensuring external validity in this situation is the use of theory (Table 4). This was done by presenting the existing theory as logic models. The deficiency of existing theory is shown, namely circumstances where the organization does not have adequate domain knowledge or experience to successfully formulate a problem. This has been postulated in the research question and identified in Figure 3 and

Figure 5.

Notwithstanding the successful application of the single case study tactic to provide external reliability, the author was subsequently able to apply the developed innovation in a different set of circumstances. These related to a problem formulated in an Eskom subsidiary company (Telecom Lesotho) to which the author was seconded as the Acting Chief Executive Officer in August 2005. This example of an application of the innovation is addressed in detail in Section 4.3, page 65.

3.4.4. Reliability

In terms of Table 4 above, the following is relevant concerning reliability.

The case study protocol and case study data base

A case study protocol was developed and applied in order to increase the reliability of the case study research and to guide the author in carrying out data collection. Aligning to Yin (2003, pages

67 to 69), the case study protocol described in Portfolio Report 4 (Page 14 to Page 34) was drawn up including the following sections:

- Overview of the case study project stating its objectives, purpose and the research question.
- 38 specific case study questions (Table 2.5, Portfolio Report 4, pages 28 to 30) were derived that guide the collection of data and the potential sources of information for answering each question.
- Units of analysis and case study variables are shown below:

  - Unit of analysis 1:

  The process of contracting for telecommunications services in Eskom.

  - Unit of analysis 2:

  The people involved in contracting for telecommunications services in Eskom.

  - Variable 1:

  The effectiveness of the problem-formulation process (dependent variable).

  - Variable 2:

  The level of problem domain skills (independent variable).

  - Variable 3:

  The level of problem domain capability (independent variable).

- Case study chance variables are shown below:

  - The level of motivation.
  - Agendas that are different to the Eskom objectives.
  - The level of problem-solving skills.
  - Participant behaviour.

The choice of categories of questions to be asked of the case study is intended to ensure that the relationship between the units of analysis, identified case study variables and possible chance variables is explored. (Portfolio Report 4, page 26). This can be seen in Table 5, page 50.

3.4.5. Ethical considerations (Portfolio Report 4, Page 72)

The case study protocol further included the following ethical considerations:

- Access to the relevant parts of Eskom in order to conduct the research.
- Conduct during the empirical research, particularly ensuring honesty in reporting results, the maintenance of participants' dignity and response to unrelated issues of company importance.
- Levels of confidentiality committed to, including publication of related material.
- Obtaining informed consent from the case study participants.

(Hussey & Hussey, 1997, page 37; Welman, Kruger & Mitchell, 2005, page 181)

These necessary ethical considerations are addressed in Portfolio Report 4 (pages 18 to 20) and Appendix 1 to Portfolio Report 4.

3.5. Summary and conclusions

The empirical research is an exploratory and descriptive single case study. It was conducted in response to a unique opportunity in Eskom to obtain access to, and conduct research into, a significant problem situation.

The empirical research undertaken was triggered by a request made, in 2004, for the author to participate in an addressing a problematic situation related to contracting for telecommunications services in Eskom, which had existed since 2000. This problem was significant to Eskom since the provision of the telecommunications services in question were a crucial factor in determining the performance of Eskom's electricity network (i.e. Eskom's core business). Whilst the author recognised the possibility that the people negotiating telecommunications services contracts did not have adequate domain knowledge, no prior hypotheses were developed or postulated related to the research question. It can therefore be concluded that an alternative approach to negotiations was about recognising that the current process was approaching that of a Type III Error, rather than a pre-determined way to improve the situation. The opportunity taken by the author was the initiation of a so far undetermined empirical research approach. Given that the empirical research would be conducted in a manner where the author would not be independent of social reality,

would be largely qualitative and would focus on the meaning of the phenomena observed, a phenomenological paradigm was chosen.

The empirical research undertaken included the author being a complete participant, as a normal member of the organization, observing the impact of the process of solving the problem of contracting for telecommunications in. It can therefore be concluded that the research included participant observation as opposed to being action research.

The research was primarily but not exclusively based on interviews, utilising and triangulating a mix of interview, archive record, document and participant observation data. However, interview data is a significant source of data as is evidenced in the process of codifying the innovations (as shown in Portfolio Report 9) and in the overall evidence analysis underpinning the case study.

Finally, Section 3.4 describes how the single case study was designed to be conducted rigorously and to achieve robustness. Two significant conclusions are made related to this. Firstly, construct validity was reinforced by using triangulated data from multiple sources of evidence including data sourced from interviews, participant observations, archive records and documents. Interview data, corroborated by data from other sources, is used primarily to codify the innovation. Secondly, the risk that a single case study poses in terms of external validity was mitigated through a thorough analysis of the established gaps in existing theory, presented in the form of newly-created logic models, together with subsequently being applied to a different situation, in a different industry in a different country.

4. The research results

Section 3 describes the design of the empirical research. This section will summarise the results of the case study, detail the research project findings and describe the innovation derived.

4.1. The case study: Contracting for telecommunications services in Eskom

The full case study is found in Portfolio Report 4, Section 3 (Page 35 to Page 62). The case study addresses the period 2000 to 2005 and focuses on how the establishment of Service Level Agreements (SLAs) for telecommunications products and services was addressed during that period. It emphasizes how problems associated with contracting for telecommunications services in Eskom were formulated and solved, and the extent to which problem-formulation enabled the successful conclusion of telecommunications services contracts.

The case study confirms that high quality telecommunications capability forms an integral part of the Eskom Holdings Ltd (Eskom) core business. Accordingly, the utility had historically invested in, and operated a private telecommunications network that was a significant and essential part of its electricity supply operations (Portfolio Report 4, Section 3.2, page 36). Prior to 2000, the Eskom telecommunications assets and resources were embedded into the cost base and structures of its operating divisions. Those assets and resources were transferred to Eskom Enterprises when it was created in 2000 as an Eskom wholly-owned subsidiary (Portfolio Report 4, Section 3.2, pages 36 to 37). In order to enable the provision of services to Eskom, direction was given for the establishment of SLAs between Eskom Enterprises and the rest of Eskom (Portfolio Report 4, Section 3.3, page 37).

The process followed to establish SLAs for telecommunications services during the period 2000 to April 2004 was based on one-on-one negotiations with individual Eskom operating divisions (Portfolio Report 4, Section 3.4, page 42). The SLA negotiations were difficult, protracted and influenced by attitudes of mistrust. Initially, and until April 2004, despite the involvement of consultants for specific assignments within Eskom and Eskom Enterprises, there was limited understanding of financial modelling for telecommunications products and services, comparisons of the telecommunications products offered by Eskom Enterprises to those available in the external market, or knowledge of designing SLAs comparable to those used in the external market

(Portfolio Report 4, Section 3.3, pages 38 to 39, page 43, pages 47 to 50). During the period 2000 to April 2004 only three out of twelve possible SLAs were concluded (Portfolio Report, Section 4.3, page 71).

In early 2004, there was concern at Eskom's Executive Committee (EXCO) level about difficulty in concluding telecommunications SLAs. At that time, on becoming extensively involved in negotiating SLAs for Eskom Enterprises, the author reviewed the status of negotiations and amongst other matters reached the following conclusions:

- Negotiations were largely unsuccessful.
- The members of the negotiating teams, despite past exposure to the work of consultants or opportunities to learn from the external market, were not able to reach agreement on the pricing of the more complicated telecommunications products.
- The overall objective to provide cost effective telecommunications services to support the Eskom core business, had been lost in favour of conflicting objectives of reduced costs (Eskom) and achieving sustained profits (Eskom Enterprises). There was no shared view of desired outcome. In fact, negotiations had reached the status of a Type III Error.

(Portfolio Report 4, Section 3.6, pages 52 to 53).

By April 2004, the author had obtained support from Eskom's top management (EXCO) to use the Eyethu Pricing Project process[1] for entering into SLAs between Eskom and Eskom Enterprises for 2004, and for long-term SLAs to be negotiated from 2005. The Eyethu Pricing Project was based on a working group principle utilising problem domain experts from Eskom's Corporate Finance Division and Gemini Consulting as an intrinsic part of an iterative problem-formulation and solving process. By the end of March 2005 an iterative process of problem defining and solving had resulted in the formal sign-off on SLAs (Portfolio Report 4, Section 4.3, pages 82 to 85). The SLA's entered into in 2005 have lasted for their intended duration (Portfolio Report 4, Section 3.6, pages 54 to 62).

[1] The Eyethu Project was an Eskom strategic initiative to re-organize the business, including a specific subset dealing with internal pricing.

4.2. Research project findings

The research project findings are based on facts that have been established from the corroborated empirical data contained in Portfolio Project 4. In Section 4 of Portfolio Report 4, pages 63 to 86 a detailed analysis of the case study and empirical data is conducted, the results of which are summarised herein in terms of the dependent variable, "The effectiveness of the problem-formulation process". The findings also address the independent and chance variables stated in Section 3.4.4, page 53.

None of the identified chance variables either prevented the formulation of problems or varied in influence when an effective problem-formulation process was applied. The impact of these variables is described in Portfolio Report 4, pages 65 to 70.

The case study shows that from 2000 until April 2004 there was inadequate domain knowledge and experience applied to identifying and defining the problem. Despite exposure to the work previously done by consultants, the negotiators had low levels of domain knowledge or experience. Consequently, problem-formulation was deficient and the wrong problem was being solved, resulting in failure to create SLAs until 2004. Having obtained support from Eskom's Executive Committee (EXCO), the author from 2004 was able to participate in and observe an approach that recognised inadequate domain knowledge, and utilised problem domain experts as an intrinsic part of a successful process of problem-formulation.

Three major areas indicating the relevance and significance of establishing SLAs, as dealt with in Portfolio Report 4, Section 4.1, page 65 and Portfolio Report 4, Section 4.4, pages 103 to 104, are described below:

- Ensuring the continuation of a service critical to the operation of Eskom's core business.
- Eliminating the risk of regulatory intervention.
- The elimination of wasted time and resources.

Until the participation, after April 2004, of Gemini Consulting's and Corporate Finance's experts in the Eyethu Pricing Project the Eskom and Eskom Enterprises negotiators had limited knowledge of the following:

- The comparison of Eskom Enterprises' telecommunications products to those available in the external market (Portfolio Report 4, Section 4.3, page 74).

- The process of determining market-based pricing for telecommunications products and services (Portfolio Report 4, Section 4.3, pages 74 to 75).
- Financial modelling of telecommunications products and services (Portfolio Report 4, Section 4.3, page 76).

The main action to increase the level of domain knowledge over the period of the case study was the use of consultants. With one exception, none of the consultants that were appointed regarding the SLA negotiations between Eskom and Eskom Enterprises prior to April 2004 was requested to or was actually engaged in the formulation of problems related to the negotiations. The consultants were given a defined scope of work, which they carried out (Portfolio Report 4, Section 4.3, pages 77 to 78). After April 2004, Gemini Consulting was used as an intrinsic part of the problem-formulation process in two ways. Firstly, their pricing knowledge and expertise was used to create 'Pricing Principles' that were applied to direct and govern the Eyethu Project. Secondly, Gemini Consulting was applied as an intrinsic part of the Eyethu Pricing Project process, which formulated and solved the problems previously impeding the establishment of SLAs in terms of facilitation, application of methodology, application of expert knowledge and in conducting research (Portfolio Report 4, Section 4.3, pages 78 to 80).

The research project findings enabled the following conclusions to be reached:

- It is not possible to correctly formulate a problem in circumstances when there is not sufficient domain knowledge to understand it.
- In circumstances where the relevant people in the organization do not have adequate knowledge or experience related to the subject area to successfully formulate the problem it is essential that this is recognised and acted upon as the problem is identified.
- Where insufficient domain knowledge or experience exists in the organization to enable a problem to be correctly formulated, expert knowledge and / or experience must be introduced as an intrinsic part of the problem-formulation process.
- There are critical success factors that enable the solving of problems that can become well-defined in an organization. These factors are described below:

    - Effective formulation of the problem.
    - Leadership follows an effective problem-formulation process.
    - Complete and shared understanding of the formulated problem, and not just problem identification, is essential to avoid solving the wrong problem.

- The processes of formulating and solving such problems will be iterative.

(Portfolio Report 4, Section 4.5, pages 110 to 111)

The above conclusions, in conjunction with the detailed analysis of the case study as contained in Portfolio Report 4, revealed the following two areas of innovation that were applied to enable the successful conclusion of all telecommunications SLAs between Eskom Enterprises in 2005. This resulted in sustained SLAs being negotiated for the first time since 2000. That is, the problem of contracting for telecommunications services in Eskom was properly formulated and solved.

- Innovation Area 1

  In circumstances where the relevant people in the organization do not have adequate knowledge or experience in the subject area to successfully formulate the problem it is essential that this is recognised and acted upon as the problem is identified.

- Innovation Area 2

  Where insufficient domain knowledge or experience exists in the organization to enable a problem to be correctly formulated, expert knowledge and/or experience must be introduced as an intrinsic part of the problem-formulation process, after the stage of problem identification.

