

An Investigation of Project Success Factors in the South African  
Petrochemical Industry

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## **Abstract**

This study will investigate project success factors in the South African petrochemical industry.

The availability of capital for projects was reduced by the 2008-2009 global economic recession. This resulted in additional strain on project performance, since the potential implications of cost and schedule overruns for clients, project teams and project managers became harsher. For project failure, the implications may be even worse. Possible implications include career damage; unemployment; financial loss; or liquidation of companies.

Projects in the South African petrochemical industry are faced with many challenges such as unfavourable legislation; lack of competent and experienced project human resources; low quality of work; low productivity; and remoteness of the region and industry. These challenges pose a risk to project success.

When projects are completed successfully, it can hold major advantages for clients as well as for project team members. These potential advantages include corporate growth; improved job security; career advancement; and financial gain.

There are certain factors which need to be managed effectively on projects to improve the probability of project success. These are referred to as success factors.

The research question for this study is: What are the most critical factors that project managers need to manage effectively in the South African petrochemical industry to improve project success?

This question will be answered by first considering theoretical data, as well as empirical data collected from project professionals with relevant experience by means of interviews and a survey. Purposive sampling was used to obtain inputs from 61 project professionals with over 1,000 years combined project experience in this region and industry. The sample includes participants from project engineering consultants, client organisations, as well as project professionals working for owner project management companies.

From the empirical data, challenges unique or dominant in the region or the industry were identified. Using qualitative content analysis, challenges were coded, which resulted in 30 challenge categories. The 10 highest priority challenge categories were consolidated to form 5 general challenges. These are an unfavourable environment; low competence and experience levels; poor availability of project resources; low quality of work; and low productivity. These challenges are a hindrance to project success.

From literature 131 success factors were identified. From interview and survey data 796 and 675 project management and project success factors were identified respectively. Using qualitative content analysis, these were coded into 12 generic success factor categories. These categories were also prioritised.

Further comparison and analysis resulted in the identification of the seven highest priority success factor categories for the South African petrochemical industry. In descending order of importance, these are:

1. Obtaining strong support for the project
2. Ensuring strong project leadership
3. Ensuring an effective project team
4. Ensuring that there are clear realistic and agreed project objectives
5. Ensuring effective scope and engineering management
6. Ensuring effective project planning and controls
7. Ensuring effective contracting

In conclusion, based on previous research and the perceptions of project professionals with relevant experience, these seven factors have been identified as the most critical success factors to manage for projects in the South African petrochemical industry.

## List of Abbreviations

AFC	Approved for Construction
BE	Basic Engineering
BEE	Black Economic Empowerment
CC	Construction Contractor
CF	Clean Fuels
CLD	Causal Loop Diagram
CSF	Critical Success Factor
DE	Detail Engineering
EC	Engineering Contractor or Engineering Consultant
EM	Engineering Manager
EPC	Engineering Procurement and Construction (contract)
EPCm	Engineering Procurement and Construction Management (contract)
FEED	Front End Engineering Design
FEL	Front End Loading
GDP	Gross Domestic Product
ID	Identification / Identifier
LSTK	Lump Sum Turn Key (contract)
LTI	Long Term Incentive
NERSA	National Energy Regulator of South Africa
No	Number
OEM	Original Equipment Manufacturer
PEP	Project Execution Plan or Preliminary Engineering Proposal
PM	Project Manager
PMT	Project Management Team
QA	Quality Assurance
QC	Quality Control
QS	Quantity Surveyor
R&D	Research and Development
Rand	South African Rand (currency)
RSA	Republic of South Africa
SA	South Africa
SF	Success Factor
TPT	Transnet Port Terminals
UK	United Kingdom

USA	United States of America
USD	United States Dollar (currency)
WBS	Work Breakdown Structure
ZA	South Africa
ZAR	South African Rand (currency)

## Glossary

Blue collar workers	Manual labour
Brownfields site	An area that has buildings or facilities present.
Business manager	A client representative evaluating and managing the project business case and justification.
Commercial official	A person managing contracts and procurement on a project. Commercial officials often have legal qualifications.
Company A	A pseudo name for a specific large petrochemical company in South Africa.
Consultant	Similar to contractor. Consultant and contractor are sometimes used interchangeably. A consultant is usually associated with professional services such as engineering, analysis or management, rather than construction.
Contractor	A company that undertakes a contract to provide materials or labour to perform a service or do a job (Oxford Dictionaries, 2014).
Design and build projects	These are projects where the owner/employer starts the design and the contractor then completes it and constructs it (Longworth Consulting, 2014).
Discipline engineer	An engineer qualified in a specific engineering discipline, for example, a mechanical engineer or an electrical engineer.
Engineering manager	An engineer responsible for scope and quality management and also for managing and integrating the different engineering disciplines. On many projects, the project manager performs this function.
Greenfields site	An area that has not been built or constructed on previously.
Maintenance representative	An owner employee assigned to support the project with knowledge, as well as decision making authority with regards to maintenance matters.
Meaning unit	“The constellation of words or statements that relate to the same central meaning” (Graneheim & Lundman, 2004, p. 106).

