UNIVERSITY OF CAPE TOWN

THE PROJECT IMPLEMENTATION PROFILE'S APPLICABILITY TO PETRO-CHEMICAL PROJECT SUCCESS: AN ANALYSIS OF THE KEY SUCCESS FACTORS

By

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Abstract

Purpose –This research seeks to develop a revised list of Key Success Factors for a petro-chemical project-specific Project Implementation Profile (PIP) tool and to identify the petro-chemical success factors that are not currently included in the PIP tool. Through the identification of petro-chemical key success factors not currently included in the PIP tool, and removing current PIP KSFs that are less applicable to petro-chemical project success.

Design – Conducting a literature review a set of 10 additional key success factors are identified to be relevant to petro-chemical projects that are currently not included in the PIP. A web-based survey with a set of 20 KSFs was sent to petro-chemical project stakeholders to determine their perceived importance of each key success factor in achieving petro-chemical survey project success.

Findings – It is found that the top ten of the key success factors considered to be most relevant to achieving petro-chemical project success contain only six of the original PIP KSFs. The four new success factors are *Change management, Client requirements, Estimating* and *Project implementation timeframe*. PIP factors found to be the least important in achieving petro-chemical project success are *Top management support, Technical tasks, Personnel* and *Project mission.*

Practical Implications – The analysed survey results lead to a revised list of ten KSFs for a possible petro-chemical project-specific PIP tool. Some limitations are noted. However, difficulty in choosing respondents representing all petro-chemical project stakeholders and the idiosyncratic views of the respondents may have skewed the results. It is recommended that further research is undertaken to confirm the research findings and to identify additional key success factors that may have been left out from this research. Testing of the revised tool is also recommended.

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Abbreviations

KSF	Key Success Factor
PIP	Project Implementation Profile

1 Background to Research

1.1 Introduction

Capital projects in the petro-chemical industry are characterised by complex engineering, procurement and construction activities. Their purpose is to create new or changed petro-chemical plant facilities and equipment, to produce new products and to maintain or develop operational capabilities to support market requirements (Merrow, 2012).

The main problem to be investigated is that some petro-chemical projects are not delivering the necessary project results. A review of projects shows the following concerns (Merrow, 2012):

- Cost and schedule commitments cannot be adhered to.
- General operability and safety concerns.

Petro-chemical projects are characterised by failure to meet budget, schedule and operational functionality commitments. Project delivery is marked by complex and changing site conditions, operational and safety requirements, changing technical process requirements, scope control and rapidly changing market conditions (Warchol and Amadi-Echendu, 2007).

The number of projects that experience budget, schedule, operability and functionality problems make it necessary to investigate the reasons why so many projects are experiencing the same challenges.

1.2 Background to the Study

The question can be asked, what makes a successful project? One suggestion is; that a project is successful when the following conditions are met (Pinto and Slevin, 1988: 481-482):

- The project is completed on schedule.
- The project is completed within the approved budget.

- The project achieved all of the goals originally set for it.
- The project is accepted and used by the client.

Pinto and Slevin concluded that *"The project manager requires the necessary tools to help him or her focus attention on important areas and set differential priorities across different project elements. If it can be demonstrated that a set of factors under the project manager's control can have a significant impact on project implementation success, the project manager will be better able to effectively deal with the many demands created by his job, channelling his energy more efficiently in attempting to successfully implement the project under development." (Pinto and Slevin, 1988:* 480).

There is a difference between success criteria and key success factors. Success criteria are used to measure project success, and the success of a project is measured by the degree to which these objectives have been met. Key success factors (KSF) are indicators of an environment of achievement or failure. The presence of KSF does not provide certainty of success, but their absence is likely to lead to failure (de Wit, 1988).

Key success factors differ between industry sectors in which projects are executed (Belout and Gauvreau, 2004; Pinto and Covin, 1989). Success factors importance change during the different phases of a project. Also, success factors are different between industry sectors (Pinto and Covin, 1989). Belout and Gauvreau (2004) recommend that further research needs to be done to determine the key success factors related to specific industry sectors.

Information from project managers from a variety of industries was used by Slevin and Pinto (1986) to develop The Project Implementation Profile (PIP). The project managers were requested to specify what actions they would consider being important and can have a significant influence on the success of the project. The identification of actions that lead to successful projects was repeated numerous times until key actions were identified. Ten success factors were developed from the grouping of fifty identified key actions. These ten success factors now make up the PIP (Pinto, 1990: 174). The ten success factors identified and their associated definitions are as follows:

- Project mission, what business goal does the project need to fulfil?

- Top management support, do senior managers and sponsor supports the project team with resources /decision-making?
- Project schedule/plans; is there a detailed schedule that lists all of the activities and milestones that need to be achieved at a certain date or time?
- Client consultation, is the ultimate user/client/ business partner identified, have agreements been reached on specifications and functionality of project deliverables?
- Personnel, are there enough resources available for activities?
- Technical tasks, do the project team have the required skills to implement the project and do they know the sequence of what and when certain activities need to be completed?
- Client acceptance, does the project team know how the project will be handed over and accepted by the customer?
- Monitoring and feedback, cost and schedule control, can information be given to the team in a timeous manner to track progress on the project?
- Communication, is the information available for the project team when it is required and is the communication media used sufficiently to support the project?
- Troubleshooting, the ability of the team to address and find solutions for unexpected challenges, circumstances, and activities?

Although in practice considerable overlap and variation in relative importance may also be found during the project life cycle, KSFs can be mapped to certain project life cycle phases (Slevin and Pinto, 1987; Pinto and Slevin, 1988). The monitoring, feedback, and communication factors are considered to be of greater importance throughout the project life cycle (Finch, 2003). Figure 1-1 displays the key success factors and their sequential relationship throughout the project life cycle.

Influential project stakeholders may make use of the PIP, although the PIP is usually implemented through the project manager (Pinto and Slevin, 1992). The PIP may also be implemented at any stage of the project life cycle, either periodically or following a significant event (Pinto and Slevin, 1992). In practice, the factors are not unique to any phase, even though the model has a sequential nature (Pinto and Slevin, 1988).

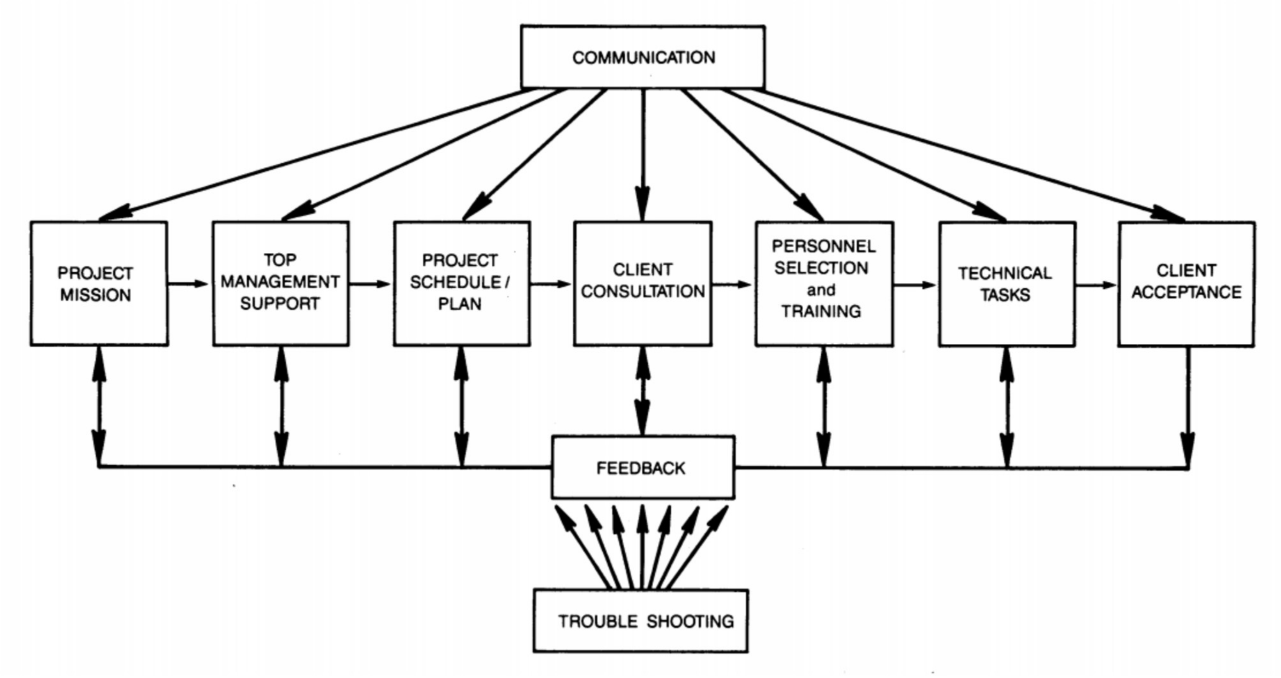

Figure 1-1: The relationship between the ten PIP key success factors (Schultz *et al*., 1987)

The implementation of PIP in retrospect on already completed projects is also a useful method to obtain lessons learned from the project (Pinto and Kharbanda, 1995). Some of the factors explicitly identified by Finch (2003) through a retrospective look are the following:

- The competence of the project manager.
- The political activity within the organisation.
- External organisational and environmental factors.
- The perceived need to rapidly implement the project.

In summary, it is apparent from the literature that KSFs enabling project success are often not generalisable to projects in every industry (Pinto and Mantel, 1990). KSFs are often associated with specific project attributes that may not be equally relevant to all projects (Pinto and Covin, 1989).

1.3 Problem Statement

The key success factors for petro-chemical plant projects are not known.

The PIP Key Success Factors would need to be examined and evaluated comprehensively in relation to petro-chemical projects Key Success Factors to determine the applicability of the PIP tool as an assurance method for petro-chemical project success. The following statement, therefore summarises the problem to be investigated in this study: The Key Success Factors for petro-chemical plant projects are not known.

1.4 Research Questions

To address the research problem stated above, the research question and sub-questions for this study are as follows:

- Which of the existing PIP factors apply to petro-chemical projects?
- Which of the existing PIP factors are not applicable to petro-chemical projects?
- What additional factors apply to petro-chemical projects and are not currently in the PIP?

1.5 Research Aim

The research seeks to develop a revised list of the following:

- Key Success Factors for a petro-chemical project-specific PIP tool.
- Identifying the petro-chemical success factors that are not currently included in the PIP tool.

1.6 Research Proposition

The set of Key Success Factors currently used with the standard PIP tool is not a good fit to ensure petro-chemical project success.

1.7 Research Objectives

To consult previous literature to ascertain which success factors are relevant to petro-chemical project success and highlighting the success factors not incorporated in the standard PIP tool.

To determine which of the PIP and non-PIP success factors petro-chemical project stakeholders consider being more or less relevant to achieving petro-chemical project success by conducting a quantitative survey.

To compile a list of recommended Key Success Factors for the future development of a revised petro-chemical project-specific PIP tool based on the research findings.

1.8 Research Method

A literature review is completed to obtain knowledge on factors that are considered to be required to enable and better the probability of petro-chemical project success.

An online quantitative survey is conducted, targeting project sponsors, programme managers, project managers, engineers, and clients. This data measures various views and opinions in the survey respondents to determine the relative importance of each of the PIP and non-PIP petro-chemical project success factors.

The research findings are analysed, discussed and summarised into a list of Key Success Factors that is recommended for the development of a revised petro-chemical project-specific PIP tool.

1.9 Limitations

The following limitations are identified to have a possible impact on this research study:

- The study will be limited to the petro-chemical environment, specifically to projects in Secunda, South Africa.
- The projects selected will be in the conceptual engineering, basic engineering or execution phase.

- The survey respondents' insight and comprehension of project success factors may not be reflected in the survey.
- The survey respondent' views may not be a true expression of project success due to their individual experience during project development and execution.

1.10 Structure of Minor Dissertation

The minor dissertation will follow the structure as in Figure 1-2 below.

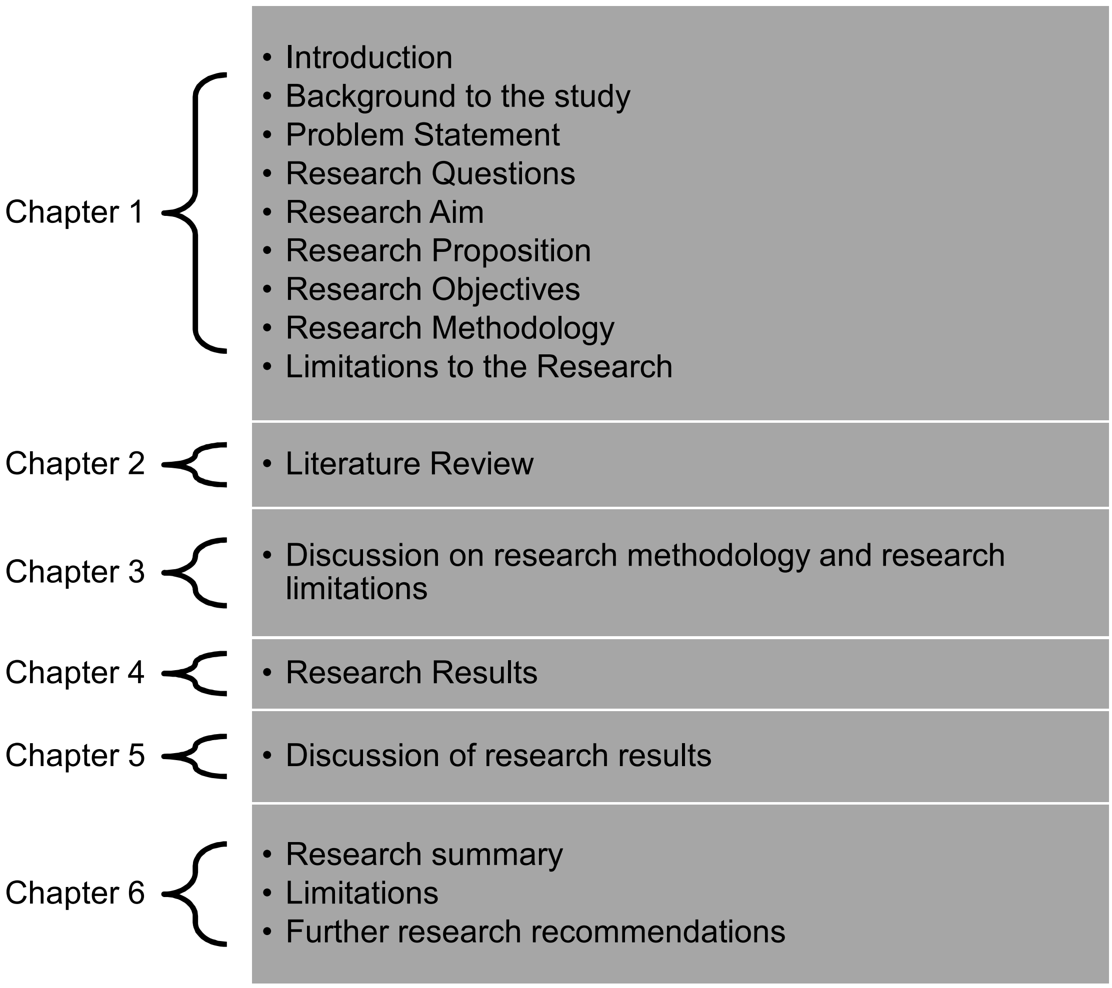

Figure 1-2: Dissertation structure

The literature review in Chapter 2 will focus on the theory of project key success factors, an analysis of the PIP-specific KSFs and available literature on petro-chemical specific project success factors. A summary of PIP and non-PIP KSFs will be examined in this chapter.