The two areas of innovation depicted in red as process elements in
Figure 10 and
Figure 11 are verified by a process of codification. Portfolio Report 9 (Codifying the Innovation) applies a methodology that explores the relationship between the areas of innovation and interview data, corroborated by data from the other case study sources. The methodology established a visible and clear relationship to these innovative process elements and interview data (as corroborated by data from other case study sources).

In terms of testing for rival explanations to the above innovation, there is no doubt that the introduction of effective leadership through EXCO, in April 2004, was significant in initiating a change that enabled the circumstances for negotiation of telecommunications SLAs to change, and to become part of the Eyethu Pricing Project. However, EXCO's involvement did not cause the problem-formulation and solving process to change. The introduction, post-April 2004, consequent to inclusion in the Eyethu Pricing Project, of processes similar to those described in Portfolio Project 2 was a factor in improving the extent to which common understandings of working definitions of the problems were derived. However, prior to 2004, in the absence of

adequate domain knowledge and / or experience, the problem-formulation process followed post-2004 would not have resulted in a correctly formulated problem.

It is also evident that after April 2004 much more of the right data, relevant to the subject matter, was gathered. This was important in the success of the process of problem-formulation. The Gemini Consulting experts were able to gather the right data because they were involved in the problem-formulation process and had the knowledge or the intuitive capability to search for and recognise relevant data. Prior to April 2004 this data gathering was not as extensive, primarily because the Eskom and Eskom Enterprises participants in the negotiations did not know what to look for.

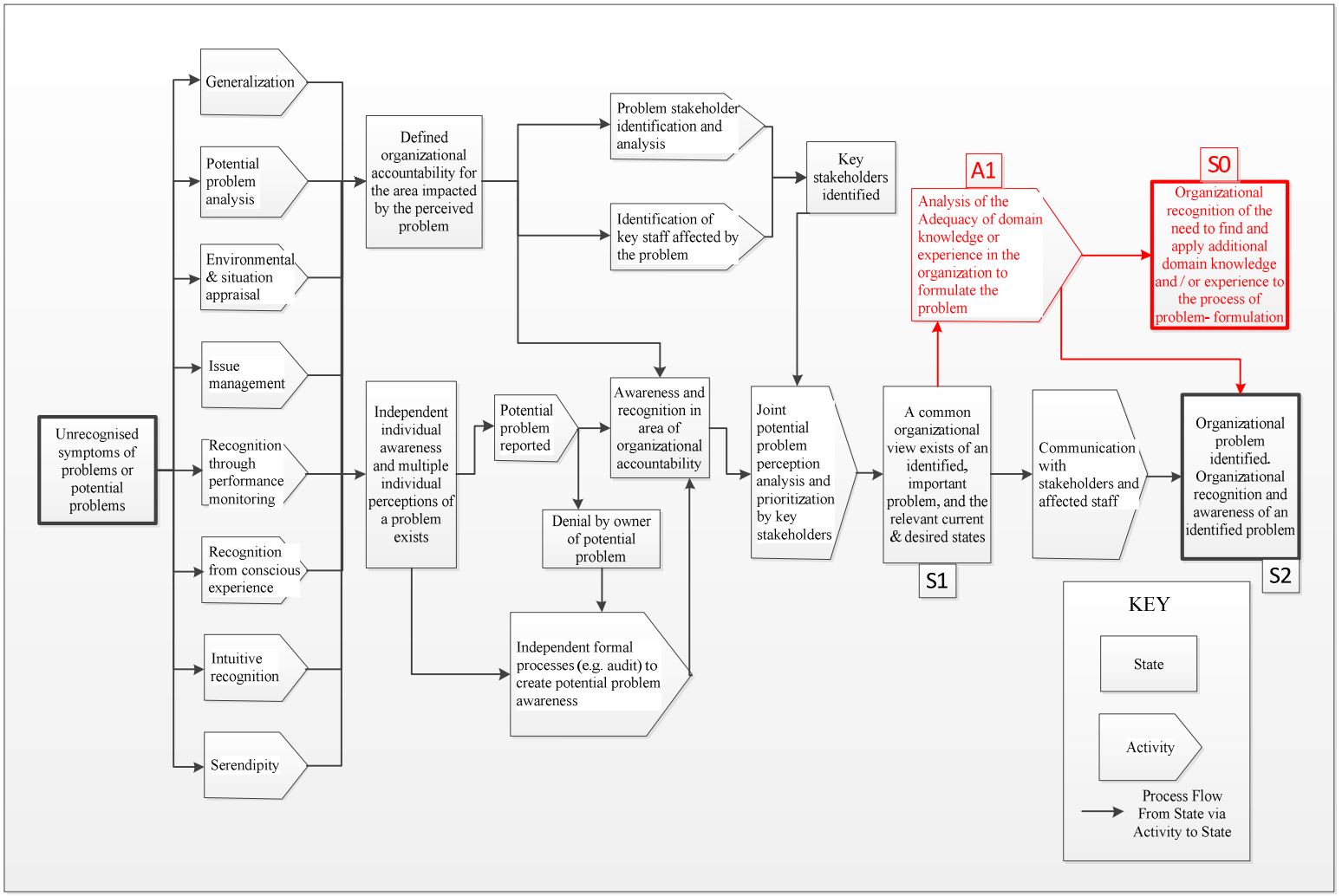

Figure 10: The problem-identification process with innovation

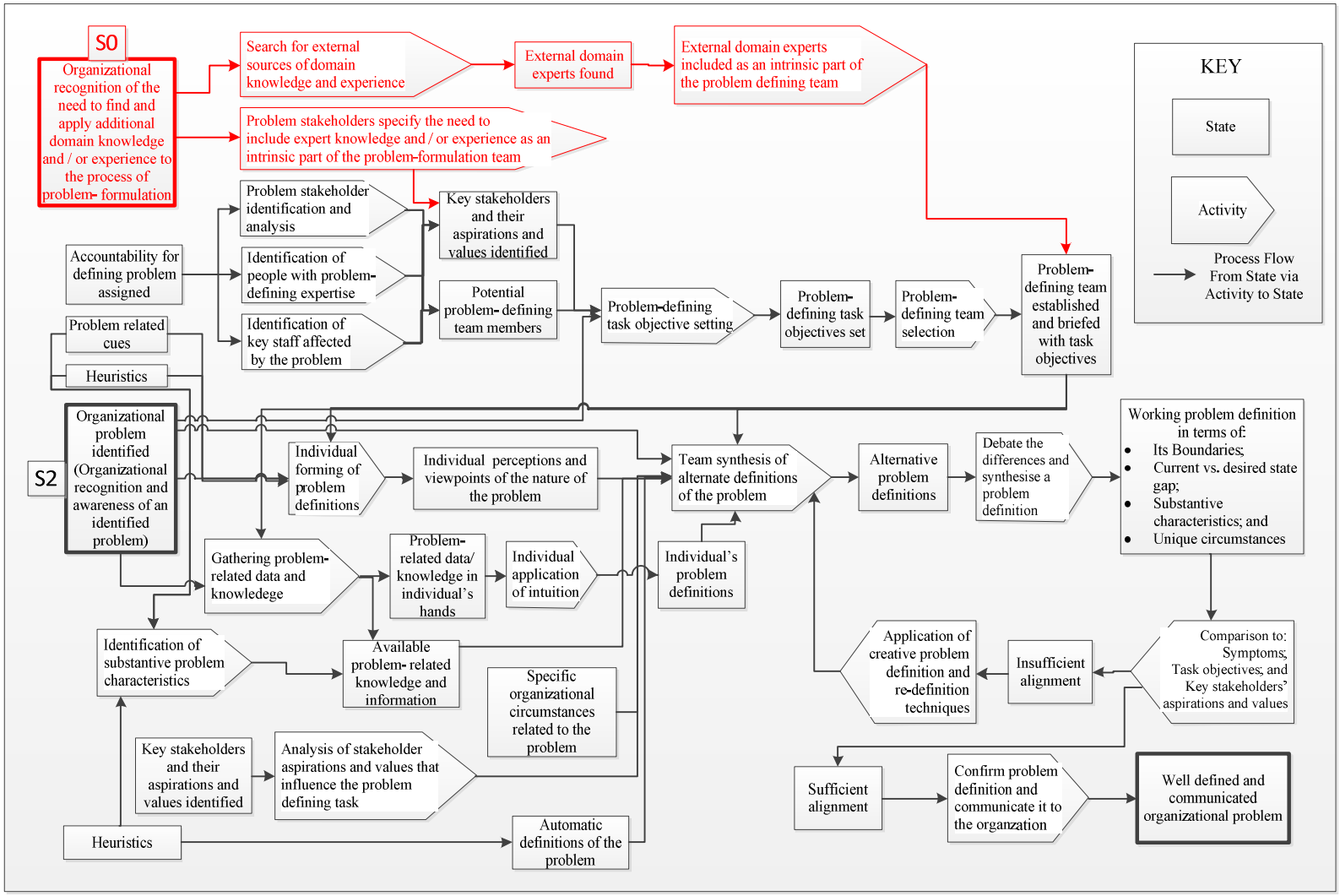

Figure 11: The problem-defining process with innovation

4.3. The innovation - external validity

The issue being addressed here is the extent to which the two areas of innovation described in Section 4.2 herein (and as depicted in red in

Figure 10 and
Figure 11) can be generalised. This is a single case-study portfolio project. An appropriate tactic relevant for ensuring external validity in this situation is the use of theory which was achieved by presenting the existing theory as logic models. The deficiency of existing theory has been postulated in the research question. The research question has been developed to the point where it is established from existing knowledge that, adequate domain knowledge and experience are pre-requisites of the concepts of skill and intuitive capability. It has been shown that this is valid through analysis of the case study data:

- Firstly, that the absence of adequate domain knowledge and experience, applied to the problem prior to 2004, caused the wrong problem to be addressed
- Secondly, when the situation of inadequate domain knowledge was recognised and when expert knowledge and experience was applied, the problem was successfully formulated and solved.

The innovation developed was subsequently applied in a different set of circumstances. These circumstances relate to a problem formulated in an Eskom subsidiary company (Telecom Lesotho) to which the author was seconded as the Acting Chief Executive Officer in August 2005. Telecom Lesotho was, at the time, the national and only fixed-line telecommunications operator in the Kingdom of Lesotho, a small nation situated close to South Africa. The problem initially thought to exist was that Telecom Lesotho did not have an adequate marketing strategy and related skills. Within months of joining Telecom Lesotho, the author recognised that the company's marketing strategy was deficient. Furthermore he, together with the Chief Sales and Marketing Officer, did not have the sales, marketing and management capability to develop and implement a marketing strategy suitable to successfully position the company in the recently liberalised telecommunications sector in Lesotho.

Thus, the author had identified that a problem existed and that there was not sufficient domain knowledge to effectively formulate it, let alone solve it. This situation was confirmed in an interview, held in November 2006, with the consultant appointed to assist Telecom Lesotho who, in summary, stated the following:

"I think that you, as the CEO, knew that there were things you don't know that mattered. It is about intuitively knowing there are things you don't know. You were, in my view, treading a bit cagily or warily because you knew there were things you didn't know. So, I think that you knew you had a problem and a big problem but you weren't quite sure how it was going to be dimensioned or what the answers to it were."

This statement is confirmation that the Process A1 was implemented leading to the Status S0 in

Figure 10 was applied.

The author was successful, in February 2006, in gaining the support of the Board of Directors of Telecom Lesotho to recognise the telecommunications marketing knowledge gaps that he and the Chief Sales and Marketing Officer had. It was further recognised that Telecom Lesotho did not have sufficient capability to bridge that gap. The Board of Directors approved the contracting in of external Sales and Marketing support in the short term to address knowledge / skills gaps and to enable the rapid formulation and implementation of detailed marketing / sales strategies and plans, and steps to provide immediate strengthening of the Sales and Marketing Division. A consulting company was found that was predominantly made up of ex-British Telecom employees who were experienced and expert in the subject area.

This consulting company, starting from the initially identified problem, implemented a process whereby they engaged with the management of Telecom Lesotho and the Sales and Marketing Division's staff, in analysing and formulating the problem faced by the company. It was found that in general, there was awareness of aspects of the problem but insufficient knowledge to effectively define it. The problem, finally formulated, was that the company had not transitioned from being a monopolistic entity in a competitive market to a market-driven, competitive organization. This problem-definition included the symptom that that Telecom Lesotho did not have an adequate marketing strategy and related skills. However, the problem was much broader in that it embraced the capability of the whole organization to transform itself into a company that could operate

successfully in a liberalising telecommunications sector, a significant factor in which was the development and implementation of a suitable marketing strategy.

The existing Telecom Lesotho management and its Board of Directors, whilst being aware that the current marketing strategy was inadequate, had not understood the extent and complexity of the problem faced.

The steps taken as described above with management, the Board of Directors and the consulting company are confirmation of the application of the innovative process elements shown in red in

Figure 11. The outcome was that the problem initially thought to exist was replaced with an effective problem-definition.