Mega projects	Projects with a value of R1,000,000,000 South African Rands or higher. This definition differs from the international definition, which refers to projects with a value of 1,000,000,000 US Dollar.
Operations representative	An owner employee assigned to support the project with knowledge, as well as decision making authority with regards to operational matters.
Owner project management company	The in-house project execution department of a company.
Petrochemical industry	Producers of substances obtained by the refining and processing petroleum (crude oil or coal) or natural gas (Oxford Dictionaries, 2014).
Project controls management	The management and control of project metrics such as project cost, schedule, quality and scope.
Project director	A very senior project manager, usually responsible for a Mega Project.
Project manager	“The person assigned by the performing organisation to lead the team that is responsible for achieving the project objectives” (Project Management Institute, 2012, p. 11).
Project planner	A person who develops, monitors and manages project schedules.
Project sponsor	“A person or group that provides resources and support for the project, program, or portfolio, and is accountable for enabling success” (Project Management Institute, 2012, p. 14).
White collar workers	Workers who work in an office or other professional work environment (Oxford Dictionaries, 2014).

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# **1. Introduction**

## **1.1 Background**

The recent 2008-2009 global economic recession (Verick & Islam, 2010) has put additional strain on project performance. Due to low capital availability (ATKearney, 2012), clients cannot afford cost and schedule overruns, substandard quality or under performance. Those accountable for project execution such as project managers, project teams and project execution organisations also cannot afford the possible negative implications of project failure. These implications may include career damage, unemployment, financial loss (Ciriello, 2010) or liquidation of companies. Project success may hold major advantages such as career advancement, improved job security, financial gain and corporate growth.

The South African petrochemical industry is faced with some very challenging issues. These include liberal labour legislation, low construction productivity, scarcity of project capital and a short supply of skilled engineering contractors, construction contractors and construction tradesmen (Department of Higher Education and Training, 2014). Muriithi and Crawford (2003) have identified some specific issues which may be present in emerging economies, such as Africa. These include political and community demands on project resources, as well as strong cultural and work values. In developing countries, large and complex construction projects are becoming more difficult to complete successfully (Swan & Khalfan, 2007).

There are certain factors which need to be managed effectively on projects to improve the probability of project success. Despite extensive research in this subject field, the factors which are the most critical to manage remain uncertain (Dvir, Lipovetsky, Shenhar, & Tishler, 1998) and differ between projects and project phases (Ika, 2009).

Project managers are expected to manage all facets of a project. Typical issues are changing project objectives, scope growth, unsupportive stakeholders, cost and schedule overruns due to unforeseen circumstances and contractual disasters. Issues which are more internal to the project team are deciding which of the overwhelming number of project management best practices should be applied, vacancies in the project team due to the unavailability of suitable resources and realising that the project has veered from its cost and schedule plan when it is already too late to recover.

Authors such as Cooke-Davies (2002), Hyväri (2006), Chan, Ho and Tam (2001) and Steinfort and Walker (2007) identified various project success factors. They have found that proper management of these factors can influence the degree of project and project management success.

If project managers knew which of the overwhelming number of factors are critical to manage in their region and industry to achieve success, they can move their focus to these factors and improve the success of their projects. When the criticalities are uncertain, project managers tend to spend effort on managing insignificant factors which steals effort away from managing those factors which matter most.

The majority of research on project success factors is based on projects executed largely in North America and Europe (Ika, 2009), with some studies also conducted in South and South-Eastern Asia. Very limited research has been published on this topic for South African projects, and no publications could be located for South African petrochemical projects in the leading management journals, based on a search using Web of Science for 1980 to 2014.

Success factors not noted in available literature, or not deemed as very significant, may be critical to regions such as South Africa, especially since South Africa is classified as a developing economy and previous research was more focussed on mature economies. Steinfort and Walker (2007) argues that such success factors may be related to political and social demands, skills availability and cultural challenges.

Considering the challenges which are faced by projects in the South African petrochemical industry, project success cannot be achieved easily. However, with a better understanding of the factors which drive success in this region and industry, project teams and project stakeholders would be better positioned to focus their effort on those aspects of the project which are most critical for success.

## **1.2 Research Question**

The research question is:

What are the most critical factors that project managers need to manage effectively in the South African petrochemical industry to improve project success?