The research methodology used will be discussed in Chapter 3, as well as any specific limitations. The research results are presented in Chapter 4, with a discussion of the results in Chapter 5 in the context of the extant literature. Chapter 6 will conclude the research by providing a summary of the research and suggest recommendations for future research that can build on the findings made in this study.

2 Literature Review

The purpose of the literature review is to

- To discuss characteristics of project Key Success Factors (KSF).
- Explore the KSFs of the Project Implementation Profile (PIP).
- Determine petro-chemical project success factors which are not included in the PIP KSFs.

To achieve the above, Section 2.1 will provide an overview of what project KSFs are and discuss project success factors and projects success criteria and their relationship, how the project life cycle influence KSFs, the different dimensions of project success and project stakeholders' perceptions of KSFs. Section 2.1 closes by listing project KSFs found in the literature review.

In Section 2.2 PIP KSFs are analysed, and the limitations and recommendations found in the literature are discussed.

Section 2.3 provides background into the petro-chemical project success factors identified in the literature.

Section 2.4 is a summary of the literature review to summarise the petro-chemical project success factors identified in the literature and emphasise the KSFs not included in the existing PIP tool.

2.1 The Key Success Factors of Projects

Key Success Factors are indicators of preconditions of project success, KSFs do not guarantee success, but their absence is likely to lead to failure (de Wit, 1988). Despite extensive research and a general agreement that some KSF's are common to all projects, there has been insignificant convergence and no agreement on the fundamental factors leading to project success (Pinto and Slevin, 1987; Prabhakar, 2008).

This section will discuss a variety of relevant attributes of project key success factors:

- The relationship between project success criteria and key success factors.
- Life cycle relevance to the project KSFs.
- Different dimensions of project success.
- Project stakeholders' views of KSFs.
- Conclusion, listing general project KSFs identified in the literature.

2.1.1 Project Success Criteria versus Project Success Factors

The relationship between project success criteria and project success factors is often misunderstood, but is important to the understanding of project success (Lim and Mohamed, 1999).

Project success criteria are defined as the set outcomes that are used to judge project success. They are usually established in the early stages of a project (Cooke-Davies, 2002). Project success criteria can further be defined as the set results that need to be achieved to establish how the success or failure of a project will be judged (Jugdev and Müller, 2005; Müller, 2012). Project success criteria are founded on the different project stakeholder's individual beliefs (Lim and Mohamed, 1999).

Project success is an important project management issue, and there is a general lack of agreement on the criteria by which success is judged (Pinto and Slevin, 1988; Freeman and Beale, 1992; Baccarini, 1999). Project success is based on stakeholder opinions. Projects will likely to be deemed a success if the following are met (Baker *et al.*, 1988):

- Technical performance specifications.
- High level of customer satisfaction on project outcome.

Commonly used success criteria such as budget and schedule are often used when there is difficulty in defining the project success measures (Baccarini, 1999; Khang and Moe, 2008). The most commonly used success criteria are summarised in the "Iron Triangle" of project management, namely time, cost and quality (Atkinson, 1999), as fulfilling the criteria for the completion of a project on time, within budget and according to specifications (Jugdev and Müller, 2005). This approach may be ineffective in determining whether the project was implemented properly (Kerzner, 2006).

In contrast, project success factors are defined as the elements that contribute to the success criteria being met (Lim and Mohamed, 1999), thus those factors that increase the likelihood of project success (Müller and Jugdev, 2012) Figure 2-1 presents a diagram of the relationship between project success factors and success criteria.

Through identification of the project success criteria, the relevant key success factors for the specific project may be inferred (Lim and Mohamed, 1999).

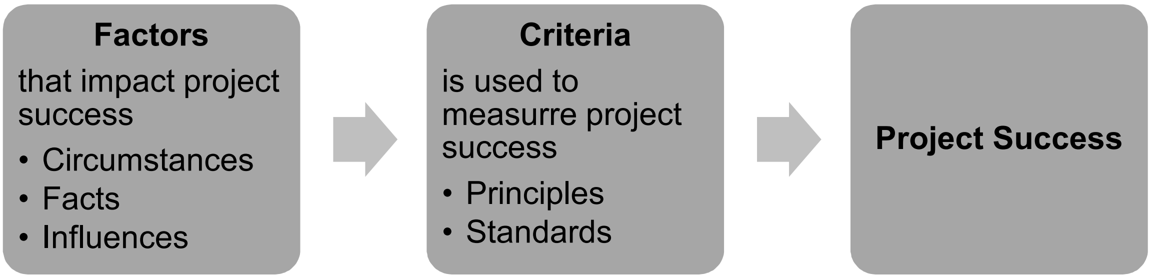

Figure 2-1: Relationship between project success factors and criteria, adapted from (Lim and Mohamed, 1999).

2.1.2 The Project Life Cycle

KSFs are not all of equal importance and changes throughout the project life cycle (Pinto and Covin, 1989; Jugdev and Müller, 2005) of initiation, planning, execution and closure; however, the project mission (clarity of goals) is critical in all stages of the project life cycle (Pinto and Slevin, 1988). Some KSF's are generic to projects irrespective of the project nature, and some KSF's are particular to project groupings. The project life cycle is accepted to follow the stages as per Figure 2-2 (Balachandra and Friar, 1997; Jugdev and Müller, 2005).

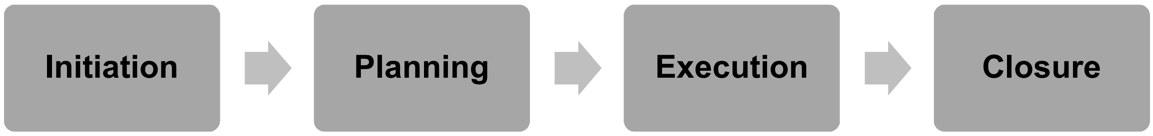

Figure 2-2: General project life cycle (Project Management Institute, 2008)

Emphasis on the KSFs considered to be of a strategic nature should be placed during the initial stages of the project and later in the project for the tactical factors (Slevin and Pinto, 1987). Schultz *et al.* (1987) proposed a clustering of the PIP key success factors into strategic and tactical groupings that can be mapped to the project life cycle. The Project Mission, Top Management Support, and Project Schedule/Plan KSFs are regarded as strategic and are therefore grouped, while the Client Consultation, Personnel, and Technical Tasks KSFs are regarded as tactical and are therefore grouped later during the project life cycle (Schultz *et al*., 1987). An illustrative representation of the grouping of the KSFs can be seen in Figure 2-3.

2.1.3 Dimensions of Project Success

Varying levels of criteria may define the success of a project (Crowston *et al.*, 2003) and the success rating of a project may also differ according to individual subjective judgment (Freeman and Beale, 1992). Success criteria must thus be comprehensive to reflect the differing points of view, leading to a multidimensional, multi-criteria approach (Dvir *et al.*, 2003).

According to Cserháti and Szabó (2014), different projects have specific characteristics which need consideration concerning the project milieu, leading to a diverse combination of success criteria and factors. Examples include objectives, stakeholders, environment, and risks.

The distinction between the different dimensions is important as the defined project success criteria are directly aligned to these (Shenhar *et al.*, 2001). This implies that the project success factors are also aligned to these dimensions. Depending on the nature of the project, i.e., strategic or operational, the success criteria must be adapted to suit. Projects may be classified as either strategic or operational (Baccarini, 1999) with the distinction between the two as follows:

- Strategic projects being those that are more important for the organisation and thus their success criteria require more emphasis on the product success (Baccarini, 1999). This typically has a longer time period implication (Shenhar *et al*., 2001).
- Operationally-managed projects emphasise meeting the project management success criteria directly (Shenhar *et al*., 2001). Project management success criteria typically refer to meeting time, quality and budget goals (Shenhar *et al*., 2001; Collins and Baccarini, 2004).

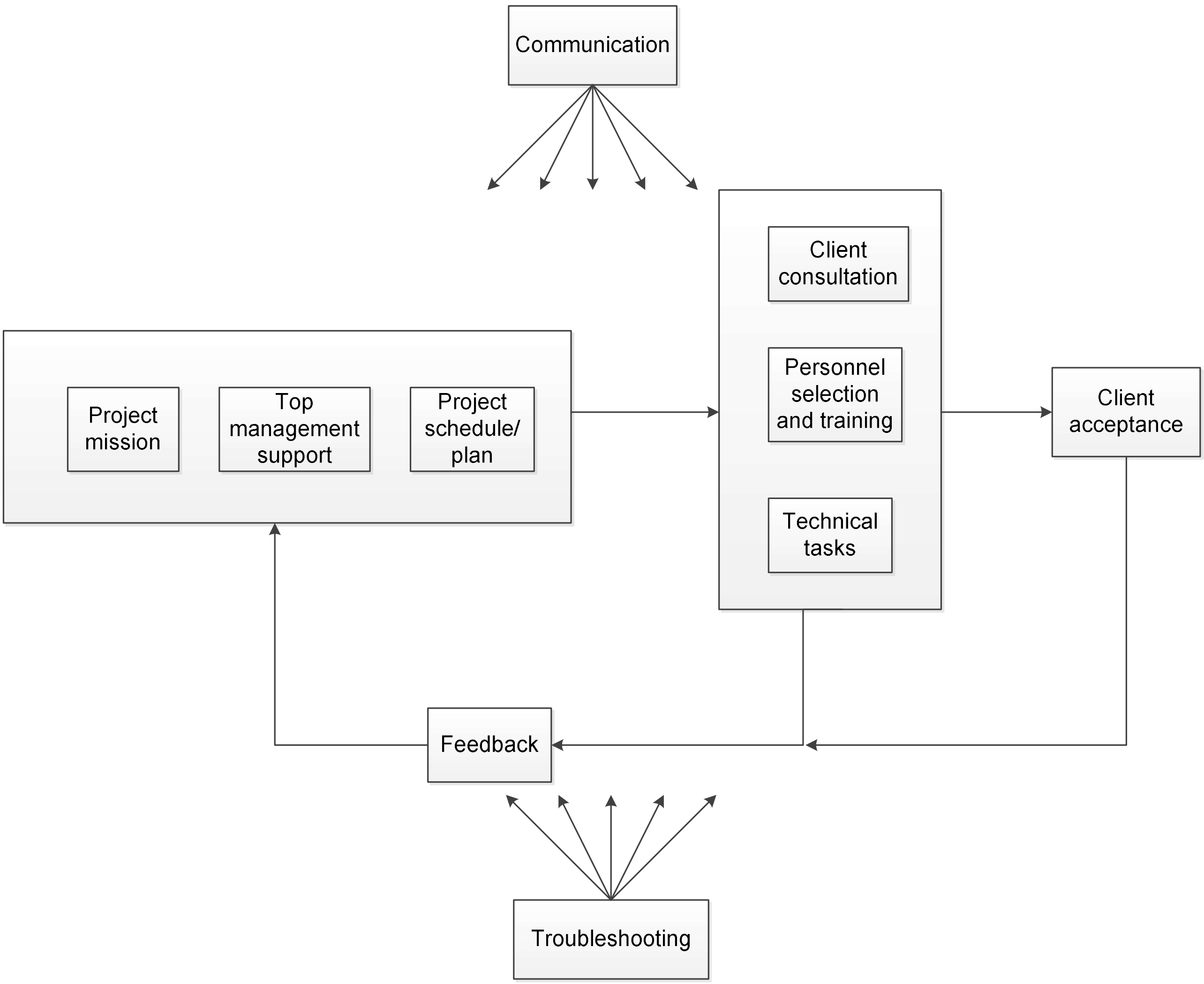

Figure 2-3: Strategic and tactical clustering of the PIP KSFs (Schultz *et al*., 1987)

Although product and project management success are common dimensions, other dimensions are also referenced in the literature. Shenhar *et al.* (2001) indicates 13 success measures which could be grouped into four dimensions, not all necessarily of the same importance:

- Meeting design goals.
- Benefit to the customer.
- Commercial success.
- Future potential.

Although an important aspect of defining project success, the dimensions are typically implied when the success criteria are defined. The criteria typically encapsulate both the project management and product success.

2.1.4 Project Stakeholder Perceptions

Stakeholders have diverging perceptions as to what constitutes a successful project (Morris and Hough, 1987). Project success is a matter of point of view, and a project will most likely be perceived a success if the following conditions are met (Baker *et al.*, 1988):

- Technical performance specifications.
- Mission to be performed.
- High satisfaction level on project outcome between the main project personnel or other stakeholders.

In general, schedule and budget performance are essential project success measures and are relatively easy to assess. Quality, however, is related to issues which may be evaluated subjectively, i.e., achievement of functional objectives and the realisation of these criteria will be subject to more variation in perception by project stakeholders (Jugdev and Müller, 2005).

There are two possible perceptions of project success: macro and micro. The macro point of view considers whether the original project concept was achieved. This is the point of view often taken by the customers and stakeholders. The micro perspective considers project success in smaller component levels, taken by each individual (Lim and Mohamed, 1999).