Without firstly being aware of a problem for which there was insufficient capability in the organization to define it, and then seeking and applying the consultant as an intrinsic part of the problem-defining team and the problem-formulation process, the problem would not have been correctly defined. The most positive consequence of the problem-formulation process was a shift in the strategic direction of Telecom Lesotho, as approved in November 2006 by the Board of Directors, from:

- Defending the core business, attacking / growing new business, reducing costs and strengthening customer relationships (the previously approved company strategic direction);

to

- Developing and implementing key business areas for Telecom Lesotho, namely Fixed Line Voice, Broadband Services with an ISP, Mobile Operations, Transmission and International Services.

This example demonstrates that the innovation can be applied to a different engineering organization in a different country in Africa.

4.4. Conclusions

A single case study designed as described in Section 3 has been implemented in response to a unique opportunity to participate in and observe a situation that led to the solution of a long-standing, significant problem for Eskom. The case study was conducted in accordance with the empirical research methodology outlined in Section 3. It has been established that the case study methodology was applied with rigour and that criteria for reliability and validity and applicable to a single case study have been met. The innovation that was applied in the case study resulted in a sustainable solution to this significant problem for Eskom.

The above mentioned innovation as derived from the findings of the case study was subsequently applied in Telecom Lesotho, establishing that it can be successfully applied in a different type of business in a different country in Africa, once again solving a major problem for an engineering business of significance to that country.

5. Creating the method

In Section 1.7.5, page 11, reference is made to Portfolio Report 5 which addressed the further development and testing of the innovation described in Section 4, together with the determination of related business benefits. This section summarises the development of the innovation into a method that can be applied in practice. The method developed expands the area of innovation applied to the problem-formulation process as shown in

Figure 10. It is depicted in process form in Figure 12 through to Figure 17, together with a set of Knowledge Based Questions. It applies only to the technical (or substantive) aspects of problem-formulation and not those related to human relations (or behavioural) aspects. This method is applicable to a problem that can become well-defined in circumstances where the organization does not possess sufficient problem domain knowledge or experience to effectively formulate it.

5.1. Recognition and response to inadequate domain knowledge or experience

At the stage of problem identification, the person who recognises the circumstances of inadequate knowledge or experience to formulate a problem is not required to be an expert in the problem domain. However, there must be sufficient awareness to recognise a deficiency in problem domain knowledge or experience. Any person or persons involved in formulating the problem should demonstrate adequate leadership to act upon the recognised deficiency at the time of problem-identification, and to bring into the problem-formulation process sources of domain knowledge and experience to compensate for the recognised deficiencies (Portfolio Report 4, Section 4.4.2.1, page 89).

Portfolio Report 5, Section 3, pages 19 to 34 takes the area of innovation described in Section 4 herein and develops it into a workable model or method. The model developed specifically addresses the need to analyse the adequacy of domain knowledge or experience in the organization to formulate the problem. It also addresses the importance of organizational recognition of a situation of inadequate knowledge. The model developed includes elements of concepts already published in literature as follows:

The differentiation between the technical and human relations aspects of a problem, as postulated by Cowan (1991). This concept is applied in Figure 12 and

- Figure 13.

The Current Reality Tree What to Change concept as described by Hu and Sun (2005) and Dettmer (2007a, 2007b). This concept is evident by virtue of identified symptoms and effects in Figure 12 and

- Figure 13.
- The concept of a knowledge map as discussed by Reich (2007). This concept is evident in Figure 14 and Figure 17.

(Portfolio Report 5, Section 3, page 19).

The model also uses thinking introduced by Kepner and Tregoe (1965) of adaptive action, that is, the type of action a manager can take after he has located the cause of a problem, which is not a solution but enables him to live with the effects of a problem and minimise them (Portfolio Report 5, Section 3, page 23). The same thinking is confirmed by Ackoff (1981) concerning the concept of resolving a problem.

The model builds upon the highest level of process activity A1, as depicted in Figure 10, *analysis of the adequacy of domain knowledge or experience in the organization to formulate the problem*. This activity is initiated by process state S1 in Figure 10 *A common organizational view of an identified important problem, and the relevant current & desired states*. Process Activity A1 results in the process state S0 *Organizational recognition of the need to find and apply additional domain knowledge and / or experience to the process of problem-formulation* in the circumstances where there is inadequate problem domain knowledge in the organization, or in process state S2 *Organizational problem identified – Organizational recognition and awareness of an identified problem.*

Process activity A1 is expanded upon as shown in Figure 12,

Figure 13, Figure 14, Figure 15, Figure 16, and Figure 17 and integrates the set of Knowledge-based Questions depicted in the page following Figure 17.

Arriving at the state where the process followed has established that there is inadequate problem domain knowledge in the organization to properly formulate the problem does

not automatically ensure that this will be accepted by all stakeholders or the problem-solving team. The final stage in the process, as depicted in Figure 12, is to convince the problem-solving team / stakeholders that there is inadequate problem domain knowledge in the organization to properly formulate the problem. This process, which is not developed further, has two possible outcomes. The first is that the problem-solving team / stakeholders are not convinced and organizational recognition of the inadequacy of problem domain knowledge does not occur. In such circumstances it is unlikely that external sources of problem domain knowledge will be sought and applied as indicated in Figure 12, with the outcome of process state S9 *Problem solving likely to result in a Type III Error*. The second, where the problem solving team / stakeholders are convinced, is the process state *organizational recognition that there is not adequate problem domain knowledge in the organization to formulate the problem*. This immediately results in the process state S0 *Organizational recognition of the need to find and apply additional domain knowledge and / or experience to the process of problem-formulation* as depicted in

Figure 10. In this situation, then the second area of innovation, as depicted in Figure 11, can be applied.

5.2. Determining if there is adequate problem domain knowledge or experience to effectively formulate the problem

This part of the method starts with the expansion of the innovation depicted in the problem-identification process shown in

Figure 10. From the expansion of process activity A1 as shown in Figure 10, the next level of process activity developed is shown in Figure 12, which introduces the concepts of the effects and the symptoms of a problem. It is important to understand why these two concepts are included rather than just referring to the symptoms of a problem. When organizations address problems at the stage of problem identification they may see some or both the effects and the symptoms of the problem. An effect is a change produced by an action or a cause; a result or an outcome (Hornby: 369, 1995). A symptom is a sign of the existence of something bad (Hornby: 1211, 1995). The most common way of identifying problems is generalization which is dependent on the recipient of the stimuli having the capability to recognise them as symptoms of a problem (Portfolio Report 2, Page 14). Thus, it is important to consider both the perceived effects and symptoms of a problem.

Process activity A1 is developed to the second level of process in Figure 12. The letters in red (a, b, c) in Figure 12 indicate that a further level of process development is needed. Also in Figure 12, reference is made to a Type III Error, State S9. In Figure 12, in developing the process activity A1, the concepts of explicit knowledge and tacit knowledge are referred to. The matter of how organizations ensure that problem-related knowledge, both explicit and tacit, is created and made available to others is explored in detail in Portfolio Report 2, pages 56 to 66. Specifically, for the purposes of this report, it is considered that tacit knowledge that has been externalised will, in fact, be in the form of explicit knowledge. Experience that is not externalised is considered to be tacit knowledge. Corporate or organizational knowledge can be represented in tacit forms such as experience, know-how, skill (Portfolio Report 2, page 63).

Process activity A2 in Figure 12 refers to categorisation of the effects and symptoms of the problem by:

- Behaviour of the players involved in the problem situation.
- Problem subject (domain).

This categorization, denoted with the symbol 'a' is further developed as shown in

Figure 13.

The process activity A3 in Figure 12 *Identification of the explicit / tacit knowledge in the affected part of the organization related to the problem domain*, denoted by the symbol 'b' is developed further in Figure 14. The process activity *Affected members of the organization and stakeholders to the identified problem questioned to establish their explicit / tacit knowledge problem domain knowledge,* denoted with the symbol 'd' in Figure 14 is further developed in Figure 15.

The process activity A5 in Figure 12, denoted by the symbol 'c', Answer the question 'Does the existing problem domain knowledge enable an explanation of the identified effects and symptoms of the problem that cannot be explained in terms of behaviours? has two initiating states namely:

(1) Existing problem domain explicit / tacit knowledge in the affected part of the organization identified. State S4.
(2) All problem domain explicit / tacit knowledge in the organization identified. State S5.

The reason for this is seen in Figure 16 and Figure 17, which expand the process element denoted by the symbol 'c' in Figure 12, in that this process has two iterative steps.

The first step in the iterative process (Figure 16) addresses the answer to the question, "Does existing problem domain knowledge enable an explanation of the identified effects and symptoms of the problem that cannot be explained in terms of behaviours?" considering only the explicit / tacit problem domain knowledge in the affected part of the organization. This is often the way that problems are dealt with, particularly in larger organizations. This first step has two possible outcomes which relate to answering the following questions for every observed symptom or effect:

- Does applying the knowledge provide an explanation of the observed symptom or effect that makes sense?
- Why?

If the answer is 'Yes', then the problem will be standard or can be well-defined by the affected part of the organization (process state S7). If the answer is 'Uncertain' or 'Not in all cases', then a need to search for further problem domain knowledge in the whole organization has been identified (process state S6). The search for further problem domain knowledge at this stage is predicated particularly on the Knowledge Management concept of Dispersed Knowledge. That is, bits of incomplete knowledge which separate individuals possess (Portfolio Report 2, page 67). It is also possible that sources of explicit knowledge exist in an organization that the affected part of the organization has not been accessed at this stage of the process.

The second step in the iterative process (Figure 17) addresses the answer to the question considering all the problem domain knowledge in the affected part of the organization. This step has three possible outcomes in answer to the question, *"Does the existing problem domain knowledge enable an explanation of the identified effects and symptoms of the problem that cannot be explained in terms of behaviours?"* If the answer is 'Yes', then the problem will be standard or can be well-defined by the organization (S7). If the answer is 'No', then the process state S8 *Inadequate domain knowledge in the organization to properly formulate the problem* has been arrived at. The 'Uncertain' state requires the set of Knowledge Base Questions shown on page 80 (as depicted by the hyperlink in Figure 17) to be answered, with the possible outcomes as stated.

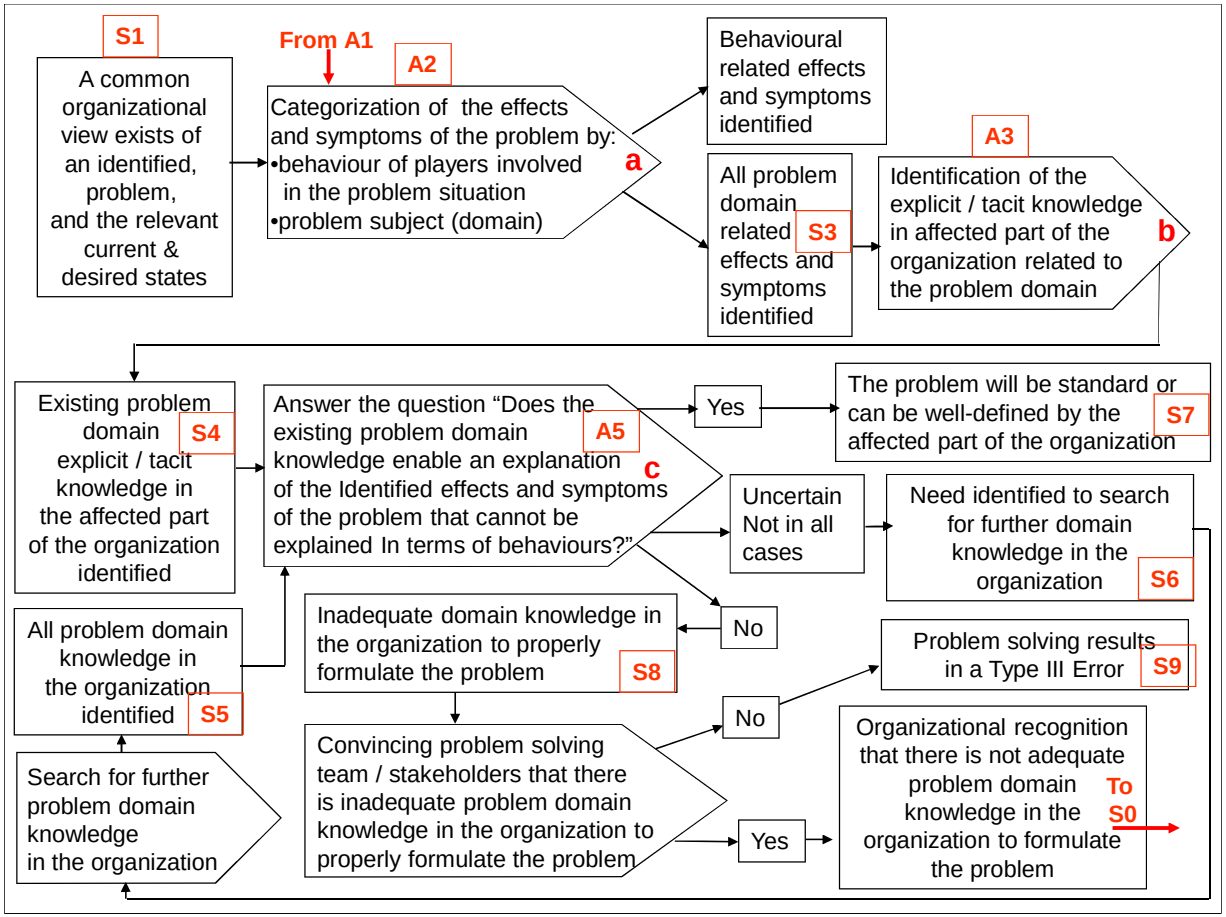

Figure 12: Analysis of adequacy of problem domain knowledge for problem-formulation