In order to answer the research question, the following objectives will be pursued in this study:

1. Identification and ranking of project management success factors and project success factors applicable to the region and industry.
2. Identification and analysis of specific challenges unique to or dominant in the South African petrochemical industry.
3. To evaluate the causal relationships between identified success factors and challenges.
4. To prioritise the identified success factors.

### **1.3 Demarcation of Study**

This study is limited to the South African petrochemical industry, except for the identification of general success factors from literature. Purposive sampling is used to obtain inputs from project professionals with experience this region and industry. The sample includes participants from project engineering consultants, client organisations, as well as project professionals working for owner project management companies.

The envisioned output of the study is a prioritised list, including specific practical details, of the most critical success factors to manage to improve project success in the South African petrochemical industry.

### **1.4 Research Objectives**

The first objective is understanding the challenges which projects in the South African petrochemical industry face currently. The second objective is determining those success factors which are most important to projects in the South African petrochemical industry and recommending the priority of each.

The second objective would give a better understanding of the factors which need to be managed to improve project success in the South African petrochemical industry. This can be beneficial to project performance in this region and industry.

Achieving these objectives will lead to a better understanding, better project decisions and hopefully more successful projects.

## **1.5 Research Report Structure and Overview**

This dissertation is presented in six chapters which are briefly outlined below:

Chapter 1 (Introduction), of which this section is a part, introduces the research topic. It considers the background, states the research question and objectives, and outlines the structure of the dissertation.

Chapter 2 (Literature Review) presents a review of literature related to this topic. It considers general topic-related research, as well as industry and region focussed research. Important concepts such as project success and project success factors are explored. Previous research on project success factors and the causal relationships between them are also discussed.

Chapter 3 (Research Design, Methodology and Methods) presents the research design, methodology and methods used for data collection and analysis. The goals, objective and research questions of the study are listed. This is followed by a discussion of the methods used for data collection and data analysis. Limitations, validity, trustworthiness and ethics are also evaluated.

Chapter 4 (Data Analysis) presents the detailed analysis of previous research on this topic, as well as the analysis of interview and survey data. It presents the details of the process of qualitative content analysis and also the results that emerge from the analysis. Project success factors as well as challenges in the South African petrochemical industry were identified. The chapter concludes with the analysis of the causal relationships between success factors.

Chapter 5 (Discussion and Findings) contains a discussion of the analysis results and also presents the findings. It compares the empirically derived success factors with those from literature. The relationships between success factors and challenges in the South African petrochemical industry are evaluated. The chapter concludes with the prioritisation of success factors.

Chapter 6 (Recommendations and Conclusions) lists the recommendations and conclusions of this dissertation. It summarises the answer to the research question by presenting a recommended list of the seven highest priority success factors to manage for South African

petrochemical projects. It also discusses the transferability of findings, as well as the usefulness of this study for possible future research.

## **1.6 Conclusion**

This chapter introduced the research topic, questions and objectives of the study.

The research question is: What are the most critical factors that project managers need to manage effectively in the South African petrochemical industry to improve project success? This question will be answered through empirical research of the challenges for projects in the region and industry and the success factors as identified and ranked by participants.

The next chapter deals with the literature review conducted for this study and explores important concepts as well as findings from previous studies on project success factors.

## **2. Literature Review**

### **2.1 Introduction**

The research topic as well as the benefits of the study were introduced in the previous chapter. This chapter deals with the literature review conducted for this study and first explores important concepts such as project success and project success factors. Secondly it presents information and findings from previous research on project success factors. This includes general success factors, success factors specific to petrochemical projects, success factors specific to developing economies, as well as causal relationships between success factors.

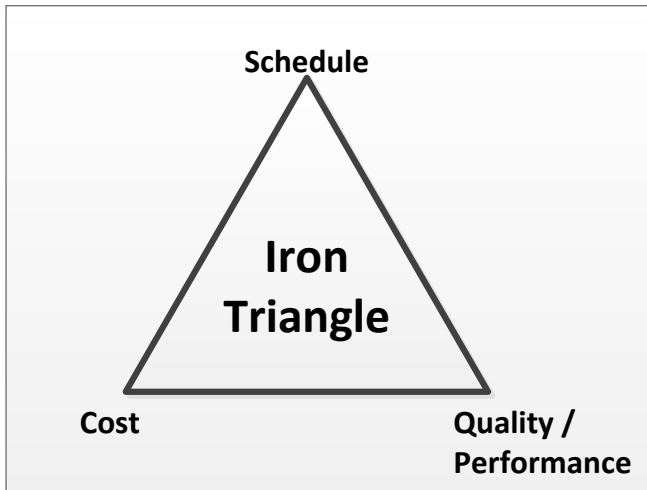
An integrative review (Whittemore, 2005) of past empirical and theoretical literature was conducted to obtain an understanding of project success and project success factors. Literature was gathered by searching three major science databases (Web of Science, Emerald and Engineering Village) as well as Google Scholar. The criteria used were the key words “project success factors” or “project success” for literature published between 1980 and 2014. Web of Science, Emerald and Engineering Village yielded 846, 1,014 and 2,643 results respectively.