Differing perceptions must be considered regarding the success criteria importance as well as overall project performance (Turner *et al.*, 2009). This makes the development of an inclusive list of success factors, taking into account the varying nature of projects, a difficult task. In addition to this, every project has a different objective, requiring its specific success factors (Chua *et al*., 1999; Liu, 1999). Various project stakeholders need to be involved in determining project success criteria, to obtain a holistic view of the criteria to address (Karlsen *et al*., 2005). Corresponding KSF’s should then be chosen to address the relevant criteria (Khandelwal and Ferguson, 1999; Jugdev and Müller, 2005).

2.1.5 Common Key Success Factors

Rockart (1979) discusses the term “critical success factors” from the perspective of a Chief Executive. This term now encompasses the factors which significantly contribute to, and thus are indicators of, project success. It is necessary to start determining the factors first which will impact the project success or failure to ensure project success. This concept has received wide attention in the literature in all fields, particularly in the area of construction and project management (Toor and Ogunlana, 2009).

The factors indicated in the PIP were identified through research on general project success factors (Schultz *et al*., 1987). The success factors are thus deemed applicable to any project type, independent from the industry in which it is being executed. This is because the factors cater to general project success criteria, such as meeting time, cost and quality objectives (Schultz *et al*., 1987).

However, since the creation of the PIP, Slevin and Pinto (1986), Burbridge and Friedman (1988), Cleland (1991), Skelton & Thambain (1993), Martinez (1994), Bailey (1998), Cooper (1999) and Meyers (1999) have populated lists of general project key success factors, and it has become apparent that new factors have emerged which were not included in the PIP (Kuruppuarachchi et al., 2002).

The empirical research identified twelve critical success factors for projects. The list of the 12 factors identified consists of factors pertinent to the following:

"F1 Adequacy of company-wide education on the concepts of risk management.

F2 Maturity of an organisation's processes for assigning ownership of risks.

F3 Adequacy with which a visible risk register is maintained.

F4 Adequacy of an up-to-date risk management plan.

F5 Adequacy of documentation of organisational responsibilities on the project.

F6 Keep project (or project stage duration) as far below 3 years as possible (1 year is better).

F7 Allow changes to scope only through a mature scope change control process.

F8 Maintain the integrity of the performance measurement baseline.

F9 The existence of an effective benefits delivery and management process that involves the mutual co-operation of project management and line management functions.

F10 Portfolio- and programme management practices that allow the enterprise to resourcefully a suite of projects that are thoughtfully and dynamically matched to the corporate strategy and business objectives.

F11 A suite of project, programme and portfolio metrics that provides direct ''line of sight'' feedback on current project performance, and anticipated future success, so that project, portfolio and corporate decisions can be aligned. Since corporations are increasingly recognizing the need for ''upstream'' measures of ''downstream'' financial success through the adoption of reporting against such devices as the ''balanced scorecard'', it is essential for a similar set of metrics to be developed for project performance in those areas where a proven link exists between project success and corporate success. For the project management community, it is also important to make the distinction between project success (which cannot be measured until after the project is completed) and project performance (which can be measured during the life of the project). No system of project metrics is complete without both sets of measures (performance and success) and a means of linking them so as to assess the accuracy with which performance predicts success.

F12 An effective means of ''learning from experience'' on projects, that combines explicit knowledge with tacit knowledge in a way that encourages people to learn and to embed that learning into continuous improvement of project management *processes and practices. Indeed, for Kerzner (2000), continuous improvement represents the fifth and highest stage of project management maturity in an organization."* (Cooke-Davies, 2002: 186-189)

A literature review of 63 publications resulted in developing a list of the top 5 KSFs for projects in general (Fortune and White, 2006). These are:

- Support from senior management support.
- Objectives that are clear and achievable.
- A project plan that is up to date.
- Strong communication and feedback mechanisms.
- Involvement of the end user and client in the project.

From the publications above, it can be seen that there is a strong alignment with the factors listed in the PIP, with user involvement being the only factor not explicitly listed in the PIP.

Kuruppuarachchi *et al*. (2002) produced a comparative analysis of the KSFs indicated in the PIP against other KSFs identified from the literature. This review is summarised in Table 2-1.

Table 2-1: Project success factors from different journals (Kuruppuarachchi *et al.*, 2002)

Success factors	Slevin and Pinto (1986)	Martinez (1994)	Meyers (1999)	Skelton & Thambain (1993)	Cooper (1999)	Burbridge and Friedman (1988)	Bailey (1998)	Cleland (1991)
Clarity of goals/clear business vision	X	X	X	X	X	X	X	
Detailed project plan	X	X		X	X		X	
Effective communications	X	X	X	X	X	X	X	X
User participation/customer involvement	X	X	X	X	X	X	X	
Top management support	X	X	X		X	X		
Skilled team members	X	X	X					

Success factors	Slevin and Pinto (1986)	Martinez (1994)	Meyers (1999)	Skelton & Thambain (1993)	Cooper (1999)	Burbridge and Friedman (1988)	Bailey (1998)	Cleland (1991)
Technical expertise	X		X	X	X			
Project management expertise		X	X		X			
Project leadership				X	X			
Project sponsoring and selling the project	X		X	X	X	X		
Stimulating work environment		X	X	X				X
Cross-functional teams			X	X	X			X
Project monitoring and control	X	X						
Decision-making processes		X	X		X			
Joint product development			X					X
Gradual change		X	X				X	
Global orientation				X				X

From the table 2-1, it can be seen that the authors note several KSFs which are not included in the PIP. These include the following:

- Project management expertise.
- Project leadership.
- Stimulating work environment.
- Cross-functional teams.
- Decision-making processes.
- Joint product development.
- Gradual change.
- Global orientation.

From this, it can be deduced that although the PIP appears to be comprehensive, some factors applicable to overall project success have been omitted. The motivation may be due to the design of PIP, which primarily assesses factors which may be directly influenced by the project manager. However, some KSF's are not limited to project manager influence only, as can be seen from the PIP's usability by different project stakeholder types (Finch, 2003).

2.2 The Key Success of the Project Implementation Profile

The PMBOK® (Belout, 1998; Project Management Institute, 2008) constitutes nine knowledge areas, of which the PIP covers seven. These factors are noted as determining project success (Kuruppuarachchi *et al.*, 2002; Finch, 2003; Hyvari, 2006). This section details the success factors which constitute the PIP, also highlighting the limitations indicated from literature. Other factors noted in the literature, which are specifically excluded from the PIP, are also noted.

2.2.1 The PIP Key Success Factors

The ten PIP KSF's originate from a literature review which aimed to identify and review general project success factors (Schultz *et al.*, 1987). The success factors in the PIP have been empirically proven to align to the following project success factors (Pinto and Prescott, 1988; Pinto and Prescott, 1990):

- Project mission.
- Top management support.
- Project plan/schedule.
- Client consultation.
- Personnel.
- Technical tasks.
- Client acceptance.
- Monitoring and feedback.
- Communication.
- Troubleshooting.

An overview of what each PIP KSF encompasses is provided below (Pinto and Slevin, 1988; Pinto, 1990).

2.2.1.1 Project Mission

Project mission - what business goal does the project need to fulfil?

The project mission factor refers to the project goals, objectives and the direction held by the relevant stakeholders (Kirkman and Rosen, 1999). This factor relates to the ultimate understanding of what the project must deliver on, why it is required and what the benefits will be to the end users.

Aligned goals lead to improved project performance (Pinto and Slevin, 1987) and foster cooperation as they can only be achieved through teamwork (Campion *et al*., 1993). Clear goals may even lead to a reduced cycle time in some projects (Zirger and Hartley, 1996; Kessler and Chakrabarti, 1999; Lynn *et al*., 1999).

This factor is characterised by the following attributes:

- Project goals are aligned with organisational goals.
- Basic goals are clear and well understood by the project team.
- Project results will be of benefit to the organisation.
- The team believed the project would be a success.
- The team can identify the organisational benefit of the project (Scott-Young and Samson, 2008).

The decision to proceed with a new project often entails significant monetary investment, as well as occupying human and material resources. It is crucial that the project mission be well understood before and during the project, life cycle to ensure optimal utilisation of resources (Pinto and Slevin, 1988; Pinto, 1990).

2.2.1.2 Top Management Support

Top management support - do senior managers, and the project sponsor, support the project team with resources and when difficult decisions need to be made?

This factor relates to the willingness of top management to commit to and invest in the project. In the case of difficult circumstances, executive and senior management must remain committed to ensuring the project is adequately resourced, funded and assisted to proceed (Pinto and Slevin, 1988; Pinto, 1990). Some aspects vital to this KSF are the following:

- Throughout the project life cycle, top management provides the required resourcing.
- Top management use of authority to assist the project.
- Assistance and support are provided by top management during crisis periods.

This factor may be measured against the following points:

- Management was responsive to requests for additional resources, as and when the need arose.
- Management shared responsibility for ensuring project success.
- Project team agreed with senior management on the degree of their powers and responsibilities for the project.
- Management support project team during crisis.
- Management enabled the project team to make their own decisions and supported those decisions (Scott-Young and Samson, 2008).

Answers to these and similar points often indicate the tangible level of support the project manager can expect to get from top management (Pinto, 1990).

2.2.1.3 Project Plan/Schedule

Project schedule/plan - is there a detailed schedule that lists all of the activities and milestones that must be achieved at a certain date or time?

For a project to be successful, project schedules are required to guide the project team through the project life cycle. Through the project life cycle, schedules are required to guide the project team this will support the project to be successful. The common elements of this factor include (Pinto and Slevin, 1988; Pinto, 1990):

- The project milestones and activities are listed.
- Allocation of resources.
- Estimates of the budget required.
- Duration of activities estimates.

- Activities dependencies linking.

This factor must be measurable to assess the actual progress of the project implementation against the original projections.

2.2.1.4 Client Consultation

Client consultation - is the ultimate user/client/ business partner identified, have agreements been reached on specifications and functionality of project deliverables?

This client is typically considered to be the end user of the project. As the project is initiated on behalf of the customer, communication and consultation should occur between the client and the project team throughout the project life cycle. This is to ensure the project remains within the intended scope and will eventually satisfy the customer's needs. Keeping the client informed creates and maintain a positive relationship with the client and project team members (Pinto and Slevin, 1988; Pinto, 1990).

2.2.1.5 Personnel

Personnel - factor relates to the availability of human resources and the appropriate skills required for implementation of the project.

Aspects relating to this factor include (Pinto and Slevin, 1988; Pinto, 1990):

- During the project the correct number of people being available.
- Did the project resources receive the required training necessary on the project?
- Resources training facilities being available.
- Skill levels required to finish the project.
- Project resources having the required qualities needed on the project.

2.2.1.6 Technical Tasks

Technical tasks - do the project team have the required skills to implement the project and do they know the sequence of what and when certain activities need to be completed?

This factor refers to the availability of the necessary technologies and technical skills required to satisfy the project objectives. It must be determined whether the organisation possesses the right technical resources to develop the project and whether the technical resources possess the required understanding from the technological viewpoint (Pinto and Slevin, 1988; Pinto, 1990).

2.2.1.7 Client Acceptance

Client acceptance - relates to the approval, use of the product and customer satisfaction upon project completion.

Client acceptance is an important factor which must be handled in a similar way to any other KSF on a project. To ensure end product acceptance by the client, it must be considered during the project life cycle (Pinto and Slevin, 1988; Pinto, 1990).

2.2.1.8 Monitoring and Feedback

Monitoring and feedback – the frequent communication to project stakeholders and members on the project status at a specific point in time.

This is a control mechanism which provides the project manager with the opportunity to pre-empt deviations in the early stages (Pinto and Slevin, 1988; Pinto, 1990).

2.2.1.9 Communication

Communication – method and efficiency of information sharing between project stakeholders, both internal and external (Pinto and Slevin, 1988; Pinto, 1990).

The availability and effectiveness whereby communication is shared between the project team, parent organisation and clients are of vital importance to ensure success during the project implementation process.

2.2.1.10 Troubleshooting

Troubleshooting – This factor refers to the continuous adjustments required to ensure the project stays on track and that potential problems or deviations from plan are dealt with via the necessary contingency plans, systems or procedures (Pinto 1988, Pinto 1990).

This factor may be measured against the following points (Pinto 1988; Scott-Young and Samson, 2008):

- Non-project personnel are involved where necessary in the event of problems.
- Brainstorming sessions are held to identify possible problems which may arise during the project.
- Assistance channels are clear to project team members when required.
- Problems arising are solved successfully.
- As problems came to the project team's attention, they are dealt with immediately (Pinto and Slevin, 1988; Pinto, 1990).

2.2.2 Limitations of the PIP Key Success Factors

The PIP's KSFs appear to be comprehensive when reviewing the literature and comparing to other KSFs. However, limitations are indicated in the literature as well. As mentioned before, some other KSFs indicated to be crucial to project success appears to have been omitted from the PIP, such as Kuruppuarachchi *et al*., (2002):

- Expertise in project management.
- Leadership on the project.
- Stimulating and motivating work setting.
- Teams cross-functionality.
- Decision-making processes.
- Joint product development.
- Gradual change.
- Global orientation.

Some factors indicated in the PIP are also found not to contribute meaningfully to project success, for example, the personnel factor is claimed to have a negligible contribution (Belout, 1998). The relative importance of the PIP KSFs is summarised in Table 2-2.

Table 2-2: Ranking of the PIP KSF's importance from different authors (Hyvari, 2006)

	Hyvari (2006)	Finch (PPM) (2003)	Delisle and Thomas (2002)	Pinto and Prescott (1988)	Pinto and Slevin (1987)
Project mission	6	7	1	1	1
Top management support	4	6	9	7	2
Project schedule/plans	5	5	5	9	3
Client consultation	2	1	2	2	4
Personnel	9	10	10	10	5
Technical task	7	9	4	3	6
Client acceptance	3	4	6	4	7
Monitoring and feedback	10	3	3	5	8
Communication	1	2	8	6	9
Troubleshooting	7	8	7	8	10

The ranking matrix demonstrates differing opinions on the relative contribution to project success which the KSFs hold. In the example of the personnel factor, it is ranked of low importance compared to the other factors (Pinto and Prescott, 1988; Delisle and Thomas, 2002; Finch, 2003; Hyvari, 2006) but then indicated as of more importance by Slevin and Pinto (1987). Other authors also confirm the link the personnel factor has to project success (Belout and Gauvreau, 2004).