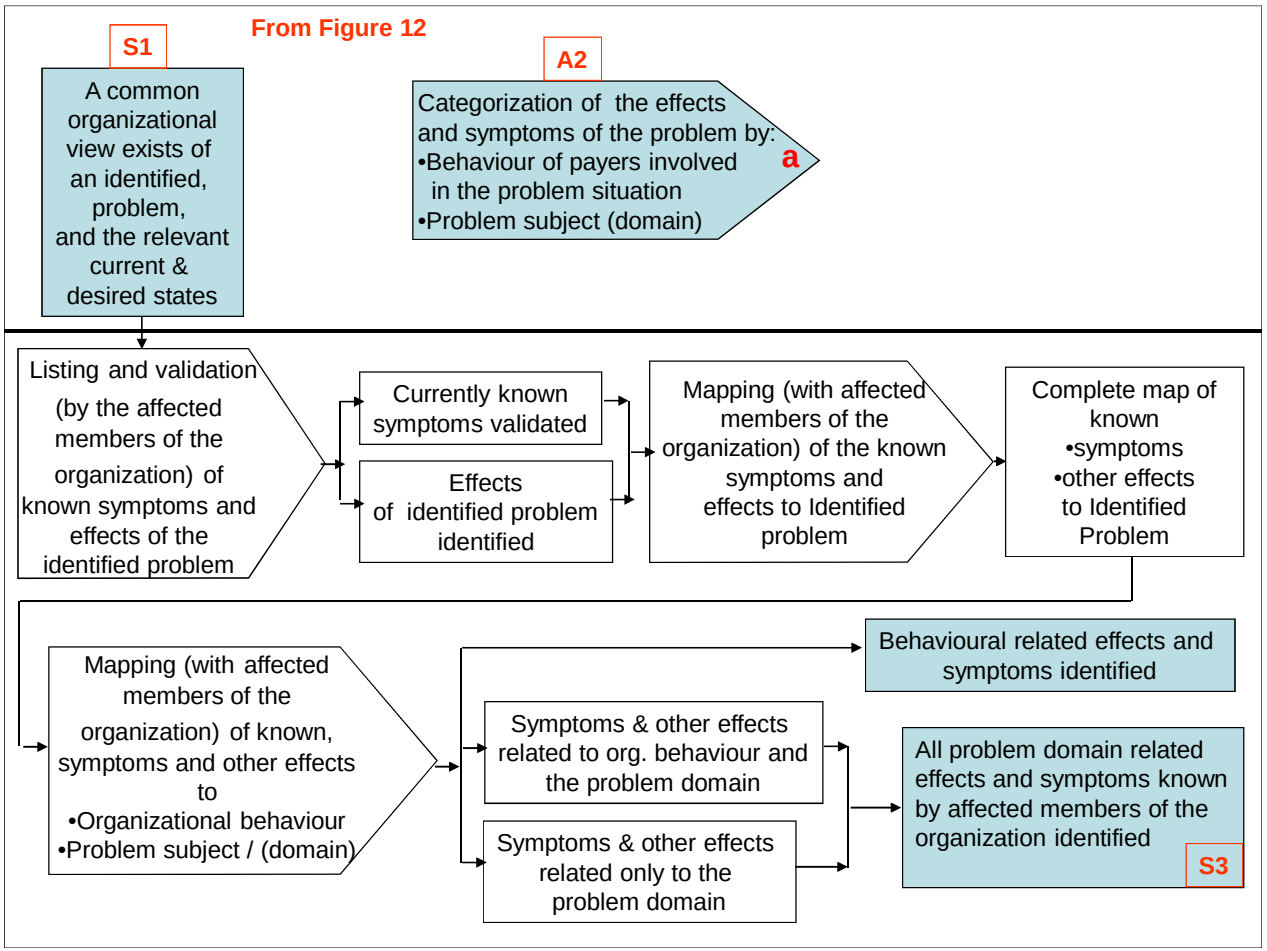

Figure 13: Categorization of the effects and symptoms of the problem

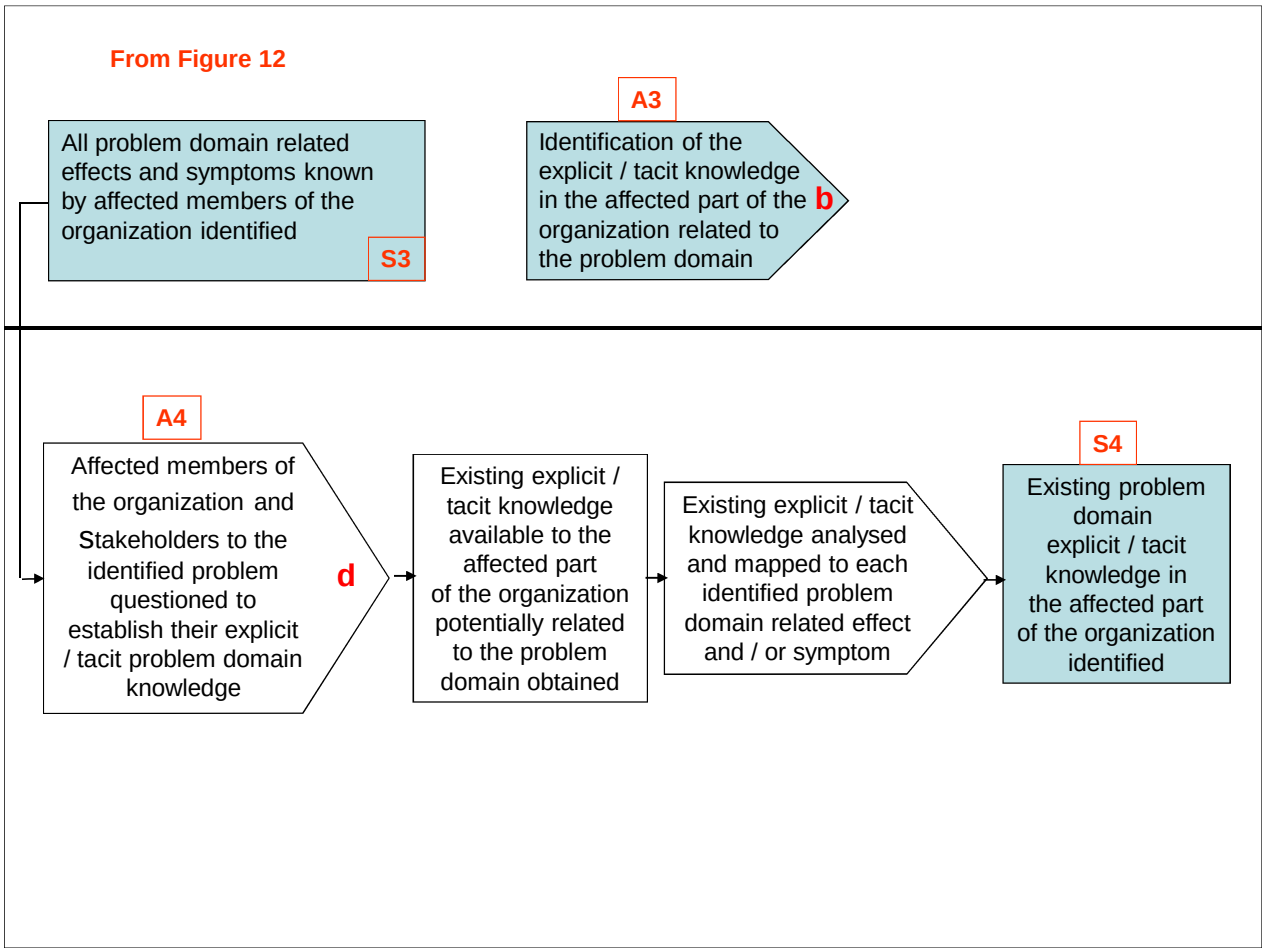

Figure 14: Identification of explicit / tacit domain knowledge in the affected part of the organization

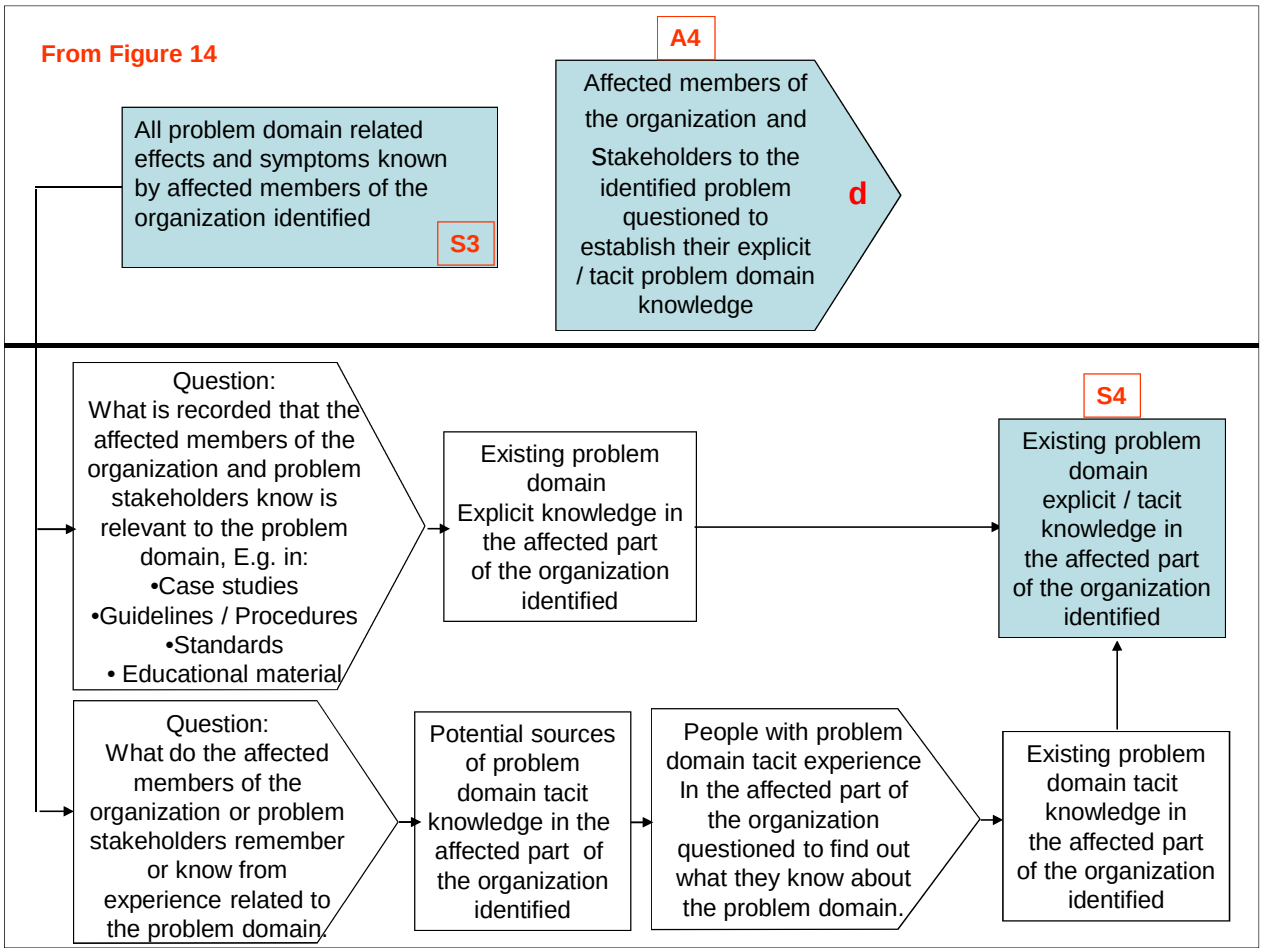

Figure 15: Affected members / stakeholders in the organization questioned for their explicit / tacit knowledge of the problem domain