The resulting collection of literature was screened and applicable literature was reviewed. Some secondary sources (literature referenced within the applicable identified literature) were also considered.

In the project management field, similar to many other fields, there are different understandings of the same terms and concepts. It is thus important to clearly define the terms and concepts used in this study. Project success will be explored first, followed by project success factors.

### **2.2 Definition of Project Success and Project Success Factors**

Traditionally project success is viewed as completing a project on time, within budget and with acceptable quality or performance. This is referred to as the triple constraint, iron triangle or golden triangle (Ika, 2009), and is depicted in Figure 1.



**Figure 1: The Iron Triangle**

This definition of project success has significant shortcomings. There are many projects which achieved their time, cost and quality goals and are considered failures. An example is the second generation Ford Taurus vehicle that was completed on time in 1995 but turned out to be a disappointing business experience (Shenhar, 2004).

There are also projects which do not meet the time, cost and quality goals, but are still considered very successful. An example is the Sydney Opera house which is generally considered a project management failure based on delayed completion and significant overspend (Steinfort & Walker, 2007). The project, while being late and more expensive, delivered a facility that is marvelled and is of great benefit to the city.

De Wit (1988) makes a distinction between project success and project management success. Project management success refers to the performance of a project against the traditional time, cost and quality objectives. Project success can be attributed to a project that delivers sufficient benefits to the client and other stakeholders (Pinto & Slevin, 1987).

Project success is based on the stakeholder perceptions of the value delivered by the project (Steinfort & Walker, 2007). It is not uncommon for some stakeholders to consider a project a success, where other stakeholders consider the same project a failure (Lim & Mohamed, 1999).

Ika (2009) argues that project management success is not unrelated to project success, but is not a guarantee that a project will be considered successful. However, failure in project management will greatly increase the probability of project failure.

Boynton and Zmud (1984, p. 17) refer to success factors as critical success factors and define them as: “*those few things that must go well to ensure success for a manager or an organisation*”. Other definitions are “*a set of factors contributing to project success*” (Chan et al., 2001, p. 93) or “*elements of a project which, when influenced, increase the likelihood of success*” (Müller & Jugdev, 2012). Frequently success factors identified in literature refer to both project success factors and project management success factors collectively.

Cooke-Davies distinguishes clearly between project management success factors, project success factors and corporate success. Corporate success is delivering “*consistently successful projects*” (Cooke-Davies T. , 2002, p. 118). This is of particular interest to large project organisations since it determines their profitability.

Lessons learnt from completed projects both in terms of what went well and what did not go well and the reasons for each, can lead to the identification of success factors which can be applied to future projects (De Wit, 1988).

Project success factors should not be confused with project success criteria. Project success criteria are used to judge the success of a project by. Both project success criteria and project success factors are important when considering project success (Crawford, 2000).

## **2.3 Project Success Factors**

The aim of this section is to explore project success factors and project management success factors identified in literature. Success factors from various industries and regions will be considered in this process. For the purpose of the identification process, no distinction is made between project success factors and project management success factors. Both are taken into account and are collectively referred to as success factors. Where authors make a specific distinction, it is noted.

Davis (2014) determined that the research focus on project success factors has shifted significantly since the 1970's when technical aspects of a project during the implementation were the main focus. During the 1980's the focus changed to how the project related to the client organisation and how success was viewed by the project manager and the project team. During the 1990's critical success factor frameworks and the appreciation of the involvement of internal and external stakeholders became popular. Since the 21'st century, research has become more stakeholder focussed and based on project life cycle goals.

Literature was scanned for studies where specific project success factors and project management success factors have been identified. Various such studies were identified. These studies were conducted in various regions, which include the USA, Europe, UK, China, Norway, France, Germany and South Africa. They include industries such as Design and Build, Construction, R&D, Decision Support and Information Technology. A detailed review of these studies resulted in the initial identification of 131 success factors. Considering repetition and similarities, this list was reduced to 103 factors. Table 1 gives an overview of the studies. A list of all the identified success factors and sources can be found in Table A-1 in Appendix A.