Finch (2003), through a retrospective view on a completed project, identifies additional restrictions to the PIP KSFs. Finch (2003) identifies project success factors that are omitted from the PIP, i.e. project manager competence.

Although the PIP KSFs are discussed widely in literature and in general appear to be comprehensive, it is clear that other factors considered crucial have been omitted and there are differing perceptions regarding the relative importance of each (Finch, 2003).

2.3 Petro-Chemical Project Success Factors

The past few decades have been characterised by significant growth in the processing industry, with projects becoming larger and more complex (Merrow, 2012). The reasons for the increasing project complexity are well understood – the landscape within which the projects are being implemented is progressively becoming more complex. This may be due to the difficulty in extraction of natural resources, changing legislation, among other reasons.

Although KSFs are not defined explicitly for the petro-chemical application, those defined for processing plants, in particular in the petro-chemical (oil and gas) industry, are relevant due to the similarities in the environment in which the projects are being implemented. According to Merrow (2012), it seems that project leadership continuity is more important to project success in the petro-chemical (oil and gas) industry than for other industrial sectors. The reasons for this are that a lack of continuity in leadership positions, particularly the project director position negatively impact the project outcome (Merrow, 2012). The reason for this is that the project director position connects the different functions in companies to provide functional integration (Merrow, 2012). In smaller projects, the change of the project manager position typically results in a delay in execution and a fair amount of cost growth, because changes to the project scope are made by the project stakeholders that could not get the changes incorporated in the project scope by the previous project manager. For mega projects, the turnover of the project director is associated with substantially poorer project outcomes (Merrow, 2012).

Gepp *et al*. (2014) conducted a survey and determined which success factors are most relevant to plant manufacturing businesses. They conclude that most success factors which are relevant to projects in general are applicable; however, success seems to be dependent on attention to technical expertise and re-use of knowledge and activities due to the significant engineering component to the projects.

To identify petro-chemical project success factors, different methods may be taken. Three approaches are used in this section:

- Section 2.3.1 summarise and discuss literature relevant to a petro-chemical project or related industries' project success factors.

- Section 2.3.2 literature on petro-chemical project success criteria is used to identify and infer project success factors.
- Section 2.3.3 literature on failed petro-chemical projects is used to infer relevant petro-chemical project success factors.

2.3.1 Factors from the Literature

Identification of the impact of various project success factors is conducted for petro-chemical projects. However, due to the limited nature of petro-chemical specific literature, similar reviews conducted within the processing industries, and the oil and gas industry were also used. This was considered to be representative of the petro-chemical industry, due to the similar environments in which the projects are executed. One survey indicates that success factors are not necessarily generic and find that not all success factors in the literature may contribute significantly to project success in the process industries (Scott-Young and Samson, 2008). For example, project team continuity and co-location do not yield any significant result on the project outcomes. They also indicate the effect some factors may have on the project schedule, for example, project goals would positively impact schedule, yet it is considered insignificant. Top management support will also impact schedule negatively but is again deemed to have an insignificant impact on project construction schedule (Scott-Young and Samson, 2008).

The studies above contradict the research by Merrow (2012), who conclude that project continuity is vital to ensure project success, particularly in industrial mega-projects.

Table 2-3: Aggregated potential factors impacting large oil and gas project performance (Chanmeka *et al.*, 2012)

Category	Factors	References
Project characteristics	Project size ($), project duration (weeks), project nature, location, ownership, delivery process, site conditions	Desnoyers (1981); Flyvbjergme , Bruzelius, N. & Rothengatter. *et al.* (2003); Fayek (2005); Fiori and Kovaka (2005); Kerzner (2006)

Category	Factors	References
Project organisation and leadership	Project organisation, team communication, governance, leadership, contractual relationships, attitude of participants	Tompkins (1978); Edwards (1982); Flyvbjerg *et al.* (2003); Liberda *et al.* (2003)
Complexities in project management	Human resources management, project planning, and scheduling, work process and integration among teams, traffic, and logistics	Tompkins (1978); Desnoyers (1981); Edwards (1982); Liberda *et al.* (2003); Kerzner (2006); Palmer and Mukherjee (2006)
Demand for technical and human resources	Project team turnover, project team experience, lack of skilled labour, labour availability, lack of skilled construction supervisors, lack of infrastructure, material availability, etc.	Desnoyers (1981); Edwards (1982); Hendrickson (1998), Flyvbjerg *et al.* (2003); Liberda *et al.* (2003); Kerzner (2006); COAA (2006)
Complexities in engineering and construction	Need for high construction technology, technology, and innovation, remoteness, need for worker camp, engineering complexity, task interdependence, safety, impact factors, i.e., weather	Smyth (2004); Fayek (2005); Rankin *et al.* (2005); Fiori and Kovaka (2005); COAA (2006)
Other external factors	Economics and finance, business market conditions, political and public policy, legal and regulatory matters, public relations, cultural landscape	Desnoyers (1981); Flyvbjerg *et al.* (2003); Snethkamp and Macklin (2004); Smyth (2004); COAA (2006)

2.3.2 Factors from Petro-chemical Project Success Criteria

As discussed in Section 2.1.1, a review of petro-chemical project success criteria presents an understanding of what project stakeholders deem necessary to define a successful project. Comprehension of the success criteria allows for the inference of factors that can be attended to and that would support the criteria being met. A literature review of success criteria of projects was completed, both from authors who had studied multiple project types and from authors who had studied petro-chemical (industrial / oil and gas) projects only (Merrow, 2011). Several success criteria listed from various sources who had only studied petro-chemical (industrial / oil and gas) projects, included the following criteria to determining thresholds for failure (Merrow, 2011: 37-51):

- *Cost overruns ratio < 25%, actual final cost vs. cost at project approval for execution.*
- *Cost competitiveness ratio < 25%, project cost vs. relative to other projects with similar scope and location.*
- *Slip ratio in execution schedules < 25%, start of detail engineering until the project is ready for operation. Slip is defined as the actual schedule divided by the schedule at project approval.*
- *Schedule competitiveness < 50%, duration of execution relative to similar projects.*
- *Production is planned with significantly reduced production capacity into year two*.

The noteworthy KSFs considered in this study are combined with previous studies of both large petro-chemical projects as well as other types of mega projects due to the inherent similarities in large-scale work. Research by Chanmeka *et al*., (2012) grouped the KSFs into six broad categories as shown in Table 2-3. A typical project in the petro-chemical environment has a high project capital cost and a long duration of front-end loading/execution. These projects experience high team turnover, extended over time and financial risks (Desnoyers, 1981). Projects are sometimes located in isolated areas, which add more complexity and uncertainty (Fayek, 2005). Experienced project teams that are accustomed to working with the petroleum industry specifications and design codes is required to manage and execute large petro-chemical projects (Desnoyers, 1981; Edwards, 1982; Kerzner, 2006; Palmer and Mukherjee, 2006). Large petro-chemical projects require innovative engineering capabilities, experienced engineering and construction contractors and reliable suppliers that can plan/control project cost, schedule and execution. There is a high demand for technical skills and experienced resources, especially concerning skilled labourers and available materials and equipment (Hendrickson, 1998; Flyvbjerg *et al*., 2003; COAA 2006). Slow project development and execution may result that a product is late to the market, resulting in an investment opportunity turning into an expensive failure. Plant operability and technical performance are very important to ensure predictable and reliable production. Production installations in the petro-chemical industry are capital intensive and require a high utilisation of the asset (Scott-Young and Samson, 2008).

2.3.3 Factors from Failed Petro-chemical Projects

Project success factors can be identified and inferred from the literature through the analysis of failed petro-chemical projects. Credit Suisse concluded that the following factors could lead to project delays and overspend (EYGM, 2015):

- 65% of project failures were due to soft aspects such as people, organisation, and governance.
- 21% of project failures were due to management processes and contracting and procurement strategies.
- 14% were due to other external factors, i.e., government intervention and environment-related mandates.

Ernest and Young (EYGM, 2015) list the following as challenges when it comes to megaproject delivery in the petro-chemical (oil and gas) industry:

- *Ineffective project management*: project plans neglect required schedule management elements and their relationship to other project disciplines, leading to project teams not fully understanding their scope and critical activities, as well as the impact of changes in schedule and other work packages. Multiple contractors, each with their specific project scope which often interlinks with another's, exacerbate the planning problem. Most project success has been observed where effective, interlinked work breakdown structures exist with real-time data input.
- *Poor contract management*: poor service quality and limited equipment capacity are common challenges in the industry. The number of projects being executed worldwide in the industry has led to a high demand for materials and services. The limited number of Engineering, Procurement and Construction Management (EPCm) and Engineering, Procurement and Construction (EPC) contractors with the necessary capabilities, processes, and systems (EYGM, 2015), has led to a shortage in the supply chain. Limited supervision of contractors during the project

life cycle further increases this risk, as projects may be subjected to variations or contractor claims.

- *Human capital deficit*: as noted in the previous point, the sharp increase in projects worldwide puts pressure on the availability of labour, leading to companies struggling to secure the human resources required to manage their projects.

An explanation of the poor outcomes on petro-chemical (oil and gas) mega-projects in the industry is provided by Merrow (2012). The factors which contribute to project failure all relate to the poor integration of functions required to yield project success:

- Front-end loading is more important in petro-chemical (oil and gas) projects. Insufficient attention to front-end loading contributes to poor outcomes.
- Project leadership continuity.
- Drive by business to establish aggressive project schedules. Aggressive schedules worsen the impact of the previous two factors.

Studies by Dozzi and AbouRizk (1993), Smyth (2004), Fayek (2005), Ahmed *et al. (*2005), and Palmer and Mukherjee (2006) identify success factors that can be related to project failures as follows:

- Project size.
- Site location and conditions.
- Inaccurate labour productivity and work unit costs.
- The extent of project scope and changes.
- Inadequate and incomplete engineering deliverables.
- Field labour productivity deterioration.
- Shortage of project teams and skilled labour.
- Inadequate front-end planning and detailed execution plan.
- Insufficient risk assessment.

Table 2-4: How to ensure a project's failure (Pinto and Kharbanda, 1996)

1. Ignore the project environment (including stakeholders).	2. Never admit a project is a failure.
3. Push a new technology to market too quickly.	4. Over-manage project managers and their teams.
5. Don't bother building in fall-back options.	6. Never, never conduct post-failure reviews.
7. When problems occur, shoot the one most visible.	8. Never bother to understand project trade-offs.
9. Let new ideas starve to death from inertia.	10. Allow political expediency and infighting to dictate crucial project decisions.
11. Don't bother conducting feasibility studies.	12. Make sure the project is run by a weak leader.

2.4 Summary of Literature Review

This section aims to provide an overview of the different KSFs considered in identifying and inferring the relevant petro-chemical project KSFs. This section also lists the petro-chemical success factors identified in the literature which is not explicitly covered in the PIP.

In the identification of the petro-chemical success factors, the following aspects are considered of importance when considering the KSF:

- Success criteria relevance.
    - Criteria for petro-chemical project failure are also relevant for project success inference.
- Life cycle impact.
    - No limitation to the particular project phase is considered in the Project KSFs.
- Different success dimensions.
    - No limitation to a particular project success dimension is considered in the Project KSFs.

- Stakeholder perception of the KSF.
    - No bias towards a particular project stakeholder's perception of success is considered in the project KSFs.

With the points above taken into account, petro-chemical KSFs are identified from the completed literature review. Table 2-5 lists the identified KSFs with a short description of each.

Table 2-5: Summary of the PIP KSFs and the non-PIP KSFs identified

Factor	Overview	In PIP	Not in PIP
Project Mission (Schultz *et al*., 1987)	*"The importance of initial, clearly defined and agreed upon goals must be spelled out in the beginning."* (Schultz *et al*., 1987:40)	x	
Top Management Support (Schultz *et al*., 1987)	*"It is necessary for top managers to get behind the project at the outset and make clear to all personnel involved that they support successful completion."* (Schultz *et al*., 1987:40)	x	
Project Schedule (Schultz *et al*., 1987)	"*A detailed plan of the required steps in the implementation process needs to be developed, including all resource requirements (money, raw materials, manpower, and so forth)."* (Schultz *et al*., 1987:40)	x	
Client Consultation (Schultz *et al*., 1987)	*"The clients, or parties for whom the project is ultimately intended, either inside or out- side the organization, need to be consulted in order to better determine their specific needs." (Schultz et al., 1987:40)*	x	
Personnel (Schultz *et al*., 1987)	"*Key personnel must be recruited, selected, and trained to form the project team for technical as well as logistical support in implementing the project. "(*Schultz *et al*., 1987:40)	x	

Factor	Overview	In PIP	Not in PIP
Technical Tasks (Schultz *et al*., 1987)	*“The project must be well managed by people who are familiar with it, who possess adequate technical skills, and who have the technology to perform their tasks.”* (Schultz *et al*., 1987:40)	x	
Client Acceptance (Schultz *et al*., 1987)	*“The ultimate success of a project rests with the client's decision of whether or not to accept it. As a result, this stage of the implementation process must be managed like any other, with efforts being made to "sell" the final product to its intended users.“* (Schultz *et al*., 1987:40)	x	
Monitoring and Feedback (Schultz *et al*., 1987)	*“At each stage of the project implementation process, key personnel receive feedback on how the project compares to the initial projections.*“ (Schultz *et al*., 1987:40)	x	
Communication (Schultz *et al*., 1987)	*“Adequate communication channels (both formal and informal) are extremely impor-tant, not only within the project team, but between the team and the organization, as well as with the project's clients.“* (Schultz *et al*., 1987:40)	x	
Troubleshooting (Schultz *et al*., 1987)	*“Because problems arise in almost every project, the manager should make adequate ini-tial arrangements for troubleshooting mechanisms.“* (Schultz *et al*., 1987:41)	x	
Project Manager Continuity	Leadership, have the project manager/ project director been replaced		x
Environmental Sustainability	Political activity within the organisation, project atmosphere, engineering, and construction labour productivity, site location, and conditions.		x

Factor	Overview	In PIP	Not in PIP
Risk Management	Project team actively identifying, assessing risks, project team consist of team members with varying levels of expertise and experience.		x
Change Management	Incorporation of a control mechanism to cater for organisational changes, extent of project scope and changes.		x
Project Size	Directly linked to the complexity.		x
Project Management Processes	The use and implementation of procedures relevant to project management.		x
Project Implementation Timeframe	The perceived need to implement the project on an expedited / fast-track basis.		x
Estimating	Inaccurate labour productivity and work unit costs, inadequate and incomplete engineering deliverables resulting in inaccurate cost estimates.		x
Client Requirements	Specifications according to the customer requirements.		x
End-User Consideration	Customer requirements, preferences, and fulfilment thereof during and after the project.		x

Chapter 3 presents the methodology used to determine the relevance of the KSFs presented in Table 2-5 in achieving petro-chemical project success, in order to answer the questions of this research.