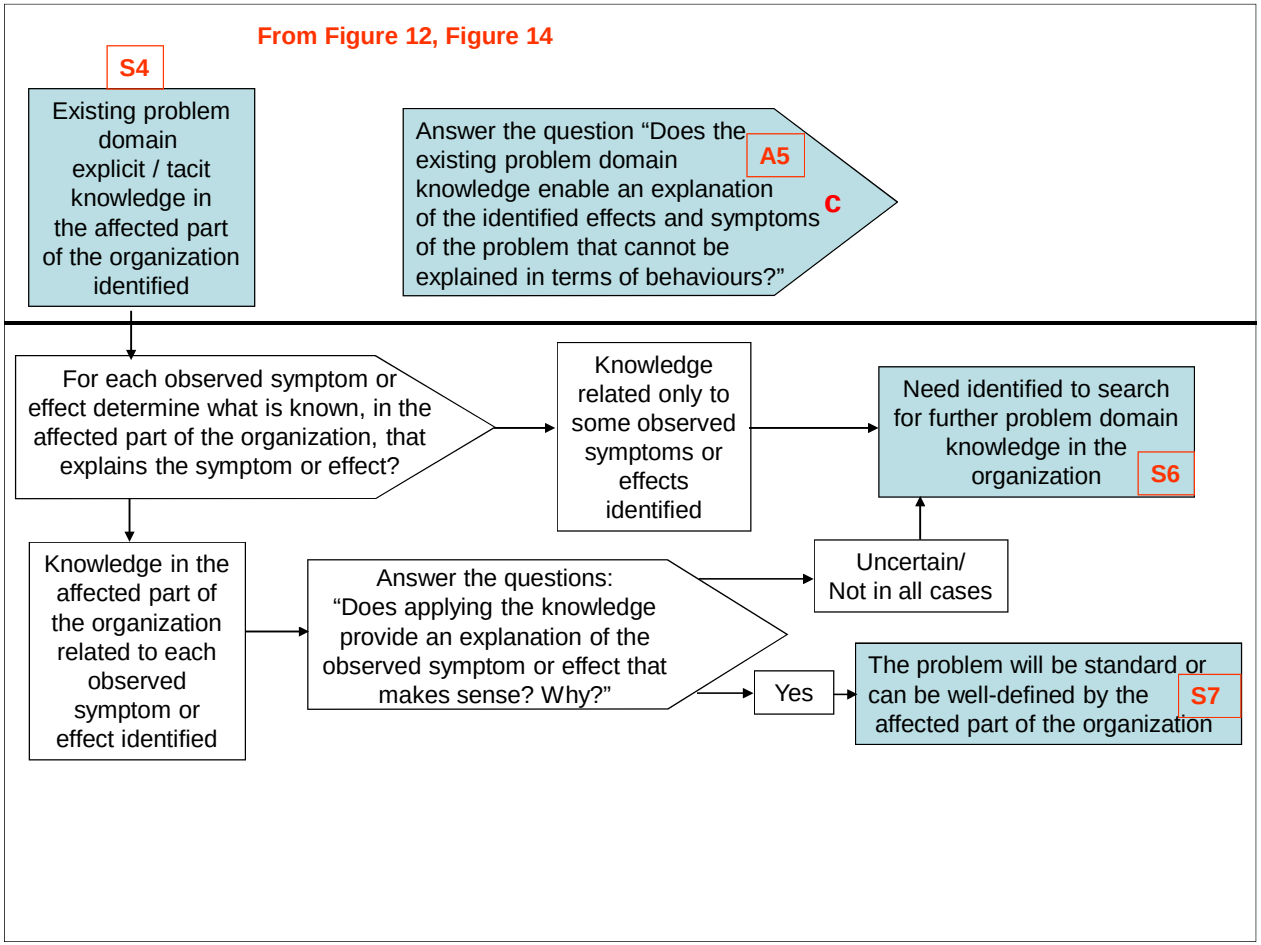

Figure 16: Problem domain knowledge in the affected part of the organization vs. problem effects / symptoms

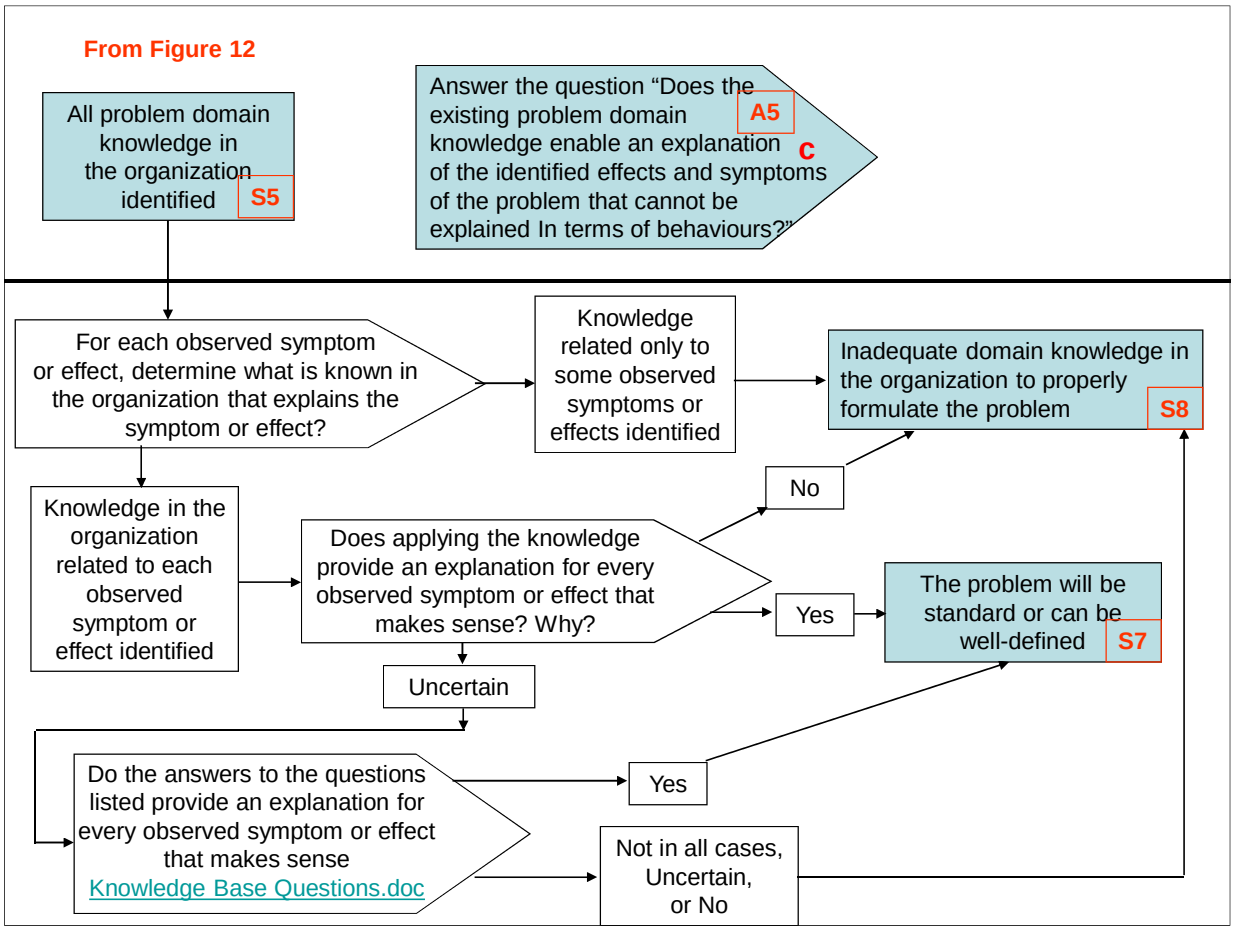

Figure 17: Problem domain knowledge in the whole organization vs. problem effects / symptoms

Knowledge Based Questions

Answer the following questions applying all the problem domain explicit / tacit knowledge obtained from within the organization:

- For each observed symptom of effect, what is known that explains the symptom of effect that was observed?
- Does the explanation based on what is known make sense? Why?
- Does what is known explain all of the observed symptoms or effects?
- What is not explained by what is known?
- Has anything been done to address the effect or symptom? What was done?
- What symptoms or effects were fully fixed by what was done?
- Did what was done to address the symptoms or effects work? Did it fix part of the symptoms or effects? Did another symptom or effect materialise?
- What symptoms or effects were not fully fixed by what was done?
- What aspects of the symptoms or effects that you observed are not explained by what is known or what has been done?
- Is anything else about the observed symptoms or effects not yet explained?
- Is enough known in the organization to fix all the observed symptoms or effects or understand the problem(s) that they materialise from?
    - Yes
    - Not in all cases
    - Uncertain
    - No

If the answer in all cases is 'Yes, then the problem will be standard or can be well-defined by the organization. If the answer is 'Not in all cases, Uncertain or No', then the process state S8 *Inadequate domain knowledge in the organization to properly formulate the problem* has been arrived at.

5.3. Application of externally sourced knowledge / experience to the problem defining process

Subject to the problem-solving team / stakeholders being convinced that there is inadequate problem domain knowledge in the organization to properly formulate the problem, the method enables State *S0 Organizational recognition of the need to find and apply additional domain knowledge and / or experience to the process of problem-formulation* as depicted in

Figure 10 and
Figure 11 to be arrived at. The next step relates to the application of externally sourced problem domain knowledge or experience to the process of problem defining as shown in
Figure 11. The processes do not require further expansion but are explained in the context of the analysis of the case study.

6. Testing the method

The process of testing the developed method is based on the author's experience and by a reference back to the case of Improving Electricity Network Performance as contained in Portfolio 1. In addition, and from a more negative perspective, the consequence of not applying the method is considered in the case of The Telephone Management System as contained in Portfolio Report 1.

The method is also compared with the cases described in Portfolio Report 4.

6.1. The cases from Portfolio Report 1

6.1.1. Improving electricity network performance

This case is described in Portfolio Report 1, pages 11 to 14. A region within the electricity utility (Eskom) had, over a period of years, delivered lower than expected levels of supply quality to certain rural customers. The overhead electricity network condition was poor, with frequent faults taking up the capacity of available maintenance resources. Customers were increasingly losing confidence and patience in the utility's ability to provide adequate quality of supply. The problem was identified by staff in the region, together with the view of the existing managers and supervisors of the field maintenance teams, that their region was inadequately funded, understaffed, and that investment in refurbishing electricity networks was needed.

New regional management, with technical knowledge and past experience in managing electricity networks, was appointed. The new management applied their domain knowledge in carrying out an analysis of the situation presented, and found the problem identified by the staff to be incorrect. The correct definition of the problem was established to be a technical deficiency and that basic maintenance had not been done adequately for years because the business processes that provided for adequate network performance were not understood or operated effectively. A solution was implemented to the problem as defined by the new regional management which included the author who has extensive knowledge of electricity network technologies, including those related

to design, maintenance, performance and operation. Also included was a senior engineer who had extensive knowledge of electricity network technologies including those related to design, maintenance and performance.

The author visited the particular area of the region that was experiencing the problems, spending time with the local staff and inspecting the electricity network conditions. The following symptoms of the problem were found:

- There was no ownership of specific network portions by individual local staff members.
- The local staff spent the majority of their time repairing faults rather than doing planned maintenance.
- Trees were growing through the electricity overhead lines.
- There was evidence of many broken insulators, failed transformers, failed surge diverters and pole top fires.
- There was evidence that earth wires had been cut away where pole top fires had occurred.
- There was a mix of types of overhead electricity network design that had differing basic insulation levels. That is, there was a technical deficiency.

The author asked the local staff questions similar to the following, with the summary of the answers given in italics:

- Why there was no specific allocation of network portions? *They were so busy fixing faults that the work was allocated based on where faults needed repairing irrespective, rather than based in individuals being responsible for specific network portions.*
- Why did they think these insulator, transformer and surge diverter failures occurred? *They did not know.*
- What was done to address the failures of insulators, transformers and surge diverters? *They were replaced with new components.*
- Did this action solve the network problem? *In some cases, but not all.*
- Why did the pole tops catch fire? *They did not know.*

- Why were earth wires cut away where pole top fires had occurred*? To prevent failure recurrence.*
- Did this action solve the network problem? *Pole tops in other locations caught fire.*

Based on the answers to the questions the author identified a situation of inadequate domain knowledge of technology and of network performance business processes, together with a situation where local staff were reacting to the symptoms of a problem and not eliminating the causes. Newly-appointed and knowledgeable resources were allocated to analyse the situation. It was found that the network had evolved over time by adding sections with differing basic insulation levels and that, in over-voltage conditions, parts of the network were being subjected to voltages that they were not designed to withstand. This technical deficiency caused uncontrolled, sustained pole-top flashovers that led to pole-top fires, together with the failure of certain insulators, transformers and surge diverters. Cutting away earth wires increased insulation levels at that point but led to failures at other locations. With regard to behavioural symptoms, these related to lack of ownership of backlogs in normal maintenance and low morale.

Comparing the situation described above to the innovation and the developed method described in Section 4 and Section 5, enables the following conclusions to be drawn:

- There were behavioural aspects to the problem (e.g. lack of ownership of network portions). The step in Figure 12, of categorising the effects and symptoms of the problems would have revealed this.

The visit by the author to the area affected by the problem triggered the process of identifying inadequate domain knowledge, Activity A1,

- Figure 10.

The analysis of the situation by the new regional management (Activity A1, Figure 10) revealed that inadequate domain knowledge was applied to defining the problem. That is, State S0 *Organizational recognition of the need to find and apply additional domain knowledge / experience to the process of problem-formulation* in

- Figure 10 had been arrived at. The analysis is aligned significantly with asking the question related to domain knowledge, "Does the existing problem domain knowledge enable an explanation of the effects and symptoms of the problem that cannot be explained in terms of behaviours?" (Figure 12, Activity A5).