**Table 1: Previous studies identifying success factors for projects**

Author/s	Year	Regions	Industries	Study Type	Number of Success Factors
De Wit	1998	USA, UK	Design and Build, Technology	Literature Review	29
Andersen, Birchall, Jessen, and Money	2006	Norway, China, France, UK	Design and Build, Production, R&D, Decision Support	Empirical	9
Chan, Ho, and Tam	2001	China	Design and Build	Literature Review	44
Gemuenden and Lechler	1997	Germany	Unknown	Empirical	8
Garbharran, Govender, and Msani	2012	South Africa	Construction	Empirical	19
Cooke-Davies	2002	Europe	Various	Empirical	12
Steinfort and Walker	2007	Unknown	Information Technology, Construction	Empirical	10
					<b>131</b>

The study by Chan, Ho and Tam (1999) includes 10 success factors from Pinto and Slevin (1987). In a recent study by Davis (2014), it was found that these 10 success factors were the most widely used throughout literature in the Web of Science database. The 10 success factors from Pinto and Slevin are listed in Table 2.

**Table 2: 10 success factors from Pinto and Slevin (1987)**

No	Success Factor
1	Project mission - Initial clearly defined goals and general directions
2	Top management support - Willingness of top management to provide the necessary resources and authority/power for project success.
3	Project schedule/plans - Detailed specification of the individual actions steps for project implementation.
4	Client consultation - Communication, consultation, and active listening to all impacted parties.
5	Personnel - Recruitment, selection and training of the necessary personnel for the project team.
6	Technical tasks - Availability of the required technology and expertise to accomplish the specific technical action steps.
7	Client acceptance - The act of "selling" the final project to its ultimate intended users.
8	Monitoring and feedback - Timely provision of comprehensive control information at each stage in the implementation process.
9	Communication - The provision of an appropriate network and necessary data to all key actors in the project implementation.
10	Trouble shooting - Ability to handle unexpected crises and deviations from plan.

De Wit (1988) lists 29 success factors, citing Hayfield (1979), Sapolsky (1972), Ashley (1986) and Morris and Hough (1986). Hayfield specifically lists factors applicable to the design and construction phase for project management success. Success factors recommended by Sapolsky are based on the USA Polaris Ballistic Missile Programme. Ashley's USA study is based on successful construction projects. Morris and Hough completed a major UK literature survey on successful and failed projects.

Andersen, Birchall, Jessen, and Money (2006) list nine success factors. Their empirical study is based on data collected from 529 experienced project practitioners from Norway (67%), China (22%), France (8%) and the UK(3%). The project dataset includes construction/production related projects (52%), R&D projects (21%), decision support projects (20%) and other project types (7%).

Chan et al. (1999) lists 44 success factors, citing Pinto and Slevin (1987), Mohsini and Davidson (1992) , Songer and Molenaar (1997), Mo and Ng (1997), Deakin (1999), Tam (1997), Leung (1999), Pearson and Skues (1999), Ashley, Laurie, and Jaselskis (1987), Chan et al. (1999), Cheng (1995), Kok (1995) and Ho (1996). These studies are mostly design and build environment related, and a large percentage of them is China-based.

Gemuenden and Lechler (1997) list eight success factors derived from an empirical study of inputs from 448 members of the German Project Management Society on 248 successful projects and 190 unsuccessful projects. According to Gemuenden and Lechler, this is one of the largest samples for the study of project success factors of its time.

Garbharran, Govender, and Msani (2012) confirmed with an empirical study that the 19 success factors identified in previous studies by Nguyen, Ogunlana and Lan (2004), Swan and Khalfan (2007), Newton (2005) and Johnson, Scholes and Whittington (2006) are relevant to the construction projects in Durban, South Africa. These success factors are grouped into the four “Coms” as defined by Nguyen et al., which are comfort, competence, commitment and communication. The study utilised inputs from 95 project managers and 61 contractors from that region. This is the only literature which could be obtained for an empirical study on project success factors in South Africa.

Cooke-Davies conducted various studies on project success, including an empirical doctoral thesis on project success factors (Cooke-Davies T. , 2001). His sample consists of mainly European projects across various industries.

Steinfort and Walker (2007) suggest 10 success factors based on an empirical study of various large information technology and construction projects.

Various success factor topics (categories) were identified during the review of literature. These topics are presented based on the outcome of the qualitative content analysis process as discussed in section 4.2 where coding was used to group similar success factors into 33, and then finally, into 11 categories. A discussion on these success factor topics will now follow.

### **2.3.1 Project objectives**

The purpose of the project must be well understood and accepted (Andersen et al., 2006) by all project stakeholders and key team members (Steinfort & Walker, 2007). Steinfort and Walker also recommend that stakeholders should agree on project vision, goals, desired outcomes, as well as on the definition of success criteria.

De Wit (1988), based on the work of Hayfield (1979), highlights the importance of thorough and realistic project objectives. Chan et al. (2001) cite Tam (1997) in that the client's requirements need to be clearly stated at the outset of the project to ensure that the client's needs are pursued.

### **2.3.2 Strong project commitment**

For success, strong commitment to the project is important from the project manager (Ashley, 1986), the project team (Chan et al., 1999), top management (Pinto & Slevin, 1987) and all other stakeholders (Andersen et al., 2006).