3 Methodology

This chapter presents the research design to address the research questions presented in chapter one. The questions are reviewed, and the means through which they will be answered are highlighted. This study is based on the premises of positivism which tests variables, measured with numbers and analyse using statistical techniques. The objective of quantitative methods is to determine whether the predictive generalisation of a theory holds true (Abawi, 2008). Andrew *et al*. (2011) attempted to do a comparative analysis of the common philosophical assumptions, methods, and research practices of the qualitative, quantitative and mixed–methods approaches. This review is summarised in Table 3-1.

Table 3-1: (Andrew *et al*., 2011)

Philosophy	**Constructivism**	**Positivism**	**Pragmatism**
Type of research	Qualitative	Quantitative	Mixed
Methods	Open-ended questions, emerging approaches, text and image data.	Closed-ended questions, pre-determined approaches, numeric data.	Both, open and closed-ended questions, both, emerging and predetermined approaches, and both, qualitative and quantitative data analysis.
Research practices	Positions researcher within the context. Collects participant-generated meanings. Focuses on a single concept or phenomenon. Brings personal values into the study. Studies the context or setting of participants. Validates the accuracy of findings. Interprets the data. Creates an agenda for change or reform. Involves researcher in collaborating with participants.	Tests or verifies theories or explanations. Identifies variables of interest. Relates variables in questions or hypotheses. Uses standards of reliability and validity. Observes and then measures information numerically. Uses unbiased approaches. Employs statistical procedures.	Collects both, qualitative and quantitative data. Develops a rationale for mixing methods. Integrates the data at various stages of inquiry. Presents visual pictures of the procedures in the study. Employs practices of both qualitative and quantitative research.

The distinction between quantitative and qualitative research methods is one of the most common research classifications (Myers, 1997). Depending on the type of data to be collected in the research, either method or both may be required. A clear distinction between the two approaches is provided below (Abawi, 2008: 10):

- *Quantitative research "involves the numerical representation and manipulation of observations for the purpose of describing and explaining the phenomenon that those observations reflect."*
- *Qualitative research "involves the examination and interpretation of observations for the purpose of discovering underlying meanings and patterns of relationship."*

The research design and the research tool are presented, research sample and instrument distribution method are discussed. A discussion of the limitations of the methodology concludes the chapter.

3.1 Why Quantitative Research?

Quantitative methods test whether the predictive generalisation of a theory is accurate (Abawi, 2008). The assumptions encompassed within quantitative research support this goal, and are listed below (Abawi, 2008: 4):

- *"Reality is objective, "out there" and independent of the researcher. Therefore reality is something that can be studied objectively.*
- *The researcher should remain distant and independent of what is being researched.*
- *Research is based primarily on deductive forms of logic, and theories and hypotheses are tested in a cause-effect order.*
- *The goal is to develop generalisation that contributes to theory that enables the researcher to predict, explain, and understand a phenomenon."*

3.2 Research Requirements

The research purpose is to formulate a revised list of ten KSFs for a petro-chemical project specific PIP. The research will identify petro-chemical success factors that are not currently included in the PIP tool and exclude standard PIP KSFs that are not applicable to petro-chemical project success. The research questions for this dissertation raised in Section 1.4 are as follows:

a. Which of the existing PIP factors apply to petro-chemical projects?
b. Which of the existing PIP factors are not applicable to petro-chemical projects?
c. What additional factors apply to petro-chemical projects and are not currently in the PIP?

Two steps are required to answer the research questions listed above:

- Identification of petro-chemical project specific KSFs that are not included in the PIP.
- Determining the relative significance of the KSFs (PIP and non-PIP).

The literature review completed in chapter 2 in part concludes the first step to identify and determine appropriate KSFs to achieve petro-chemical project success. This provides a basis for answering research questions *(a)* and *(b).* Table 2-5 provides 10 PIP KSFs as well as ten non-PIP KSFs, identified from literature, which may be substantial contributors to success in petro-chemical projects.

Step 2 entails the comparison of the PIP and non-PIP KSFs and determines the relative significance in realising petro-chemical project success. Currently, no measures are available to precisely rank KSFs significance in measuring petro-chemical success, and it is, therefore, the case that a select few KSFs are widely considered to be the most important (Schultz *et al*., 1987).

Rank-ordering of the KSFs relative to their role in and contribution to success in petro-chemical projects will be required to assess their relative importance to each other. An ordinal scale is appropriate due to the rank-ordering requirement (Stevens, 1946).

3.3 Research Structure

To answer the research questions of this dissertation, the structure of the research employed and used is described in this section.

- Section 3.3.1 describes the research instrument selected to collect the required data for analysis.

- Section 3.3.2 provides a summary of the potential survey respondents chosen for the research.
- Section 3.3.3 describes the research instrument distribution methodology implemented.

The research is non-experimental and is according to Page and Meyer (2000), by far the most frequently used type of research in business and management. No variables will be controlled in this research as is in the case of experimental research.

The key success factors for project success have been identified in theory review. The success factors from the PIP, as well as selected factors not specifically included in the PIP, are then combined in a questionnaire with the respondents requested to indicate the relevance of each factor to contribute to project success.

3.3.1 Research Instrument

The most common method of ranking ordinal data is to use a Likert-type scale (Albaum, 1997; Blaikie, 2003). Gepp *et al*. (2014) used a 5-point Likert scale in an online survey to determine a list of 41 KSFs for plant engineering projects. The scale is widely utilised and well published in literature (Kaplan and Saccuzzo, 1993) due to the general ease of development by the researcher, and ease of understanding by the respondent.

The factors listed in Table 2-5 are listed on a Likert scale for evaluation and distributed as a survey. The respondents are requested to indicate the relevance of each KSF to achieving petro-chemical project success.

Respondents are not informed of the PIP being used as a basis for the research. The five-point Likert scale, using five ordinal points is designed to measure the opinion and is a common variant of the traditional Likert scale (Jamieson, 2004). Survey respondents are requested to rank the significance of the KSFs in realising petro-chemical project success, according to the scale below:

- Not influential at all.
- Somewhat influential.
- Influential.

- Very influential.
- Absolutely critical.

For computational purposes, the ordinal points used in this research are assigned a ranking from 1 to 5. A 6th ranking possibility of 'Cannot answer.' is included in the survey. This ranking provides an answer to the respondent if the respondent's role does not make use of the KSF, or the respondent does not have knowledge of the specific KSF's significance.

The overall importance of each KSF is calculated by applying Equation 3-1 on the survey results ranking data.

$$W_k = \frac{100\left(\sum_i^N S_i\right)}{5\,(N - C)}$$

Equation 3-1

N = total number of respondents

Wk = normalised (percentage) importance value for KSF k, with k being one of the 20 KSFs

S_i = ranking for KSF k provided by respondent

C = total number of respondents who answered 'Cannot Answer' for KSF k

Equation 3-1 provides a percentage measure of the perceived importance of a specific KSF in measuring petro-chemical project success.

The respondents are also given the option to list any additional KSFs not explicitly listed in the survey, which they perceive to be important to achieving petro-chemical project success. Listing of additional KSFs is a qualitative question which will not contribute to the overall results, but is included to obtain additional research results. The qualitative responses are evaluated to see if they match the already listed KSFs, or whether they are new KSFs not listed in the survey. These results may be considered for inclusion into future KSFs for projects and may merit further research. No conclusions are, however, drawn from the results due to the subjectivity involved.

3.3.2 Sample

When choosing the survey respondents, a decision was made that the research survey will only be completed by petro-chemical professionals (project portfolio managers, senior managers, cost estimators, planners, project managers, construction managers, engineers, project sponsors, clients, and end-users) who have direct involvement in petro-chemical projects. The choice to use petro-chemical professionals is essential to the research question, and sub-questions relate to the success factors specific to petro-chemical projects. The decision to not limit the respondents to any specific stakeholder group within petro-chemical projects environment that are developed and executed in Secunda, South Africa relates to the absence of restrictions of PIP implementation to appropriate stakeholders.

Respondents completing the research survey are requested to provide their project role; this enables further observations to be made from the data collected. Six project role options are given to the survey respondents to choose from. The project stakeholder roles chosen correspond to stakeholders considered to have the most interest in project success (Davis, 2013):

- Project manager.
- Senior management.
- Project team member.
- Client.
- End-user.
- Other.

In order to test the homogeneity of the sample, a Chi-square test will be done on each KSF based on the project type and role the survey correspondents selected.

3.3.3 Survey Hypotheses

Hypotheses is set for the sake of the Chi-square test.

H_0: Survey respondent's survey result per individual KSF is homogeneous per project type and or project role.

H_1: Survey respondent's survey result per individual KSF is not homogeneous per project type and or project role.

Significance level, a = 0.05.

The decision rule is: Reject H_0 if the Chi-square test result (*P* Value) is equal to or greater than 0.05 per project type and or project role per individual KSF

3.3.4 Data Collection

The data is gathered by administering a web-based survey questionnaire. The analysis method to be used as is as described in section 3.3.1. The factors contributing to project success are presented in the questionnaire in a point format. Respondents must then rate each statement according to the Likert scale distribution. The content of the survey, as well as the Likert Scale research instrument, is provided in Appendix A.

Tiene (2000) and Wright (2005) note the following advantages of this methodology:

- Has a lower interviewer bias.
- Provides anonymity.
- Provides access to distinctive and major populations.
- Is time effective during implementation.
- Is cost effective during implementation.

The survey instrument was sent electronically to petro-chemical professionals.

3.4 Limitations

The following limitations are noted for the methodology implemented for this research:

- The number of responses received may be impacted by the respondents' workload during the survey period, as well as the limited time allowed for distribution of the survey and collection of responses.
- The limited geographical area the survey focuses on.

- Choosing respondents who represent all of the petro-chemical project stakeholders could be difficult. This could potentially impact the generalizability of findings.
- Individual respondents' subjective views of what constitutes actual success in projects which may not be a representative view due to prior experience in projects.

3.5 Research Ethics

The following ethics guidelines, as stated by Page & Meyer (2000), will be followed:

- Data that is not relevant to this research will not be collected.
- Research conducted should add to the project management knowledge base.
- Research respondent's rights need to be protected as not to diminish and or violate their rights.
- The genuine purpose of the research needs to be disclosed to the potential respondents before research commences.
- All support for the research should be disclosed, including any financial assistance.
- Research results should be made available to respondents and public in a responsible manner.
- All research conclusions should be supported by the data collected and the literature reviewed.
- The limitations of the research need to be reported.
- The research methodology and results need to be reported.

4 Research Results

The results obtained from the survey undertaken are presented in this chapter, as described in Section 3.2. The full and unmodified survey results are in Appendix B, showing each respondent's type of project, project role, individual KSF importance ranking and additional information provided.

Section 4.1 gives an overview of the respondent demographics, indicating the type of project and role breakdown of the survey respondents. Section 4.2 presents the primary research results. Section 4.3 presents the additional research results.

4.1 Participant Demographics

The survey returned 51 responses in total, 47 completed responses and 4 responses which were prematurely stopped and were incomplete. These 4 incomplete surveys are not included in the data analysis. Responses were received from petro-chemical project stakeholders involving the full set of petro-chemical project types. A representative data set for petro-chemical projects is achieved as the available project stakeholder roles are covered by the research respondents. It should be noted that although the respondents covered the available petro-chemical project roles and petro-chemical project types, project team members alone amount to 44,7% of the survey respondents. Project managers and team members together amount to 72.3% of the survey respondents.

Table 4-1 provides the survey respondents' demographcs, showing the number of different respondents per petro-chemical sub-industry and project stakeholder roles.

Table 4-1 Survey participant demographics

	Mega > R1000 million	Large < R1000 million	Medium < R500 million	Small < R50 million	Total
Project Manager	4	3	3	3	13
Senior Management	3	4	1	1	9
Project Team Member	6	11	4	0	21
Client	1	2	0	0	3
End User	0	0	0	0	0
Other	0	0	0	1	1
Total	14	20	8	5	47

4.2 Primary Research Findings

The overall survey respondents' rankings of the KSF relevance can be seen in a heat map shown Table 4-2. The percentage of responses received, out of a possible total of 47 is indicated in each cell for each of the KSF relevance rankings. The heat map shows the PIP KSFs and non-PIP KSFs, and further indicates the percentage of respondents who answered "Cannot Answer" for the KSF relevance ranking.

The following results can be observed from the heat map shown in Table 4-2:

- There is no strong preference for PIP KSFs over non-PIP KSFs when selecting the relative importance of the factors, although when considering only those factors which are indicated as absolutely critical to project success, the majority identified are PIP KSFs.
- 61% of respondents report that the Communication KSF (PIP KSF) is perceived to be absolutely critical in achieving petro-chemical project success. Communication scored the highest of all the KSFs.
- Other KSFs perceived as being absolutely critical for achieving petro-chemical project success are: Change Management (non-PIP KSF) and Client Requirements (non-PIP KSF). Both achieved a score of 57% by respondents.
- Additional factors perceived to be absolutely critical for achieving petro-chemical project success are: Client acceptance (53% of those surveyed, PIP KSF) and Client consultation (49% of respondents, PIP KSF) and Project schedule (51%, PIP KSF).
- Project size, a non-PIP KSF, is perceived to be not influential at all in achieving petro-chemical project success by 11% of respondents. This factor is thus not perceived to be relevant at all.