- The questions asked by the author reflect the intent to ascertain the adequacy of the level of explicit / tacit domain knowledge in the affected part of the organization, to support the processes depicted in Figure 12, Figure 14, Figure 15 and Figure 16 using the questions similar to Knowledge-Based Questions referred to in Figure 17. The answer to these questions allowed an equivalent to State S6 *Need identified to search for further domain knowledge in the organization* in Figure 12 to be arrived at.
- The decision by the author to assist and to bring in the newly-appointed regional skills after arriving at the equivalent of State S6 in Figure 12 reflects the search for further problem domain knowledge in the organization, leading to state S5 *All domain knowledge in the organization identified* in Figure 12.

The application of the technical knowledge and past experience in managing electricity networks by the new regional management, which enabled a valid definition of the problem to be produced, supports the concept of including domain experts in the process of problem defining as in Innovation Area 2 and as indicated in

- Figure 11.
- The application of adequate domain knowledge and experience reflects the processes depicted in Figure 17, leading to state S7 *The problem will be standard or can be well-defined by the affected part of the organization*.

6.1.2. The Telephone Management System replacement

This case is described in Portfolio Report 1 (pages 18 to 20). A newly-formed business unit took over the provision of telecommunications services to the Eskom head office, in which over 3 000 telephone extensions were installed. Although not stated in Portfolio Report 1, this business unit included the existing staff from the previous organizational unit. The past practice of information being obtained from the Telephone Management System (TMS) and used to determine internal charges was augmented by the system being used for invoicing customers. Immediately invoices were issued, the customers complained that their bills were wrong. Almost at the same time, the TMS became unstable. The staff considered this situation as a crisis, of which poor billing was a symptom and which had the effect of customer complaints regarding wrong bills. The cause was wrongly identified as the unstable TMS. The existing TMS was replaced and the situation worsened; a Type III Error.

Another person from the newly-formed business unit reviewed the problem and established the following:

- Poor quality TMS data.
- No process existed for customers to keep the supplier informed of changes to locations or telephone numbers by their users.
- No data maintenance processes existed.
- The customers frequently changed workstations and telephone numbers, without keeping the service provider informed. Hence the database used by the old and new TMS was inaccurate, leading to incorrect bills.

This is not an example of the innovation or the method being applied to any great extent. It does, however, give insight into what happened and also what would have happened had the innovation been applied. Comparing the situation described above to the developed method, enables the following conclusions to be drawn:

- If Activity A3 and Activity A5 in Figure 12 and the processes depicted in Figure 15 and Figure 16 been applied, looking at the effects and symptoms of the problem, there would have been realisation of the inadequacy of domain knowledge to formulate the problem at the stage of problem-identification. In other words, State S6 in Figure 12 would have been arrived at.

- By initially not following a process similar to that depicted in Figure 12, the existing staff were not aware that they did not have adequate domain knowledge to formulate the problem. Consequently, the State S9 *Problem solving results in a Type III Error*, Figure 12 was initially arrived at.

- Applying the knowledge-based questions, as referred to in the method at the stage depicted in Figure 17, would have revealed the following:

  - Does what the existing staff know that explains the observed symptoms or effects? *Not enough was known that explained the symptoms or effects that were observed.*
  - Has anything been done to address the effect or symptom? *What was done? The TMS was replaced.*
  - What symptoms or effects were fully fixed by what was done? *None of them.*
  - Did what was done to address the symptoms or effects work? *No.*
  - What aspects of the symptoms or effects that you observed are not explained by what is known or what has been done? *All of them.*

  In other words, the answers to these questions would have revealed that the staff in the affected area of the business did not have enough domain knowledge to formulate the problem.

6.2. The cases in Portfolio Report 4

The empirical research subject case study Contracting for Telecommunications Services in Eskom is described in Section 4.1, together with a case described as a problem initially identified as 'inadequate marketing and related skills in Telecom Lesotho'. The case study analysis and findings established and validated the innovation shown in red in

Figure 10 and
Figure 11. Notwithstanding that, their relevance to the developed method is addressed as follows.

6.2.1. Contracting for telecommunications services in Eskom

The case study confirms the content of Figure 12. Not convincing the problem-solving team / stakeholders that there is inadequate domain knowledge in the organization to properly formulate, leads to problem-solving resulting in a Type III Error. Also whilst the State S0 in

Figure 10 was arrived at by the author intuitively, the case study in terms of chance variables validates the differentiation between domain knowledge and the behavioural aspects of the problem, which aligns with Activity A2, Figure 12.

The support of EXCO for including the matter as part of the Eyethu Pricing Project reflects the importance of stakeholder support as depicted in

Figure 11, leading to including domain experts as an intrinsic part of the problem-defining process.

6.2.2. Inadequate marketing strategy in Telecom Lesotho

Comparing this case to the innovation and the developed method enables the following conclusions to be drawn:

The initial problem-solvers did not have adequate problem domain knowledge to define the problem. The author, as the CEO of the company, was intuitively aware of this situation, thus arriving at State S0 in

- Figure 10.

The activity shown in Figure 12 *Convincing problem solving team / stakeholders that there is inadequate problem domain knowledge in the organization to properly formulate the problem* took place. This resulted in reaching State S0 in

- Figure 10.

The support of the Board of Directors for and the application of the expert knowledge and past experience in the form of a consulting company predominantly with existing staff enabled a valid definition of the problem to be produced. This support reflects the importance of convincing stakeholders as depicted in Figure 12, leading to including domain experts as an intrinsic part of the problem defining process as depicted in

- Figure 11.

6.3. Conclusions

Section 5 indicates that the method subject to testing is developed from the areas of innovation post the stage of empirical research. The review of the case of Improving Electricity Network Performance establishes evidence of credibility concerning significant aspects of the method. The important aspect of team / stakeholder support to recognition of the inadequacy of problem domain knowledge is evident in those aspects of the Contracting for Telecommunication Services in Eskom Case Study and Inadequate Marketing Strategy in Telecom Lesotho. Notwithstanding this positive confirmation of the credibility of the developed method, the importance of applying it is verified by the analysis of the case of The Telephone Management System.

7. Impact of the innovation on Eskom

This impact of the innovation on Eskom is addressed in Portfolio Report 5, Section 4.3, pages 48 to 55. There have been instances in which Eskom has experienced significant, protracted and unresolved problems that could have been avoided. The innovation described herein has delivered and will continue to deliver related benefits to Eskom. Such business benefits can be derived in a number of ways. These include the following:

- Time saved by the business.
- Money saved by the business.
- Improved delivery of products and services to customers.
- Goodwill between the supplier and the customer.
- Damage to the reputation of the business avoided.

Benefits associated with the intuitive application of the innovation by the author are claimed as having solved two significant problems impacting Eskom. The two significant problems are 'Electricity Delivery Network Performance' as described in Portfolio Report 1, Section 4, pages 11 to 14 and further developed herein, and 'Contracting for Telecommunications Services in Eskom', the subject of Portfolio Report 4.

7.1. Significant problems impacting Eskom : Benefits derived from the intuitive application of the innovation

7.1.1. Improving electricity network performance

Portfolio Report 1 describes the problem and the steps taken to resolve it. The problem related to rural customers being impacted by poor network performance in one of Eskom's distribution businesses was a significant problem for Eskom. The intuitive application of the innovation by the author provided the basis to solve to the problem. This solution had four impacts. Firstly and most importantly, further damage to the reputation of Eskom was avoided. Secondly, delivery of Eskom's products and services to customers improved. Thirdly, goodwill between Eskom and the rural customers

affected was restored. Fourthly, the solution was implemented within the region's budget. This, at the time, avoided the application of funds, over and above the approved budget, to a Type III Error (Portfolio Report 5, Section 4.3.1.1, page 49).

7.1.2. Contracting for telecommunications services in Eskom

Portfolio Report 4 provides full detail of this case study, as summarised in Section 4.1 herein. The following benefits to Eskom can be attributed to the intuitive application of the innovation by the author in 2004.

Time saved by the business

Portfolio Report 5, Section 4.3.1.2, pages 49 to 50 indicates that unproductive time was spent by Eskom and Eskom Enterprises in the period 2000 to 2004 in negotiating to establish pricing and SLAs for telecommunications services. The unproductive time is conservatively estimated to be approximately 3 man-years per annum, eliminated between the two companies from 2005.

Money saved by the business

Portfolio Report 5, Section 4.4.5.3 indicates that during the period 2000 to 2004, six consulting appointments related to unsuccessful SLA negotiations were made at an estimated cost of two million Rands. Since the problems were solved in 2005, continued use of consultants in this area has been unnecessary, resulting in cost avoidance estimated at no less than 2 million Rands.

Whereas time was saved by the business, this will only translate into money saved if there is a consequent reduction in staff. In terms of staff savings it is known that Eskom Telecommunications effected the saving of one staff member since 2008, the cost (to company) of whom would amount to approximately 1 million Rands per annum. Conservatively, an amount of 1.5 million Rands can be considered to have been saved.

7.2. Significant problems impacting Eskom: Benefits that would have been derived had the innovation been applied earlier

7.2.1. Improving electricity network performance

In this case, the impacts would have been similar except that the innovation could have been applied at the time when the symptoms of electricity network performance deteriorating first materialised. The application of the innovation at that time would have produced the correct definition of the problem earlier and consequently the goodwill between Eskom and the customer's would not have been affected. There is no basis to indicate that there would have been significant cost savings, except for the cost of staff overtime.

7.2.2. Contracting for telecommunications services in Eskom

There was potential for Eskom to have obtained increased revenues from the electricity tariff had the innovation been applied when the problem materialised in 2000. There is a reasonable possibility that the costs of telecommunications to Eskom would not have been determined by allocation of budgets, but as a consequence of applying an appropriate pricing structure for telecommunications products and services. The impact of this could have been up to 55 million Rands annually between 2001 and until 2004, which could have been recovered by Eskom through the electricity tariff (Portfolio Report 5, Section 4.3.2.2, pages 52-52).

Time saved by the business

Approximately 3 man-years per annum of unproductive time are estimated to have been applied to the unresolved problems prior to 2005. Assuming that the work done from April 2004 in terms of the Eyethu Internal Pricing process, as referred to in Section 4.2.1, was productive, the unproductive time spent from 2000 until April 2004 could have been avoided. This is estimated at 10 man-years of unproductive time.

Money saved by the business

Applying the same conservative reasoning as in the same topic in Section 7.1.2, a significant part of the consultant appointments made between 2000 and 2004 could have been avoided. Using a similar conservative approach and assuming that not all of the six consulting assignments would have been eliminated, a cost saving of the order of 2 million Rands would have been possible.

Goodwill between the supplier and the customer

Had the innovation been applied at the time that the problem first materialised, there would have been no loss of goodwill between Eskom Enterprises and its Eskom telecommunications customers, the cost of which is impossible to ascertain.

7.3. Avoiding Type III errors

The descriptions of both Improving Electricity Network Performance case (Portfolio Report 1, Section 4) and the analysis case study Contracting for Telecommunications Services in Eskom demonstrate that Eskom had reached the stage of a Type III Error in trying to solve the problem. The application of the innovation enabled the perpetuation of these errors to be avoided, for the related problems to be well-defined and solved.

In the case of the inadequate marketing strategy in Telecom Lesotho by proactively and intuitively applying the innovation, including obtaining stakeholder support for it, a Type III Error was avoided in its entirety.

7.4. Summary: Impact of the innovation on Eskom

In considering benefits to Eskom from applying the innovation, two significant problems were solved, albeit in one case by the intuitive application of aspects of the innovation. The benefits accrued in this way amount to an actual saving of at least 3 man-years of unproductive time and of the order of 3.5 million Rands. The solution to both problems

also resulted in improved delivery of products and services to customers, together with eliminating the causes of loss of goodwill between the supplier and the customer.

If the innovation had been applied in full at the time that symptoms of the problems first materialised the problem of Electricity Delivery Network Performance would not have occurred at a level of significance to Eskom. In the case Contracting for Telecommunications Services in Eskom, it is estimated that Eskom could have recovered increased revenue of up to 55 million Rands per annum through the tariff from 2001 to 2004, with increased profitability resulting in Eskom Enterprises (Pty) Ltd. Also 10 man-years of wasted time and no less than 2 million Rands in consulting fees would have been avoided. Further, there would have been limited problems of product / service delivery, and no deterioration in good will between the parties.

Situations of Type III Errors, related to problems of significance to Eskom, were either addressed to the point of effectively defining the problems, or in the case of Telecom Lesotho, avoided altogether.

8. Discussion and conclusions

8.1. Objectives of the research project

The objectives of the research project were to:

- Confirm that Eskom has difficulties in solving problems.
- Identify the possible causes for this.
- Create and apply a solution.

Portfolio Project 1 and the case study Contracting for Telecommunications Services in Eskom have established that Eskom has difficulties in solving problems.

- In Eskom, people are often treating symptoms of problems.
- Inadequate domain knowledge is a root cause.
- Existing literature does not provide a solution.

The case study has shown that fundamental to these difficulties is failing to effectively formulate the problem; particularly in circumstances where the people affected do not have adequate domain knowledge or experience to do so.