Based on the findings of Nguyen et al. (2004), Garbharran et al. (2012) state that top management needs to provide political support to the project in dealing with business politics which may affect the project. This usually relates to issues external to the project, such as resource allocation or project trade-offs.

### **2.3.3 The project team**

Steinfort and Walker (2007) found that resources (team members) must be assigned to the project based on a realistic project execution plan and that they must have the correct competence levels. Hayfield (1979), as cited by De Wit (1988), found that the project team must be organised according to a clear and simple project team structure and that their level of motivation is important.

Assigning the right project manager (Gemuenden & Lechler, 1997) with the correct competence level (Nguyen et al., 2004) as well as the correct technical capabilities (Ashley, 1986) is also important to achieve success.

### **2.3.4 Project scope**

The project scope must be clear (Nguyen et al., 2004), well-defined and be well-understood by all (Songer & Molenaar, 1997). Chan et al. (1999) specifically recommends, based on various other studies (Ashley et al., 1987; Pinto & Slevin, 1987; Songer & Molenaar, 1997) that a clear understanding of the scope by the client is ensured. This helps to ensure that the client's objectives are met. In turn it also means that the team must understand the client's objectives and requirements clearly as discussed in section 2.3.1.

Scope changes, especially late scope changes, should be avoided. Scope changes should only be allowed via a mature scope management process (Cooke-Davies T. , 2002).

### **2.3.5 Stakeholder management**

It is important to involve all relevant stakeholders (Nguyen et al., 2004) and influence them early in the project (Andersen et al., 2006). This includes getting input from intended end-

users (Deakin, 1999), consulting with the client on project matters (Pinto & Slevin, 1987), managing stakeholder needs (Swan & Khalfan, 2007) and obtaining endorsement from stakeholders on project plans (Andersen et al., 2006).

It is also important that project stakeholders understand and accept their roles and duties (Chan et al., 1999). Based on various studies (Cheng, 1995; Ho, 1996; Kok, 1995; Mo & Ng, 1997) Chan et al. also concluded that the quality of relationships and the degree of cooperation within the project team, as well as with contractors, are important for success.

### **2.3.6 Project management**

A “well-structured and formal project management approach” is recommended (Andersen et al., 2006, p. 141). This entails managing the project according to a specific set of guidelines and having the required governance in place to ensure compliance to the guidelines. It is also important that the project team has the correct technology and tools available to effectively execute their project (Steinfort & Walker, 2007).

### **2.3.7 Communication**

Previous studies found that rich project communications, both internally and externally, is a driver of success ((Andersen et al., 2006; Chan et al., 1999). Chan et al. also found that establishing an agreed project communication channel improves success. It is also recommended that a detailed communication plan is developed and used (Newton, 2005).

### **2.3.8 Planning**

Many authors found that proper planning is a success factor (Ashley, 1986; Gemuenden & Lechler, 1997; Morris & Hough, 1986; Pinto & Slevin, 1987; Steinfort & Walker, 2007). Steinfort and Walker highlight the importance of a plan that is agreed with all key stakeholders and which takes resources requirements, contingencies and risks into account.

### **2.3.9 Risk management**

Management of risk is an important success factor. Cooke-Davis (2002) has found that having an adequate, regularly-updated risk management plan and risk register, improves project success.

### **2.3.10 Project control**

Proper project controls have been identified as a success factor in various studies (Andersen et al., 2006; Cooke-Davies T. , 2002; De Wit, 1988; Gemuenden & Lechler, 1997; Nguyen et al., 2004; Pinto & Slevin, 1987). Pinto and Slevin argues that it can be used to monitor and provide feedback on ongoing processes compared to the project plan, specifically with regards to cost and schedule. Andersen et al. states that its purpose is to influence these processes to remain in line with the plan. Cooke Davies (p. 188) also highlights the usefulness of project controls as a portfolio management tool which provides “line of sight” to managers in support of decision making.

### **2.3.11 Contracting**

For projects utilising contractors, effective contracting strategies and methods are considered important for success (Morris & Hough, 1986; Nguyen et al., 2004). Nguyen et al. consider the use of comprehensive and detailed contract documentation as important.

## **2.4 Success Factors for Petrochemical Projects**

The identified success factors are not specific to petrochemical projects. However, petrochemical projects include aspects of design and build projects, construction projects and R&D projects, which were represented in the literature.

Petrochemical projects are usually expensive, complex in nature and have many interfaces to manage. This is due to their technical complexity, stringent design and material specifications and their magnitude. As a result, organisations executing projects in this industry, generally have the most disciplined approach to project management (Cooke-Davies & Arzymanowc, 2003) when compared to other industries such as pharmaceutical and defence industries.