Table 4-2 KSF Relevance Heat Map

* Non-PIP KSF PIP KSF	Absolutely critical	Very influential	Influential	Somewhat influential	Not at all influential	Cannot answer
* Change Management	57%	28%	13%	2%	0%	0%
Client Acceptance	53%	34%	11%	2%	0%	0%
Client Consultation	49%	34%	13%	4%	0%	0%
* Client Requirements	57%	26%	15%	2%	0%	0%
Communication	61%	30%	9%	0%	0%	2%
* Project Manager Continuity	34%	43%	17%	2%	4%	0%
* End-User Consideration	30%	40%	30%	0%	0%	0%
* Environment Stability	17%	32%	38%	13%	0%	0%
* Risk Management	40%	36%	15%	9%	0%	0%
Monitoring and Feedback	39%	28%	26%	7%	0%	2%
Personnel	32%	36%	26%	2%	4%	0%
* Project Management Processes	31%	33%	20%	13%	2%	0%
* Project Size	9%	13%	38%	29%	11%	4%
Project Mission	15%	28%	30%	24%	2%	0%
Project Schedule	51%	36%	9%	2%	2%	4%
* Estimating	35%	46%	11%	7%	2%	2%
* Project Implemetation Timeframe	30%	46%	20%	4%	0%	2%
Technical Tasks	32%	40%	23%	4%	0%	0%
Top Management Support	37%	35%	15%	11%	2%	2%
Troubleshooting	39%	28%	26%	7%	0%	2%

Equation 3-1, as described in Section 3.3.1 is used to aggregate the numerical rankings, and a normalised value is calculated. The normalised percentage value of each of the KSFs can be seen in Figure 4-1 in descending order. The graph also shows the PIP KSFs and non-PIP KSFs.

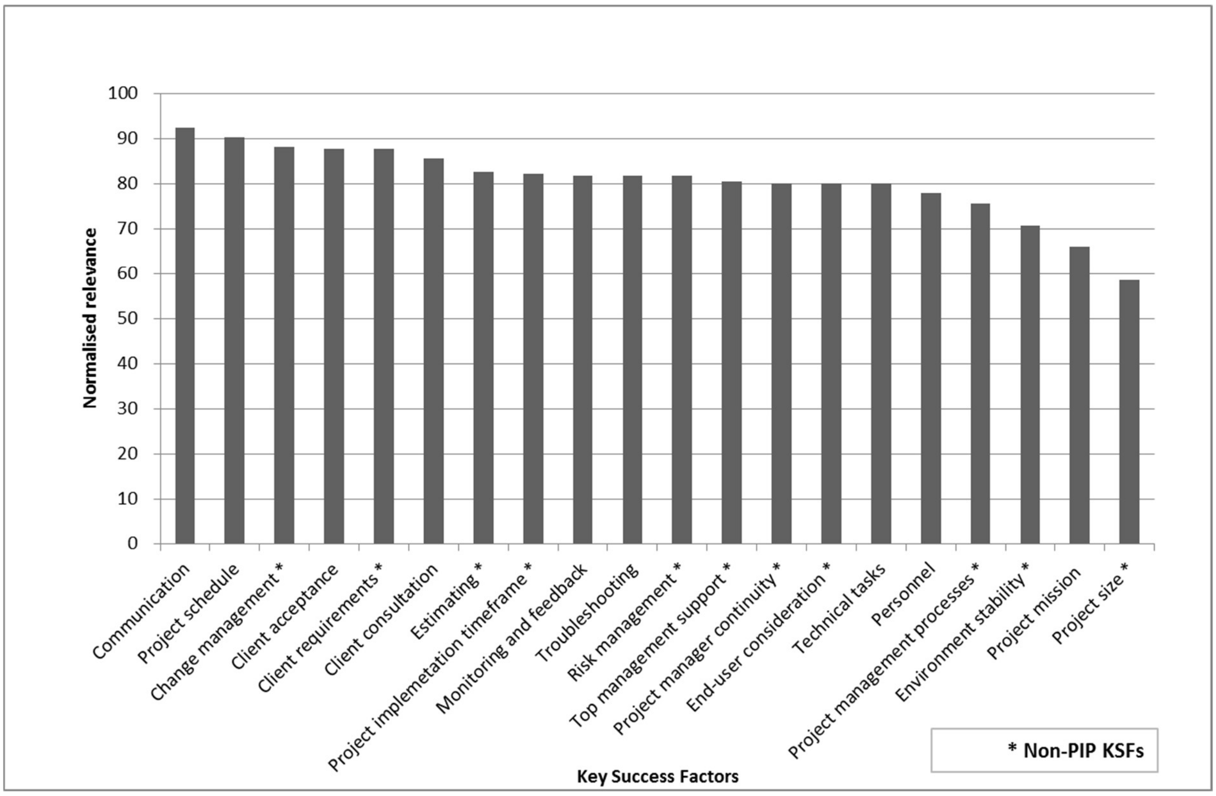

Figure 4-1: Primary research findings: petro-chemical project KSF relevance

The following results can be observed from the graph in Figure 4-1:

- All 20 KSFs score a relevance ranking of 50% or above.
- The top 18 KSFs all score a relevance ranking of 70,6% or higher.
- Communication, a PIP KSF, at 92,4% is the factor with the highest importance.
- Project size, scored 58,6% and is considired as the least important.
- The top ten KSFs consist of 4 non-PIP KSFs, namely:
    - Change management (3rd at 92,4%).
    - Client requirements (5th at 87,7%).
    - Estimating (7th at 82,7%).
    - Project implementation time frame (8th at 82.2%)
- The bottom ten of the KSFs consist of 4 PIP KSFs, namely:
    - Top management support (12th at 82,2%).
    - Technical Tasks (15th at 80,0%).
    - Personnel (16th at 77,9%).
    - Project Mission (19th at 66,1%).

4.3 Additional Research Findings

The additional research results are surmised from qualitative respondents' comments obtained from the survey, as well as the project type and project role selection options, as discussed in sections 3.3.1 and 3.3.2 respectively.

Table 4-3 gives an overview of the available qualitative responses and provides subjective KSF coding of the survey responses, as discussed Section 3.3.1.

Table 4-3 Qualitative Additional KSF Responses

Respondent Number	Qualitative response	KSF Coding
6	Networking	Communication
8	Management must appoint, empower, support and trust a strong project manager into an organisation position that gives him the "helicopter overview," sole-point accountability and decision-making authority. Organisational support systems and sponsor's contributions to the project need to support this position, "barrier bust" and assist with the enabling there-off.	Top Management Support
9	Upfront agreement on how success will be measured (Success Criteria).	Client Acceptance
12	Stakeholder engagement, stakeholder management plan, quality control	Client Consultation
15	Culture within a company.	Environment Stability
16	Good communication between Client and Clients.	Communication
17	Quality management.	Technical tasks
18	Healthy professional trust relationship.	Environment Stability
20	Safety - Incident and Injury Free.	Safety
22	Agreed objective with clear roles and responsibilities.	Project Mission
23	Competency of individuals and attitude/ownership.	Personnel
24	Team alignment on project goals and objectives and ensuring that the client needs are fully understood to ensure client satisfaction.	Client Consultation

Respondent Number	Qualitative response	KSF Coding
25	Structured approach to reporting deviations and accountability defined.	Project Management Processes
26	1.) Scope freeze. 2.) Management of compensation events with regard to schedule impact and cost. 3.) Managing of the Accepted program. 4.) Adherence to contract stipulations (NEC) - "Hard on system - soft on people" approach. 5.) Creation of an environment where ALL People want to perform in and be part of the project (ownership and to be proud to be associated with the project and project team.	Project Management Processes
28	Engineering & Technical QA/QC.	Technical tasks
29	Proper scope definition.	Client Requirements
30	Experienced project team.	Personnel
31	Alignment.	Communication
32	Sourcing strategy for long lead item and manning power plan.	Troubleshooting
35	Procurement Systems and Strategy.	Project Management Processes
36	Resource Management.	Personnel
37	Team continuity.	Personnel
39	Scope freeze as early as possible.	Client Requirements
40	Scope definition and management.	Client Requirements
46	Response time to resolve issue/queries.	Troubleshooting
47	Project Controls (in total) - Complete Engineering.	Project Management Processes
48	Effective Project Controls - e.g., cost control, monitoring, and reporting.	Project Management Processes
49	Team Composition.	Personnel
50	Using the one team approach: Client, PMT and EC senior members involved & supporting the project.	Personnel

The complete normalised KSF relevance per project type and stakeholder role are presented in Appendix C. The table should be considered carefully concerning the number of respondents per role and project type. Due to some cases where there is a low number of respondents the normalised data can appear to be distorted. Figure 4-2 provides a representation of the normalised KSF relevance for the different stakeholders responding to the survey. Figure 4-2 excludes stakeholders of which less than five survey responses are received.

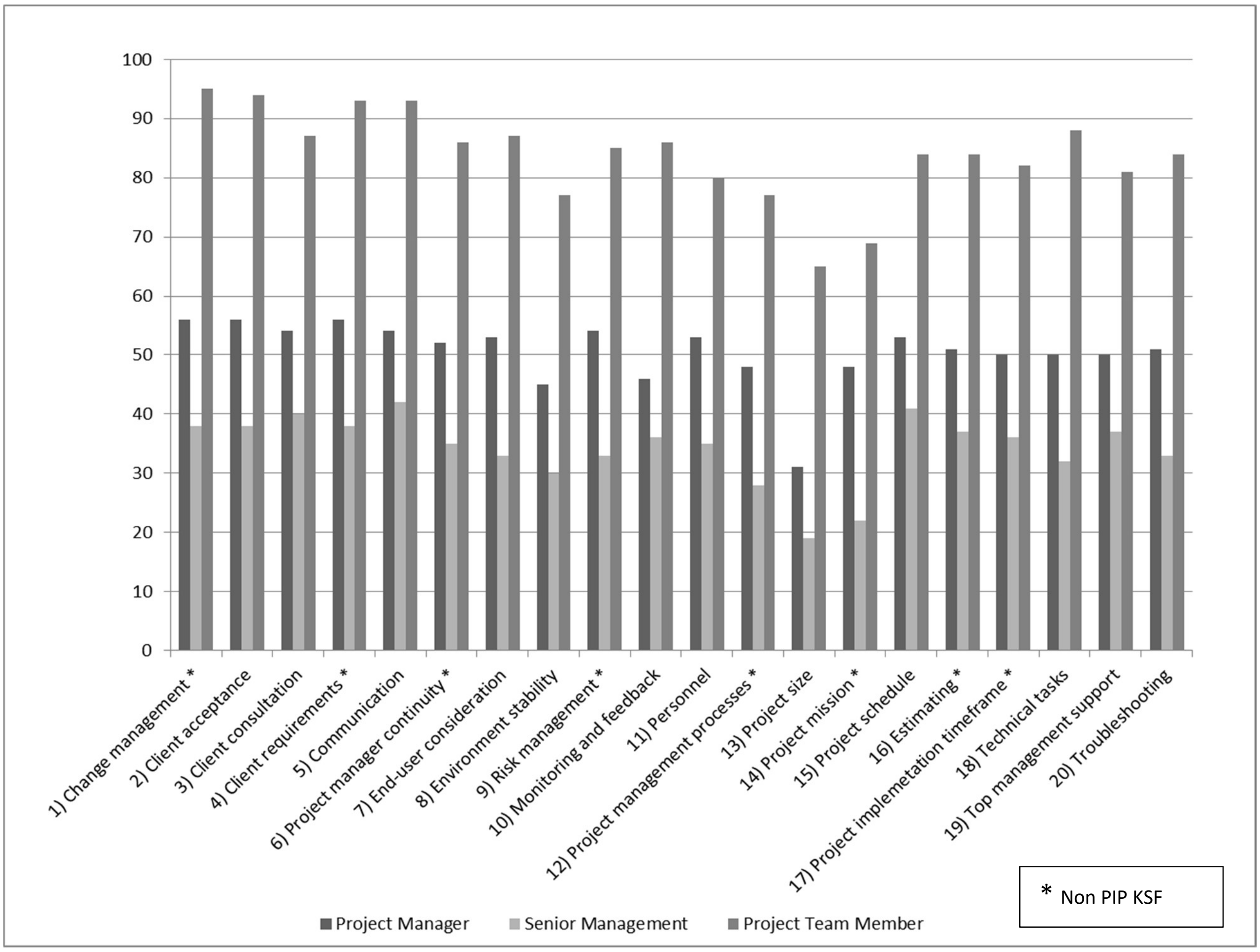

Figure 4-2 Additional research findings: petro-chemical project normalised KSF relevance by stakeholder role

From the graph in Figure 4-2 above some results can be established.

Additional research findings: KSF relevance by petro-chemical stakeholder role:

- Project Managers:
    - Least relevant KSF: *Project Size (56%).*
    - Most relevant KSF: *Communication* (98%).
    - KSF considerably lower than other roles: *Project Size (by 12%).*
    - KSF significantly higher than *other* roles: *Project Mission* (by 25%).

- Senior Managers:
    - Least relevant KSF: *Project Size (42%).*
    - Most relevant KSF(s): *Communication* (93%).
    - KSF considerably lower than other roles: *Project Size (by 26%).*
    - KSF significantly higher than other roles: *Client Consultation (by 6%).*

Project Team Members:

- Most relevant KSF: *Change Management* (90%).
- Least relevant KSF: *Project Size (68%).*
- KSF significantly higher than other roles: *Project Mission (by 20%).*
- KSF considerably lower than other roles: *Project Size (by 12%).*

Furthermore, Figure 8-1 makes use of the petro-chemical project types instead of petro-chemical project roles in Appendix C provides a comparable view to Figure 4-2.

4.4 Discussion of Chi-Square Test Results

Chi-Square Test is done on the survey data to confirm the H_0 hypothesis that the survey results per project role and project type is homogenous. The results from the Chi-Square Test can be seen in table 4-4 and confirms the H_1 hypothesis as all P values are < 0.05: The survey respondent results per individual KSF is not homogeneous per project type and or project role. Thus, the survey data does not provide sufficient evidence that the responses are similar per project type or project role and there is a high variation in the view from the respondents as to the relative importance of the provided KSFs. This may be attributed to the relatively small sample group analysed.