In addressing this, the research project has done the following:

- A single, comprehensive problem-formulation process has been created based on the fragmented elements of knowledge derived from existing literature, for the formulation of problems that can become well-defined.
- Through empirical research innovative sub-processes that address gaps in the existing literature, related to formulating problems that can become well-defined, have been created and applied.
- By applying the innovation, a significant problem, critical to the performance of Eskom has been properly formulated and solved.

The innovation is in the form of steps to enable circumstances of inadequate domain knowledge or experience to be recognised, and together with stakeholder support, the inclusion of domain experts as an intrinsic part of the problem-formulation process.

The innovation, applied successfully in the case of Contracting for Telecommunications Services in Eskom, enabled a significant problem for Eskom to be solved. It was also replicated in Telecom Lesotho as described herein. Furthermore, the innovation has been further developed into a workable method and tested.

The research undertaken has industrial relevance to Eskom, an engineering business. In applying the innovation a significant contribution to the performance of that business has been made with quantifiable benefits.

It is therefore established that in meeting the objectives, research has been undertaken of industrial relevance to an engineering business and that innovation has been created and applied that has made a significant contribution to the performance of that business.

8.2. Discussion

8.2.1. The assumptions made

In Section 1.3, page 4 three assumptions were made, namely that:

a) Relevant knowledge is essential to the effectiveness of treating problems.
b) Problems that are formulated to become well-defined have the potential to be solved.
c) In an organization the behaviour of the stakeholders to a problem, and the behaviour of the people affected by it, influences the effectiveness and efficiency of the problem solving process.

The choice of case study variables as shown in Section 3.4.4, page 53 specifically addresses Assumption (a) and Assumption (c). Accordingly, the case study questions explored these variables, together with a specific question that looked into problem solving. The following points arise from considering the assumptions made.

Assumption (a) is verified in Section 2.1.7, page 33 by the review of literature dealing under the sub-heading 'Domain knowledge and domain experience in the context of problem-solving'. It is also verified by the case study findings.

With regards to Assumption (b) this research provides validation from three perspectives. Firstly, the definition of problem-formulation Section 2.1.1, page 15

establishes the context of problem definition. Secondly, from the literature reviewed which establishes that problem definition provides the best defence against a Type III Error (Section 2.1.4, page 24). Thirdly, the findings of the empirical research establish that once a problem is effectively formulated and thus well-defined, it can be solved.

Assumption (c) is verified in Section 2.1.4, pages 25-26 by the review of literature. This is reinforced by the empirical research (Portfolio Report 4, Section 4.4.3) which found that the effectiveness of problem-formulation was negatively impacted by stakeholder behaviour prior to April 2004 (that is, before a more effective problem-formulation process including stakeholder management was applied). The implication of assumption (c) on the applicability of the innovation is that practitioners responsible for problem-formulation must ensure that a climate of positive behaviour prevails. In this research this was achieved through executive management intervention and stakeholder management.

8.2.2. Methodology limitations

There are two primary potential limitations to the empirical research: the use of a single case study and the lack of a pilot study. The use of a single case potentially reduces the ability to generalise the research findings. In this research the impact of a single case is reduced because the study concerns closing well-defined gaps in the documented process of problem-formulation as demonstrated in the logic diagrams. The research findings were subsequently tested in Telecomm Lesotho. Notwithstanding this argument, the author proposes further replication in Section 8.3.1.

The primary purpose of a pilot study is to prove the research protocol before extensive data is collected. As explained previously, the case study was an opportunity for the author to gain unique access. The sitation was urgent and there was no time to conduct a pilot. However, at the time of this opportunity, the author had conducted extensive reviews of the literature on problem-formulation and the theory and practice of conducting case studies. He was also a highly experienced senior manager in the case organization with an extensive track record in problem-solving, in particular, problem-formulation. Thus, he was well prepared to undertake the risk of conducting a case study without the benefit of a prior pilot study. On completion of the research project the

author reflects that a pilot study may have helped the efficiency and management of data collection and analysis, but the content was not adversely affected.

8.2.3. The innovation's applicability and limitations

The synthesis of a single comprehensive problem-formulation process (depicted diagrammatically in Figure 3 and

Figure 5) is fundamental to providing the basis from which the gaps in literature were established relating to inadequate domain knowledge being applied to the formulation of problems.

In the simplest of terms this research is about dealing with circumstances where I don't know what I don't know. Despite all the existing literature on the subject of problem-formulation, there is no existing procedure that deals with this situation. This work is relevant in circumstances where organizations have inadequacies in explicit and / or tacit domain knowledge or experience related predominantly to operational problem situations. Such circumstances may arise when experienced people leave without transferring their knowledge, or when either new or long dormant activities are introduced.

The two areas of innovation, as depicted in red in
Figure 10 and
Figure 11, are:

Innovation Area 1

In circumstances where the relevant people in the organization do not have adequate domain knowledge or experience to successfully formulate the problem it is essential that this is recognised and acted upon as the problem is identified.

Innovation Area 2

Where insufficient domain knowledge or experience exists in the organization to enable a problem to be correctly formulated, expert knowledge and/or experience must be introduced as an intrinsic part of the problem-formulation process, after the stage of problem-identification.

The key to the innovation being of value is the recognition of inadequate domain knowledge or experience at the stage of problem-identification, for which awareness is

essential. This is the reason for the development of the method described in Section 5 herein; a step-by-step process that enables those involved in formulating the problem to proactively test the adequacy of their own domain knowledge or experience and that available in the rest of the organization. This step must occur before any attempts are made to define the problem, if the risk of a Type III Error is to be avoided.

The problem-formulation process shown in
Figure 10 and
Figure 11 applies to problems that can become well-defined, that is, typically complex operational problems and certain strategic problems. Once a problem is well-defined, there are established processes to solve it. These processes are explored in Portfolio Report 2 and as an extension of the Problem-Formulation Process in Figure 6. Simpler, routine operational problems are normally addressed through the application of standard operating procedures, although in their absence this process is applicable.

The behavioural aspects of a problem have been excluded from the developed innovation, except to the extent that they relate to problem-solving team and / or stakeholder recognition. Whilst it is accepted that behavioural factors can form part of the problem, this area is a significant area of research in its own right and its exclusion is accepted as a limitation.

Messy problems should be addressed through the application of PSMs. Although the concept of recognising inadequate problem domain knowledge or experience is relevant to them, the developed method is not applicable to messy problems.

In summary, the innovative problem-formulation processes are limited in their application to problems that can become well-defined and are not impacted by behavioural factors that will impede the problem being properly defined. Also, the innovation is not applicable to messy problems.

8.3. Improvements or further extension of this work

8.3.1. Improvements to this work

The work could be improved upon as the subject of further research. The aspects where improvement could be made are listed as follows:

- Not all problem-formulation methods have been recorded in the literature as empirically tested.
- The single case study took advantage of a unique opportunity for the author to develop and apply innovation. There may be merit in achieving greater replication to create confidence in future practitioners that the logic diagrams are universally applicable.
- The method developed in Section 5 herein could be subjected to extensive empirical testing and further refined.
- The behavioural and stakeholder-related aspects that impact problem-formulation could be explored.
- The concept of recognising inadequate domain knowledge could be explored in terms of its potential to apply to PSMs.

8.3.2. Further extensions to the work

The following subjects are considered to be suitable for a further extension of this work.

Application of external subject matter experts in problem-formulation

Figure 11 shows the area of innovation related to introducing external experts as integral participants in the problem-formulation process. Solving complex problems may require additional knowledge to be acquired external to the organization, recognising the importance of applying problem domain knowledge in a manner such as the Consulting / Intervention Process proposed by Kilman and Mitroff (1979). The proposal by Kilman and Mitroff in the Consulting / Intervention Process does not adequately establish where or how such integration takes place. The possibility therefore exists of experts coming equipped with ready-made solutions related to their domain as opposed to becoming engaged in the process of problem-formulation. There is scope to take this work further in the area of how consultants or other external experts should be employed by organizations.

The role of leadership in effective problem-formulation

Stakeholders, including leadership, significantly influence the problem-formulation process, particularly in terms of acting on the realisation that an organization does not possess sufficient problem domain knowledge for effective problem-formulation. Section 4.1 identifies that in the case study, the introduction of effective leadership through Eskom's top management (EXCO), in April 2004, was significant in changing the approach to addressing the problems associated with negotiating telecommunications SLAs. Reiter-Palmon and Illies (2004, page 55), in dealing with the subject of creative problem-solving, state that "*It is unlikely that creative outcomes will be realised without a large degree of support from organizations and organizational leaders. To provide this support, leaders must understand the cognitive requirements of creative problem-solving.*" There is scope to develop further aspects of leadership related to acquiring domain knowledge to be applied to problem-formulation.

Organizational culture

Does the organization have a culture that will enable people to accept that I don't know what I don't know when confronted with problems in an organizational context? There is scope to research the cultural issues related to people accepting the need to acquire domain knowledge related to the innovation developed in this Research Project.

8.4. Conclusions

The objectives of the research project have been met and, through the empirical research, a significant problem for Eskom has been solved.

A robust empirical research strategy and methodology has been developed and applied to a single case study where a unique opportunity arose to develop, apply and test innovation in circumstances of a significant problem affecting the performance of Eskom. The results of this empirical research established two areas of innovation. One of those areas has been developed further into a tested, workable method that can be applied in organizations to establish the extent to which there is sufficiently adequate domain knowledge or experience to ensure that the problem is effectively defined.

An acknowledged limitation concerning testing for external validity that applies to all single case study situations has been addressed by applying the innovation to another problem situation, in another engineering industry segment, in another African country. The innovation is has thus been shown to be applicable in South Africa and Africa.

This research has been shown to be applicable to the substantive aspects of formulating problems where a problem can become well-defined, typically in the areas of complex operational problems and some aspects of strategic problems. The innovation is not applicable to the application of PSMs to messy problems. In addition, the behavioural aspects of organizational problems have been excluded and are a limitation that must be taken into account in the application of the innovation. Accordingly, areas of improvement and potential extensions of work have been identified.

9. References

Ackermann, F. (2011). Problem Structuring Methods 'in the Dock': Arguing the Case for Soft OR. European Journal of Operational Research, Electronically Available

Ackoff, R. L. (1974). The Systems Revolution. Long Range Planning, 7, 6, 2-20

Ackoff, R.L. (1981). The Art and Science of Mess Management. Interfaces, 11, 1, 20-26

Ackoff, R. L. (1994). Systems Thinking and Thinking Systems. System Dynamics Review, 10, 2-3, 175-188

Ackoff, R. L. (1998). A Systemic View of Transformational Leadership. Systemic Practice and Action Research, 11, 1, 23-36

Afifi, F. A. (2007). Action Research: Solving Real World Problems. Tourism and Hospitality Research, 8, 153-159

Agre, G. P. (1982). The Concept of Problem. Educational Studies, 13, (2), 121-142

Alavi, M. and Leidner, D. E. (2001) Review: Knowledge Management and Knowledge Management Systems Conceptual Foundations and Research Issues. MIS Quarterly, 25, 1, 107-136

Basadur, M., Pringle, P., Speranzini, S. and Bacot, M. (2000), Collaborative Problem Solving Through Creativity in Problem Definition: Expanding the Pie. Creativity and Innovation Management, 9, 1, 54-76

Basadur, M. and Gelade, G. (2003). Using the Creative Problem Solving Profile. Emergence, 5, (3), 22-47

Bennet, D. & Bennet, A. (2008). The Depth of Knowledge: Surface, Shallow or Deep? The Journal of Information Management Systems, 38, 4, 405-420.

Bennett, R. H. III, Wheatley, W. J. M., Maddox, N. E. and Anthony, W. P. (1994). The Mind's Eye and the Practice of Management: Envisioning the Ambiguous. Management Decision, 32, 2, 21-29

Bowman, D.D. (2008), Building a Better Model for Technical Problem Solving. The Information Management Journal, September / October 2008, 66-71

Butler, P. (1994). Marketing Problems: From Analysis to Decision. Marketing Intelligence & Planning, 15, (2), 4-12

Buyukdamgaci, G. (2003), Process of Organizational Problem Definition: how to Evaluate and Improve It. Science Direct, 31, 4, 327-338

Chae, B., Paradice, D., Courtney, J. F. and Cagle, C. J. (2005). Incorporating an Ethical Perspective into Problem-formulation: Implications for Decision Support System Design. Decision Support Systems, August, 40, 197-212

Chi, M. T. H. & Glaser, R. (1985). Problem-Solving Ability. Learning and Development Centre University of Pittsburgh Report No. LRDC-1985/6. 227-250

Copland, M. A. (2000), Problem-Based Learning and Prospective Principal's Problem-Framing Ability. Educational Administration Quarterly, 36, 4, 585-607

Cowan, D. A. (1986). Developing a Process Model of Problem Recognition. Academy of Management Review, 11, 4, 763-776

Cowan, D. A. (1991). The Effect of Decision-making Styles and Contextual Experience on Executive's Descriptions of Organizational Problem-formulation. Journal of Management Studies, 28, Sept., 463-483

Dettmer, H. W. (2007a). The Logical Thinking Process: A Systems Approach to Complex Problem Solving. Page 164. Milwaukee: ASQ Quality Press.