In South Africa, petrochemical projects range from about one million rands to tens of billions (1000 million) of rands. The smallest and simplest of these projects are usually related to the renewal of equipment items such as distillation columns, reactors or drums. Additions or modifications to existing facilities are also common and usually involve a large and complex multi-discipline scope consisting of mechanical, piping, civil, instrumentation and electrical elements and can cost hundreds of millions of rands. The construction of new production or storage facilities is usually the most complex and expensive. An example is the proposed

new PetroSA crude oil refinery on the South African east coast, estimated at a value of 82 billion rands (Matavire, 2012).

## **2.5 Success Factors for Developing Economies**

Two developing economies were represented in the literature contributing to the 131 success factors, namely South Africa and China. Although these regions have major culture differences, there are certain similarities based on their level of economic development.

As discussed in section 2.3, the research conducted by Garbharran et al. (2012) in the construction industry in Durban, South Africa, provides good insight into the success factors for South Africa. Some specific challenges listed by Garbharran et al. are a mistrust between project managers and contractors and that the majority of project managers and contractors are close to retirement.

Chan et al. (2001) conducted their research in the design and build environment in China. They found that the three most important success factors for that industry and regions are the project team's commitment, the client's competencies and the contractor's competencies.

Considering the findings of these two studies, it is clear that both owner and contractor resources are a concern in terms of meeting the resource demand with suitably skilled and experienced resources.

It was found that published empirical research into the South African petrochemical industry is limited. This empirical study will assist to address some of the gaps in the available knowledge in the project management field for this region and industry.

## **2.6 Causality of Success Factors**

Not all success factors are within the control of one stakeholder such as the project manager. Andresen, Birchall, Jessen and Money (2006) argue that there is benefit for project managers in understanding the interrelationships between success factors, since it will guide their influence on those which they can control.

The causality of success factors has been studied in previous research by scholars such as Andresen et al. (2006), Gemuenden and Lechler (1997) and Dvir et al. (1998).

Andresen et al. (2006) found that rich project communications, a well-structured and formal project management approach in terms of cost and schedule control, strong project commitment and early stakeholder involvement are strong drivers for project success.

Gemuenden and Lechler (1997) used a Linear Structural Relationships (LISREL) approach to analyse data from 438 projects. They found that top management (support) directly influences project success since it provides the organisational environment conducive to successful projects. Further they found that a good project team is strong driver for project success since it leads to better planning, control and communication. Communication was found to be the factor with the highest direct impact on project success. Ineffective conflict management and changes in goals were found to have a strong negative impact on project success.

Dvir et al. (1998) applied multivariate methods on analysing a sample of 110 projects. Their first important finding was that success factors are not universal for all project types. Project teams need to consider which factors are critical to their projects. This is in line with finding from Steinfort and Walker (2007) which was that the relative importance of success factors varies for different projects and project phases. Secondly Dvir et al. (1998) found that pre-contract activities, involving a customer follow-up team and good project controls are very important success factors for all project types.

## **2.7 Conclusion**

In this chapter the literature review for this study was presented. It included the definitions of project success and project success factors; the identification of 131 success factors; a discussion on success factors for petrochemical projects and developing economies; and a discussion on the causality of success factors.

In the next chapter the research design will be discussed. It will detail the approach with regards the literature analysis and the design of the empirical data collection and analysis.

### 3. Research Design, Methodology and Methods

#### 3.1 Introduction

In the previous chapter, a literature review was presented on success factors, which included both project success factors and project management success factors. This chapter will present the research design and methodology for this study. It will discuss sampling, how data from literature will be analysed, as well as the approach followed with interview and survey data collection and analysis. Limitations, validity, trustworthiness and ethics will also be discussed.

#### 3.2 Research Design

The research design for this study will be discussed based on the Interactive Model of Research Design as developed by Maxwell (2005) which was developed for qualitative research. This model has five design components which are goals, conceptual framework, research questions, methods and validity. The components interact and are interconnected in a flexible structure. Maxwell argues that a reflexive model such as this is required for qualitative research since qualitative research is an iterative process, as opposed to a sequential research process. Figure 2 depicts the model.