Table 4-4 Chi-Square test results

	Chi-square test results *P* Value		
	KSFs	Project Role	Project Type
1	Change management	0.9683	0.5505
2	Client acceptance	0.9556	0.8545
3	Client consultation	0.4306	0.7470
4	Client requirements	0.9935	0.2049
5	Communication	0.9710	0.9019
6	Project manager continuity	0.4337	0.7215
7	End-user consideration	0.7334	0.3220
8	Environment stability	0.7339	0.5957
9	Risk management	0.8032	0.9136
10	Monitoring and feedback	0.6031	0.7616
11	Personnel	0.9782	0.7508
12	Project management processes	0.9970	0.5702
13	Project size	0.8972	0.9098
14	Project mission	0.1068	0.5535
15	Project schedule	0.5548	0.6727
16	Estimating	0.8476	0.8937
17	Project implementation timeframe	0.9887	0.4903
18	Technical tasks	0.9249	0.6814
19	Top management support	0.9799	0.7432
20	Troubleshooting	0.7410	0.9035

5 Discussion of Research Results

This chapter discusses the results presented in chapter 4. Emphasis is placed on the primary research findings from chapter 4, i.e., those which answer the research questions. The additional results of research are discussed briefly as well.

A representative data set is gathered for petro-chemical projects in general; 72,3% of the respondents in section 4.1 were project managers and team members. This could suggest that the survey results are biased towards project professional's opinions and does not reflect all of the project stakeholder's views and opinions.

5.1 Discussion of Primary Findings

Observing the heat map in table 4-2 several key findings can be made. In the survey responses, it is found that no particular preference for PIP KSFs can be made. *Communication*, a PIP KSF has the highest percentage of survey responses 61%, which indicates that it is perceived to be absolutely critical in achieving petro-chemical project success. *Change Management*, a non-PIP KSF, and *Client Requirements*; a PIP KSF have the 2nd highest percentage of survey responses. 57% of survey respondents indicate that the two KSFs are critical to achieving project success. Other factors listed which are indicated to be absolutely critical to project success, are *Client Acceptance* (53%, PIP KSF), *Schedule* (51%, PIP KSF) and *Client Consultation* (49%, PIP KSF).

The findings have a strong alignment with a list of the top 5 KSFs identified by Fortune and White (2006), for projects in general:

- Support from Senior management.
- Objectives that's is clear and achievable.
- A project plan that is up-to-date.
- Strong communication and feedback mechanisms.
- User and client involvement in the project.

Noteworthy is that of the six factors achieving the highest respondent consensus, three KSFs are client-orientated. This finding indicates that a significant focus on petro-chemical project success is reasoned to come from the customer focus and interaction as opposed to other internal project aspects. Respondents' made qualitative comments in which they indicate what they believe is essential to enable project success:

- Stakeholder management, creating and building a professional trust relationship.
- Having defined roles and responsibilities.
- Creation of a strong bond between the project management team, project manager and the project sponsor and his staff.

An unexpected result, when comparing to the literature surveyed, is that Project Mission, a PIP KSF, is not perceived to be a critical success factor. This contradicts the findings of Pinto and Slevin (1988).

The relative importance of the KSFs is visually illustrated in Figure 4-1 and allows for the KSFs to be compared against each other. It is determined that all 20 of the KSFs have 50% or greater relevance in achieving petro-chemical project success, with 18 of the 20 KSFs having 70% or higher.

It is observed that the top 10 factors perceived to be most critical to petro-chemical projects consist of four non-PIP KSFs; *Change management, Client Requirements, Estimating and Project implementation timeframe*.

The ten key success factors that are perceived to have a lesser importance in attaining petro-chemical project success contain 4 PIP KSFs, i.e., *Top management support, Technical Tasks, Personnel and Project Mission.* The lower importance of the *Top management support* and *Technical Tasks* KSFs ratings could be rated as less relevant because the project manager and project engineering team are directly affected by these key success factors. This can potentially result in an overall lower impact in achieving petro-chemical project success. The *Project Mission* PIP KSF is ranked 19th in the research survey, which is the lowest of all of the PIP KSFs and can be perceived as less important in realising petro-chemical project success. This observation contradicts the literature on the PIP KSFs, as presented in Section 2.2.1, no clear explanation can be provided for this observation. The non-PIP KSFs *Change management* ranking is very important as it shows the growth of complexity in the project engineering solutions required in the petro-chemical industries, this will also have a direct bearing on the other three non-

PIP KSFs C*lient Requirements, Estimating and Project implementation timeframe as Change management* can be directly associated with them.

5.2 Discussion of Additional Findings

Additional results of the research that is relevant to the research questions are presented in Section 4.3. Table 4-3 shows the Qualitative Additional KSFs respondents selected as having the most influence in achieving petro-chemical project success; the research omits these findings. It is noted that only one new KSF has been identified, ”*Safety*” from the qualitative responses. This finding is not used in the research as it is determined by the author’s coding of the survey respondents’ qualitative comments. This finding may be of value for inclusion in future research.

6 Conclusion and Recommendations

This chapter summarises the purpose of the study, the limitations faced in the research and the findings. In conclusion, some research aspects extending beyond the scope of this dissertation are highlighted, and recommendations are made for future research in this field.

6.1 Research Background and Approach

This research is based on the premise that the existing PIP KSFs are inadequate in monitoring petro-chemical project success. It is proposed that changes in the current set of KSFs can make the PIP tool more applicable to evaluating the petro-chemical project success, benefiting stakeholders in projects overall.

The research questions posed initially are:

a. Which of the existing PIP factors apply to petro-chemical projects?
b. Which of the existing PIP factors are not applicable to petro-chemical projects?
c. What additional factors apply to petro-chemical projects and are not currently in the PIP?

Ultimately, the questions above lead to the aim of the research being defined as follows: *The purpose of the research is to formulate a revised list of ten KSFs for a petro-chemical project specific PIP. The research will identify petro-chemical success factors that are not currently included in the PIP tool and exclude standard PIP KSFs that are not applicable to petro-chemical project success.*

To meet the above objective, the following research objectives are set:

- To identify which success factors are most applicable, in general, to petro-chemical project success by reviewing the literature and highlighting the success factors currently not included in the standard PIP tool.
- To determine the relevance of the PIP and non-PIP success factors petro-chemical project stakeholders deem more or less relevant in achieving petro-chemical project success by conducting a quantitative survey.

- From the research findings compile a final list of ten suggested KSFs to develop a revised, petro-chemical project specific PIP tool.

6.2 Research Findings

The research results are presented and discussed in chapter 4 and 5 respectively. The findings from the survey indicate that the existing KSFs from the PIP tool are not perceived to be sufficient in measuring petro-chemical project success. The primary research findings indicate no preference for PIP versus non-PIP KSFs, with the top ten KSFs identified consisting of six PIP and four non-PIP KSFs. The list is as follows:

- Communication (PIP)
- Project schedule (PIP)
- Change management (non-PIP)
- Client acceptance (PIP)
- Client requirements (non-PIP)
- Client consultation (PIP)
- Estimating (non-PIP)
- Project implementation timeframe (non-PIP)
- Monitoring and feedback (PIP)
- Troubleshooting (PIP)

The survey confirms these factors to be essential in achieving petro-chemical project success, and therefore research question (a) is answered.

The survey also indicates factors which are perceived as less applicable in achieving petro-chemical project success. This answeres the research question (b).

Question (c) is answered through the compilation of the list of the ten most relevant KSFs identified through the survey. Five of the top ten KSFs are non-PIP KSFs.

The recommendation noting the KSFs which may be used for a petro-chemical project specific PIP tool ensures that the research objectives are met, and thus the research aim is achieved.

6.2.1 Additional Findings

Additional results of the research reveal several KSFs that are not currently included in the PIP, but are perceived to be relevant to petro-chemical project success. This finding can provide value for further research to be undertaken to find other key success factors.

Different project stakeholders have different views of what importance can be attributed to the individual KSFs. This could merit further research to determine KSFs importance to different project stakeholders.

The survey results are not homogenous and can be attributed to the number of completed surveys and the different interpretations of survey respondents of what a KSF is.

6.3 Research Limitations

The geographical area (Secunda, Mpumalanga) reduces the potential number of responses. Forty-seven responses that could be used were received from the online survey. However, this is an adequate amount of replies for this research. Most project types and roles are represented in the research. Accessing respondents that represent the complete community of petro-chemical project stakeholders is difficult; this observation is supported by the respondent analysis per project types and project stakeholder role. The limited group and geographical area implies that the survey results received cannot be generalised. Also, the idiosyncratic nature of the surveyed ratings of the Key Success Factors (KSFs) may have an impact on the accurateness of the research results. Lastly, the identification of additional KSFs by the respondents could potentially be linked to the work environment and culture in the geographical area selected for the research.

6.4 Beyond this Research

It is recommended that this research is repeated to reduce limitations identified in section 6.3 and to corroborate and expand on the research findings. The number of respondents to a survey should be increased to ensure homogenous survey results in further future research and capture additional qualitative feedback to minimise the possible bias attributable to the relatively small geographical area the current research was conducted in. The research respondents should be representative of petro-chemical project stakeholders from various geographical regions and petro-chemical sub-industries to increase the comprehensiveness and applicability of the results to the broader petro-chemical industry. The idiosyncratic nature of respondents' views to relevant key success factors could be moderated by conducting interviews, instead of only utilising a survey.

It is recommended that further research is carried out, to find additional key success factors that could be relevant to petro-chemical projects but were not identified in this research. Future research needs to focus on the applicability of petro-chemical projects key success factors during the different project life cycle stages as illustrated in Figure 2-2 to determine the key success factors to the relevant project life cycle stage.

To conclude, in developing a petro-chemical specific PIP tool, it is proposed to include more than ten key success factors in a petro-chemical specific PIP tool, as 18 of the 20 key success factors in this research scored above 70% on the normalised key success factors relevance ranking.

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8 Appendices

8.1 Appendix A: Survey

Introduction

Good day,

My name is Thinus Johnsen and I am conducting research, as part of my Masters degree, into the key factors that lead to project success in the petrochemical industry. I would like you to participate in this survey and assist me with my research.

This survey investigates the perceived importance of petrochemical project success factors and will only be available to you if you have had involvement in petrochemical projects. You may only complete one instance of this survey, should you wish to do so. I would also appreciate it if you would forward this survey to any other suitable candidates.

Please be advised that the information shared in this survey is completely anonymous. Your participation is voluntary and if you wish to withdraw at any time you will be able to do so.

Should you wish to find out more about this research then please do not hesitate to contact me at thinus.johnsen@gmail.com and I will gladly share my findings with you.

* 1. Please indicate your consent to your response being used in my research

◯ Yes

Project Information

* 2. Please indicate the type of petrochemical projects you are/were involved in:

3. Please indicate the role you served in the project:

- Project Manager
- Senior Management
- Project Team Member
- Client
- End User
- Other

Perceived importance of success factors

Key success factors are the aspects of a project that, when appropriately addressed, lead to the success criteria of the project being met.

For example: addressing the Project Schedule (key success factor) may lead to the petrochemical project begin completed on time, therefore meeting the success criterion.

Please rate the importance of each of these key success factors in achieving success in the petrochemical project you were involved with. If you are unfamiliar with the factor then please refer to the table below for a brief description. If any factor did not have relevance to your role of your project, select 'Cannot Answer'.

4. Please make your selection below

	Not at all influential	Somewhat influential	Influential	Very influential	Absolutely critical	Cannot answer
1) Change management	○	○	○	○	○	○
2) Client acceptance	○	○	○	○	○	○
3) Client consultation	○	○	○	○	○	○
4) Client requirements	○	○	○	○	○	○
5) Communication	○	○	○	○	○	○
6) Project manager continuity	○	○	○	○	○	○
7) End-user consideration	○	○	○	○	○	○
8) Environment stability	○	○	○	○	○	○
9) Risk management	○	○	○	○	○	○
10) Monitoring and feedback	○	○	○	○	○	○
11) Personnel	○	○	○	○	○	○
12) Project management processes	○	○	○	○	○	○
13) Project size	○	○	○	○	○	○
14) Project mission	○	○	○	○	○	○
15) Project schedule	○	○	○	○	○	○
16) Estimating	○	○	○	○	○	○
17) Project implemetation timeframe	○	○	○	○	○	○
18) Technical tasks	○	○	○	○	○	○
19) Top management support	○	○	○	○	○	○
20) Troubleshooting	○	○	○	○	○	○

Description of success factors:

Change management - Incorporation of a transformation control mechanism to cater for organisational changes

Client acceptance - The project customer's agreement and approval of the final project deliverables

Client consultation - Ongoing interaction and communication between project stakeholders and the client of the project

Client requirements - The project team's understanding and specifications of the project customer's needs and prerequisites

Communication - Effective exchange of relevant information among all key project stakeholders during project implementation

Project manager continuity - Have the project manger /project director been replaced

End-user consideration - Attention to the consumer's requirements, preferences and satisfaction during and after the project

Environment stability - Cohesive project atmosphere, with no organisational politics and conflict amongst individuals

Risk management - Project team actively identifying, assessing risks and is composed of members with varying practical expertise and experience

Monitoring and feedback - Implementation of a system for overseeing project progression and providing response to the relevant project stakeholders

Personnel - Availability of skilled and capable employees and the accessibility to training facilities for them

Project management processes - Effective use and implementation of procedures specific to project management, such as cost, time and quality control and supervision

Project size - Directly linked to the complexity

Project mission - Understanding of the project's goals and objective (what is needed from the project and why)

Project schedule - Use of a detailed plan for project implementation including the action steps and resourcing needed and the project timelines

Estimating - Inaccurate labour productivity and unit costs, inadequate and incomplete engineering deliverable's resulting in inaccurate cost estimates

Team implementation time frame - The perceived need to implement the project on a expedited / fast tracked basis

Technical tasks - Accessibility to the necessary technological expertise and resources

Top management support - Willingness and ability by senior management to provide resourcing, authority and influence over the project

Troubleshooting - Ability to manage and resolve any deviations to the original project plan

Additional factors of importance

5. Please note any additional factors, not included in the previous list, that you deem necessary for achieving petrochemical project success:

Thank you

Thank you for participating in this survey.

Should you wish to find out more about my research then do not hesitate to contact me (thinus.johnsen@gmail.com) and I will gladly share my findings with you.