Dettmer, H. W. (2007b). The Intermediate Objectives Map. Goal Systems International, 1-13.

Dettmer, H. W. (2008). Conflict and Complexity. Quality Progress, 41, 1, 22-29.

Devine, D. J. & Kozlowski, S. T. J. (1995). Domain-Specific Knowledge and Task Characteristics in Decision Making. Organizational Behavior and Human Decision Processes, 64, 3, 294-306.

Dewey, J. (1910). How We Think. Boston: Heath

Drummond, H. (1992). Another Fine Mess: Time for Quality in Decision Making. Journal of General Management, 18, 1, 1-13

Dutton, J. E., Fahey L., Narayanan, V. K. (1983) Towards Understanding Strategic Issue Diagnosis. Strategic Management Journal, 307-323

Easterby-Smith, M., Thorpe, R. and Lowe, A. (2000). Management Research: An Introduction. London: Sage

Eden, C and Ackermann, F. (2006). Where Next for problem Structuring Methods. The Journal of the Operational Research Society, 57, 7, 766-768

Eierman. M. A. & Philip, G. C. (2003). The Task of Problem-formulation. International Journal of Information Technology & Decision Making, 2. 3, 353-372.

Etzioni, A. (1989). Humble Decision Making. Harvard Business Review. July-August, 122-126

Fiol, M. C. and Lyles, M. A. (1985). Organizational Learning. Academy of Management Review, 10, 4, 803-813

Fontenot, N. A. (1993). Effects of Training in Creativity and Creative Problem Finding Upon Business People. The Journal of Social Psychology, 133, 1, 11-22

Gay, P. H. (2001). A Problem-solving Perspective on Knowledge Management Practices. Decision Support Systems, 31, 1, 87-102

George, F. H. (1980). Problem Solving. London: Gerald Duckworth & Co. Ltd.

Glaser, R. (1984). Education and Thinking – The Role of Knowledge. American Psychological Association, 2, 39, 93-104.

Gupto, R. C. and Labbett, P. (1994). Creative Problem-solving Techniques: Relevance to Doctors in Management? Journal of Management in Medicine, 8, 1, 24-28

Haines, S. G. (2000). Systems Thinking & Learning. USA: HRD Press. 15-16

Hargadon, B. H. and Bechky, B. A. (2006). When Collectives of Creatives Become Creative Collectives: A Field Study of Problem Solving at Work. Organization Science, 17, 4, July-August, 484-500

Harlow, H. (1951). Theoretical Foundations of Psychology. New York: Van Nostrand

Ho, S. K. and Cicmil, S. (1996). Can the S-S Problem-solving Method Help to Win the World Cup? Management Decision, 34, (2), 53-58

Hornby, A. S. (1995). Oxford Advanced Learners Dictionary. Oxford: Oxford University Press

Hsu, P-F. & Sun, M-H. (2005). Using the Theory of Constraints to Improve the Identification and Solving of Managerial Problems. International Journal of Management, 22, 3, 415-425.

Hussey, J and Hussey R. (1997). Business Research. United Kingdom: Palgrave

Jones, M. D. (1995). The Thinker's Toolkit. New York: Three Rivers Press

Kepner, C. H and Tregoe, B. B. (1965). The Rational Manager. New York: McGraw-Hill

Kepner, C. H., and Tregoe, B. B. (1981). The New Rational Manager. Princetown: Princetown Research Press

Kim, J. and Courtney, J. F. (1988). A Survey of Knowledge Acquisition Techniques and Their Relevance to Managerial Problem Domains. Decision Support Systems, 4, 269-284

Kilman, R. H. and Mitroff, I. I. (1979) Problem Defining and the Consulting/Intervention Process. California Management Review, 21, 3, 26-34

Kuo, F-Y., (1998). Managerial Intuition and the Development of Executive Support Systems. Decision Support Systems, 24, 89-1-3.

Lang, J.C. (2001). Managing in Knowledge-based Competition. Journal of Organizational Change Management, 14, 6, 539-553

Lok, D. and Mofulatsi, C. (2003). Distribution Knowledge Management. Eskom Holdings Ltd. (South Africa) Research Report No. RES/PR/03/21424

Lyles, M. A. (1981). Formulating Strategic Problems: Empirical Analysis and Model Development. Strategic Management Journal, 2, 1, 61-75

Lyles, M. A. (1987). Defining Strategic Problems: Subjective Criteria of Executives. Organizational Studies, 8, 3, 263-280

Lyles, M. A. and Mitroff, I. I. (1980). Organizational Problem-formulation. Administrative Science Quarterly, 25, 102-120

Lyles, M. A. and Thomas, H. (1988). Strategic Problem-formulation: Biases and Assumptions Embedded in Alternative Decision-Making Models. Journal of Management Studies, 25,2, 131-145

Macdonald, A. M. (Ed.), (1981). Chambers Twentieth Century Dictionary. Edinburgh: W & R Chambers Ltd.

Malhotra, Y. (2002). Why Knowledge Systems Fail. BRINT Institute www.brint.org./WhyKMSFail.htm, 2004

Marsick, V. J., Gephart, M. A and Huber, J.M. (2003). Action Research: Building the Capacity for Learning and Change. Human Resources Planning, 26, 2, 14-18

Massey, A. P. and O'Keefe, R. M. (1993). Insights from Attempts to Validate a Multi-Attribute Model of Problem Definition Quality. Decision Sciences, 24, 1, 106-125

Massey, A.P. and Wallace, W.A. (1996). Understanding and Facilitating Group Problem Structuring and Formulation: Mental Representations, Interaction, and Representation Aids. Decision Support Systems, 17, 4, 269-274

McFadzean, E. (1998). Enhancing Creative Thinking Within Organizations. Management Decision. 36, 5, 309-315

Mingers, J. and Rosenhead, J. (2004). Problem Structuring Methods in Action. European Journal of Operational Research, 152, 530-544

Minkler, A.P. (1993). The Problem with Dispersed Knowledge: Firms in Theory and Practice. Kyklos, 46, 4, 569-587

Mintzberg, H., Raisinghani, D. and Theoret, A. (1976). The Structure of Unstructured Decision Processes. Administrative Science Quarterly, 21,2, 246-275

Mittoff, I. I., (1997). Smart Thinking for Crazy Times: The Art of Solving the Right Problems. San Fransisco: Barret-Koehler Publishers

Mullen, E.J. (2002). Problem-formulation in Practitioner and Researcher Partnerships: A Decade of Experience at the Centre for the Study of Social Work Practice. Social Work Education, 21, 3, 323-336

Nickersen, J.A. and Zenger, T.R. (2004). A Knowledge-Based Theory of the Firm – The Problem-Solving Perspective. Organizational Science, 15, 6, 617-632

Nord, W. Ed. (2006). Researching Organizations Using Action Research. Handbook of Organizational Studies (excerpt by Eden. C. and Huxham pages 388-408). Beverley Hills: Sage

Nonaka, I. and Takeuchi, H. (1995). The Knowledge-Creating Company. Oxford. Oxford University Press

O'Dell, C and Grayson, C.J. (1998). If Only We Knew What We Know: Identification and Transfer of Internal Best Proactices. California Management Review, 40, 3, 154-174

Ohlmer, B. (1998). Models of Farmers Decision Making. Swedish Journal of Agricultural Research, 28, (1), 17-27

Ortenblad, A. (2001). On Differences Between Organizational Learning and Learning Organization. The Learning Organization, 8, 3, 125-133

Pande, P. S., Neuman, R. P. and Cavanagh, R. R. (2000). The Six Sigma Way. New York: McGraw-Hill

Partington, D. (Ed). (2002). Essential Skills for Management Research. London: Sage

Pounds, W. F. (1969). The Process of Problem Finding. Industrial Management Review. 11, 1-19.

Quesada, J., Kintsch, W. and Gomezi, E. (2005). Complex Problem Solving: A Field in Search of Definition. Theoretical Issues in Ergonomics Science, 6. 1, 5-33

Radding, A. (1998). Knowledge Management: Succeeding in the Information Based Global Economy. Charleston, USA: Computer Technology Research Corp.

Ramakrishna, H. V. and Brightman, H. J. (1986). The Fact-Net Model: A Problem Diagnosis Procedure. Interfaces, 16, November - December, 86-84

Ramaprasad, A. and Mitroff, I. I. (1984). On Formulating Strategic Problems. Academy of Management Review, 9, 4, 597-605

Reiter-Palmon, R. and Illies, J. J. (2004). Leadership and Creativity: Understanding Leadership from a Creative Problem-solving Perspective. The Leadership Quarterly, 15, 1, 55-77

Remenyi, D., Williams, B., Money, Y., & Swartz, E. (1998). Doing Research in Business and Management. United Kingdom: Sage

Reynolds, M and Holwell, S. (Eds). (2010) Systems Approach to Managing Change: A Practical Guide. London: Springer

Rosenhead, J. (Ed). (1989). Rational Analysis for a Problematic World: Problem Structuring Methods for Complexity, Uncertainty and Conflict. Chichester: John Wiley & Sons

Rosenhead, J. (1996). What's the Problem? An Introduction to Problem Structuring Methods. Interfaces, 26, Nov. – Dec., 117-131

Rosenhead, J. (2006). Past, Present and Future of Problem Structuring Methods. Journal of Operational Research Society, 57, 759-765

Schulz, M. (2003). Pathways of Relevance: Exploring Inflows of Knowledge into Subunits of Multinational Corporations. Organizational Science, 14, 4, pages 440-459

Schwenk, C. R. (1984). Cognitive Simplification Processes in Strategic Decision-making. Strategic Management Journal, 5, 2, 111-128

Senge, P. M., Kleiner, A. Roberts, C., Ross, R. B., and Smith, Bryan J. (1994) The Fifth Discipline Field Book. London: Nicholas Brealey Publishing

Smith, G. F. (1988). Towards a Heuristic Theory of Problem Structuring. Management Science, 34, 12, 1489-1506

Smith, G. F. (1989) a. Defining Managerial Problems: A Framework for Prescriptive Theorizing. Management Science, 35, 8, 963-981

Smith, G. F. (1989) b. Managerial Problem Identification. International Journal of Management Science, 17, 1, 27-36

Stevenson, A. (Ed.). 2010. Oxford Dictionary of English Third Edition. Exford: Oxford University Press

Stonehouse, G. H. and Pemberton, J. D. (1999). Learning and Knowledge Management in the Intelligent Organization. Participation and Empowerment, 7, 5, 131-144

Thomas, H. and Schwenk, C. (1983). Problem-formulation and the Consultant-Client Relationship. Interfaces, 13, 4, 25-34

Van Grundy, A. B. Jnr. (1988) Techniques of Structured Problem Solving. New York: Van Nostrand Reinhold

van Zolingen, S. J., Streumer, J. N. and Stooker, M. (2001). Problems in Knowledge Management: A Case Study of a Knowledge Intensive Company. International Journal of Training and Development, 5, 3, 168-184

Vera-Munoz, S. C., Kinney Jr. W. R., and Bonner, S. E. (2001). The Effects of Domain Experience and Task Presentation Format on Accountants' Information Relevance Assurance. The Accounting Review, 76. 3. 405-429

Volkema, R. J. (1983). Problem-formulation in Planning and Design. Management Science, 29, 6, 639-652

Volkema, R. J. (1986). Problem-formulation as a Purposeful Activity. Strategic Management Journal, 17, 267-279.

Volkema, R. J. (1995). Creativity in MS/OR: Managing the Process of Formulating the Problem. Interfaces, 25, 3, 81-87

Volkema, R. J. (1997). Managing the Problem-formulation Process: Guidelines for Team Leaders and Facilitators. Human Systems Management, 16, 1, 27-35

Ward, K. (1991). Project Approach to Quality Management. International Journal of Health Care Quality Assurance, 4, 4, 27-31

Weber, E.P. and Khademian, A. M. (2008). Wicked Problems, Knowledge Challenges, and Collaborative Capacity Builders in Network Settings. Public Administration Review, March – April 2008, 334-349

Welman, C., Kruger, F., & Mitchell, B. (2005). Research Methodology. South Africa: Oxford University Press

Wiley, J. (1998). Expertise as a Mental Set: The Effects of Domain Knowledge in Creative Problem Solving. Memory & Cognition, 26, 4, 716-730.

Woiceshyn, J. and Falkenberg, L. (2008). Value Creation in Knowledge-Based Firms: Aligning Problems and Resources. Academy of Management, 85-99

Yadav, S. B. and Korukonda, A. (1985). Management of a Type III Error in Problem Identification. Interfaces, 15, July-August, 55-61

Yang, X., Zheng, W. and Bo, Z. (2008). Research on Formulation Method of Complicated Design Making Problem Based on Domain Knowledge. 2008 International Conference of Management Science & Engineering, September 10-12, 122-127

Yasin, M. M. and Yavas, U. (2003). A Synergistic Problem-Solving Approach To Meeting Challenges In Retail Organizations. Marketing Intelligence & Planning, 21, 1, 45-50

Yin, R. K. (2003). Case Study Research Design and Methods. United Kingdom: Sage

Zandi, I. (1999). Problem Identification, Problem-formulation – A Systems Approach. A Lecture Tour in South Africa, unpublished