8.2 Appendix B: Survey Response Data

Table 8-1: Qualitative Additional KSF responses

Respondend #	Type of petrochemical projects:	Role served on project:	1) Change management *	2) Client acceptance	3) Client consultation	4) Client requirements *	5) Communication	6) Project manager continuity *	7) End-user consideration	8) Environment stability	9) Risk management *	10) Monitoring and feedback	11) Personnel	12) Project management processes *	13) Project size	14) Project mission *	15) Project schedule	16) Estimating *	17) Project implemetation timeframe *	18) Technical tasks	19) Top management support	20) Troubleshooting	Additional Information
1	Medium < R500 million	Project Manager	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	Medium < R500 million	Project Team Member	5	5	5	5	4	5	4	4	4	5	5	5	4	4	5	4	5	4	3	3	
3	Large < R1000 million	Client	5	5	5	5	4	3	4	2	5	3	4	4	4	3	4	3	5	3	4	2	
4	Medium < R500 million	Project Manager	4	3	2	3	5	4	3	3	4	3	4	4	3	3	4	4	4	3	3	3	
5	Large < R1000 million	Project Team Member	5	4	4	5	5	4	4	4	3	4	3	3	3	4	3	3	3	4	5	5	
6	Medium < R500 million	Project Manager	5	4	5	5	4	4	4	4	4	4	4	4	3	3	5	5	5	4	4	4	Networking
7	Large < R1000 million	Senior Management	4	5	3	5	4	4	3	4	2	5	4	3	3	2	5	5	4	4	5	3	N/A
8	Mega > R1000 million	Senior Management	5	5	5	4	5	5	5	5	5	5	5	0	3	5	5	5	4	4	5	5	Management must appoint, empower, support and trust a stong project manager into an organisation position that gives him the "helicopter overview", sole-point accountability and decision-making authority. Organisational support sytems and sponsor's contri
9	Large < R1000 million	Senior Management	3	4	5	3	5	5	4	3	4	4	4	4	2	2	4	4	4	4	5	3	Upfront agreement on how success will be measured (success Criteria)
10	Mega > R1000 million	Project Team Member	5	4	5	4	5	5	5	4	4	5	5	4	5	5	5	5	5	4	5	5	
11	Mega > R1000 million	Project Manager	4	5	5	5	4	4	5	3	4	5	5	4	3	4	4	4	4	4	4	5	Important factors covered
12	Large < R1000 million	Project Manager	4	5	5	5	5	4	4	5	5	5	5	5	3	4	5	5	5	5	4	5	Stakeholder engagement, stakeholder management plan, quality control,
13	Small < R50 million	Project Manager	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
14	Large < R1000 million	Project Team Member	4	5	5	4	5	5	4	5	5	4	5	5	5	4	5	5	5	4	5	4	
15	Large < R1000 million	Project Team Member	5	4	4	5	5	5	5	4	5	5	4	5	4	4	5	5	5	5	5	5	Culture within a company
16	Small < R50 million	Project Manager	5	5	4	5	5	4	4	2	4	5	4	2	1	3	3	4	3	2	2	4	Good communication between Client and Clients C
17	Mega > R1000 million	Project Team Member	5	4	4	4	4	5	4	3	3	3	3	4	3	2	4	4	3	3	4	3	quality management
18	Small < R50 million	Senior Management	5	5	5	5	5	3	4	3	2	3	5	2	2	2	3	4	5	5	2	5	Healthy professional trust relationship
19	Medium < R500 million	Project Team Member	4	5	5	5	4	5	5	4	3	4	5	4	4	3	4	4	5	5	2	CA	
20	Small < R50 million	Project Manager	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Safety - Incident and Injury Free
21	Large < R1000 million	Project Team Member	4	5	3	5	4	4	4	4	5	4	4	3	3	4	CA	5	4	4	5	5	N/A
22	Mega > R1000 million	Project Manager	5	4	4	5	5	4	5	4	4	4	5	4	3	3	4	4	4	4	4	3	Agreed objective with clear roles and responsibilities

Note: * - Non PIP KSF

Respondend #	Type of petrochemical projects:	Role served on project:	1) Change management *	2) Client acceptance	3) Client consultation	4) Client requirements *	5) Communication	6) Project manager continuity *	7) End-user consideration	8) Environment stability	9) Risk management *	10) Monitoring and feedback	11) Personnel	12) Project management processes *	13) Project size *	14) Project mission	15) Project schedule	16) Estimating *	17) Project implemetation timeframe *	18) Technical tasks	19) Top management support	20) Troubleshooting	Additional Information
23	Mega > R1000 million	Project Team Member	5	4	3	4	4	5	3	3	4	3	4	0	5	3	4	4	4	3	5	4	Competency of individuals and attitude/ownership
24	Large < R1000 million	Project Manager	4	5	4	4	4	4	4	3	4	3	3	3	3	4	4	4	4	4	3	3	Team alignment on project goals and objectives and ensuring that the client needs are fully understood to ensure client satisfaction.
25	Large < R1000 million	Senior Management	3	4	5	5	5	4	3	3	3	5	3	3	3	2	4	2	2	3	3	3	structured approach to reporting deviations and accountability defined
26	Large < R1000 million	Senior Management	4	5	5	5	5	4	4	5	4	5	5	5	1	3	5	5	5	4	4	4	1.)Scope freeze. 2.) Management of compensation events with regard to schedule impact and cost. 3.) Managing the Accepted program. 4.) Adherence to contract stipulations (NEC) - "Hard on system - soft on people" approach. 5.) Creation of an environment wh
27	Small < R50 million	Project Manager	5	5	5	5	5	4	5	4	5	5	4	5	2	5	5	5	5	4	4	5	
28	Mega > R1000 million	Project Team Member	5	5	4	5	5	4	5	3	5	4	3	5	2	0	5	4	4	5	5	3	Engineering & Technical QA/QC
29	Medium < R500 million	Project Team Member	2	5	4	3	4	3	3	3	4	5	4	5	3	3	4	5	3	4	3	4	Proper scope definition
30	Large < R1000 million	Project Team Member	5	5	4	5	5	5	4	5	5	5	5	4	2	4	5	4	4	5	5	5	Experienced project team.
31	Large < R1000 million	Project Team Member	5	5	4	5	5	5	5	4	5	5	5	5	4	5	4	5	4	5	5	5	Alignment
32	Mega > R1000 million	Client	5	4	5	4	5	5	3	3	5	3	3	3	2	3	5	4	4	5	CA	5	sourcing strategy for long lead item and manning power plan
33	Mega > R1000 million	Project Manager	3	5	5	5	CA	4	5	4	5	CA	5	5	CA	4	CA	CA	CA	5	5	5	
34	Medium < R500 million	Project Team Member	5	4	5	5	5	3	4	4	5	4	4	4	CA	4	5	5	4	4	4	4	
35	Small < R50 million	Other	5	5	5	5	5	4	5	5	5	5	4	5	3	5	5	4	5	5	5	4	Procurement Systems and Strategy
36	Large < R1000 million	Project Team Member	5	5	4	4	5	5	4	3	5	4	3	3	3	3	4	4	3	3	4	4	Resource Management
37	Large < R1000 million	Project Team Member	5	5	4	4	5	5	4	3	4	4	3	4	2	2	4	3	4	3	3	4	Team continuity
38	Medium < R500 million	Senior Management	5	3	5	3	5	2	3	2	5	3	2	4	1	2	5	3	5	2	4	5	
39	Large < R1000 million	Project Manager	4	3	3	2	4	5	3	4	3	2	3	3	2	5	4	5	4	4	5	4	Scope Freeze as early as possible
40	Mega > R1000 million	Project Team Member	4	5	4	5	4	3	5	3	4	4	4	4	3	4	5	4	4	5	4	4	Scope definition and management
41	Mega > R1000 million	Project Team Member	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
42	Large < R1000 million	Client	3	4	5	5	5	3	3	4	5	5	4	5	2	2	2	3	3	5	4	5	
43	Large < R1000 million	Project Team Member	5	4	5	3	3	1	3	3	4	4	1	2	3	3	3	2	3	5	2	5	
44	Large < R1000 million	Project Team Member	3	2	4	5	4	1	5	5	3	3	1	1	1	1	1	1	2	5	1	5	
45	Medium < R500 million	Project Manager	3	4	5	3	5	3	3	2	2	2	3	2	1	3	5	4	4	3	3	3	
46	Mega > R1000 million	Senior Management	5	3	3	4	3	4	3	2	4	3	3	3	2	2	5	4	3	3	4	3	Response time to resolve issue/queries
47	Mega > R1000 million	Project Team Member	5	5	4	5	5	4	4	3	3	5	5	5	2	3	5	4	4	4	4	4	Project Controls (in total) - Complete Engineering -
48	Mega > R1000 million	Senior Management	4	4	4	4	5	4	4	3	4	3	4	4	2	2	5	5	4	3	5	2	Effective Project Controls - e.g. cost control, monitoring and reporting
49	Large < R1000 million	Project Team Member	4	4	3	3	3	4	3	3	2	2	4	2	4	4	4	4	4	4	2	3	Team Composition
50	Mega > R1000 million	Project Manager	5	3	2	4	3	3	3	2	5	3	3	2	2	2	5	2	3	3	4	2	Using the one team approach: Client, PMT and EC snr members involved & supporting the project thi

8.3 Appendix C: Additional Research Findings

Table 8-2: Normalised KSF relevance for petro-chemical project roles and project types

		Project role						Type of project			
	All respondents	Project manager	Senior management	Project Team Member	Client	End user	Other	Mega > R1000 million	Large < R1000 million	Medium < R500 million	Small < R50 million
Change management	88	86	84	90	87	No responses received	100	87	84	73	83
Client acceptance	88	86	84	90	87		100	80	88	73	83
Client consultation	86	83	89	83	100		100	76	84	80	80
Client requirements	88	86	84	89	93		100	83	87	71	83
Communication	92	98	93	89	93		100	88	90	80	83
Project manager continuity	80	80	78	82	73		80	79	80	64	67
End-user consideration	80	82	73	83	67		100	79	77	64	77
Environment stability	71	69	67	73	60		100	60	76	58	63
Risk management	82	83	73	81	100		100	79	81	69	70
Monitoring and feedback	82	84	80	82	73		100	77	81	67	77
Personnel	78	82	78	76	73		80	76	73	69	73
Project management processes	76	74	70	77	80		100	63	72	71	63
Project size	59	56	42	68	53		60	57	57	54	43
Project mission	66	74	49	69	53		100	56	65	56	67
Project schedule	90	96	91	88	73		100	94	83	82	70
Estimating	83	93	82	80	67		80	82	77	76	73
Project implementation timeframe	82	91	80	78	80		100	77	77	78	77
Technical tasks	80	77	71	84	87		100	73	83	64	70
Top management support	80	77	82	77	160		100	89	79	58	60
Troubleshooting	82	78	73	88	80		100	71	82	74	77

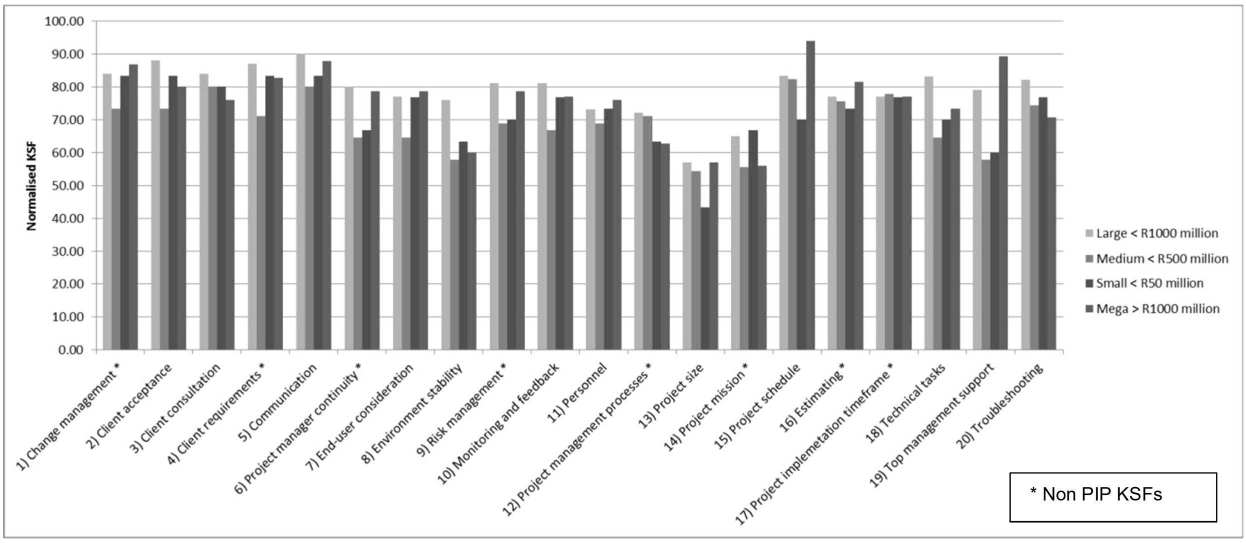

Figure 8-1 Additional research findings: KSF relevance by project type

8.4 Appendix D: Ethics Clearance

Application for Approval of Ethics in Research (EiR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form **before** collecting or analysing data.The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the **EBE Ethics in Research Handbook**(available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/usr/ebe/research/ethics.pdf

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		Marthinus Wessel Johnsen
Department		Department of Construction Economics and Management
Preferred email address of applicant:		Thinus.johnsen@sasol.com
If a Student	Your Degree: e.g., MSc, PhD, etc.,	MSc in Project Management
	Name of Supervisor (if supervised):	Ian Jay
If this is a researchcontract, indicate the source of funding/sponsorship		No,
Project Title		The Project Implementation Profile's Applicability to Petro-Chemical Project Success: An Analysis of the Key Success Factors Research Proposal

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

SIGNED BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	MW Johnsen	Thinus Johnsen	**15 Jun 2016**

APPLICATION APPROVED BY	Full name	Signature	Date
Supervisor (where applicable)	Ian Jay		20/09/2016 Click here to enter a date.
HOD (or delegated nominee) Final authority for all applicants who have answered NO to all questions in Section1; and for all Undergraduateresearch (Including Honours).	ABIMBOLA WINDAPO Click here to enter text.		28 July 2016 Click here to enter a date.
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.	Click here to enter text.		Click here to enter a date.

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