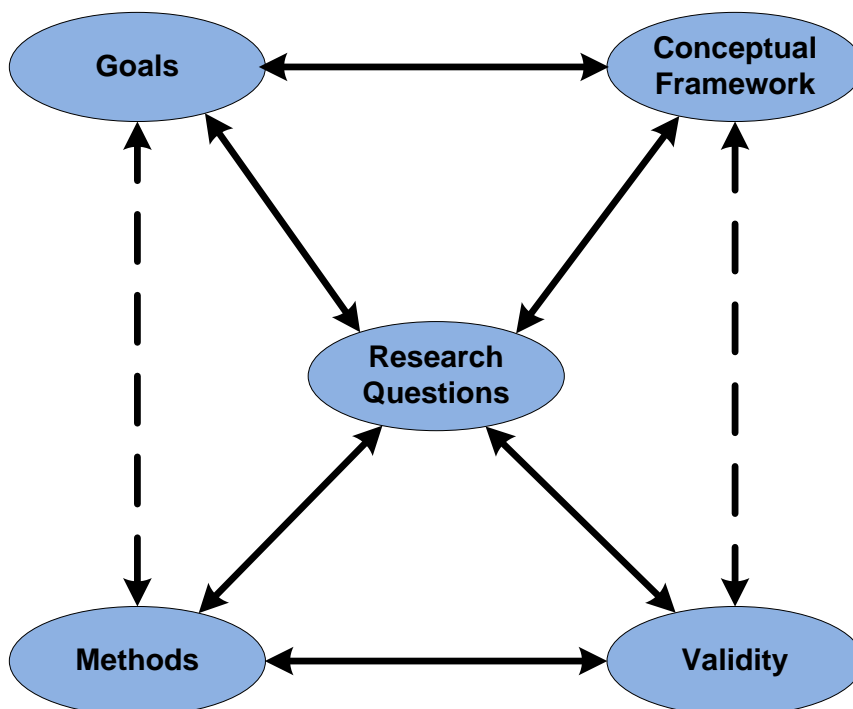


Figure 2: Interactive Model of Research Design (Maxwell, 2005, p. 3)

The upper triangle components, which are goals, conceptual framework and research questions, directly affect each other. The bottom triangle components, which are methods, validity and research questions, also directly affect each other. The research questions are directly related to all the other design components and are thus central to the research design.

There is also a relationship between goals and methods. The goals will influence the methods which are appropriate. Similarly, the methods which are practical may also affect the goals which can be achieved. A similar relationship exists between conceptual framework and validity.

A discussion on each design component of this study will now follow.

### **3.2.1 Goals**

Projects in the South African petrochemical industry are faced with various challenges. This study aims to develop an understanding of the factors which influence project success in the South African petrochemical industry in order to improve project success. The objective is to identify the most critical success factors that project managers need to manage. Clients, contractors and project teams can benefit from more successful projects.

### **3.2.2 Conceptual Framework**

According to Maxwell (2005, p. 33) the conceptual framework is “the system of concepts, assumptions, expectations, beliefs, and theories that supports and informs research”. Such theories and assumptions can include those theories about what is going on with issues or settings that one develops from observation and engagement and those theories drawn from literature and previous studies.

In this study, the researcher had experience as an engineer and project manager working for a large South African petrochemical company. This experience contributed to an understanding of project management as transdisciplinary and situational, providing the context for the research. An initial review of the literature revealed a range of perspectives and concepts, supporting a study that was inductive i.e. key concepts and categories emerged from the data.

These assumptions are consistent with that of qualitative research. In addition to drawing out the factors that were considered relevant, the relationships between factors are considered

to have importance. This is as a consequence of the conceptual framework being informed by systemic thinking and theories of what constitutes project success.

### 3.2.3 Research Questions

The questions which will be asked as part of this study are:

1. What success factors have been identified in previous studies?
2. What challenges are faced by projects in the South African petrochemical industry?
3. What are the most critical factors that project managers need to manage effectively in the South African petrochemical industry to improve project success?

### 3.2.4 Methods

The methods which were used for data collection are:

1. An integrative review (Whittemore, 2005) of past empirical and theoretical literature. This method enables the collation of knowledge from previous studies in various regions and industries on the subject matter.
2. Structured interviews (Mathers, Fox, & Hunn, 1998) with project professionals. The importance of context in the management of projects presented the possibility of data that contributed to the building of theory.
3. A web-based survey (Roztocki & Morgan, 2001). Web-based surveys provide access to a broader range of participants. It also assists in gathering information in the desired format and is deemed more convenient and less time-consuming than personal interviews by some.

Participants were selected using purposive sampling (Tongco, 2007). They were contacted using email. Interviews were conducted in person at their place of work. Survey data was collected using a web-based survey.

The method used for data analysis is qualitative content analysis (Berg, 2008) and was used to analyse empirical data as well as data from literature. This method is well suited for analysing qualitative data. Content analysis is a systematic method for analysing the content of documents. In particular, qualitative content analysis requires some interpretation of the document content to arrive at the meaning of data (Schreier, 2012).

### 3.2.5 Validity

To evaluate the validity of the findings of the study, the credibility of the sample; the dependability and confirmability of the data; and the transferability of the findings are considered. This is discussed in section 3.10.

## 3.3 Qualitative Content Analysis

To enable analysis of qualitative data originating from sources like interviews, field notes or surveys, the information they convey must be “condensed and made systematically comparable” (Berg, 2008, p. 238). By applying an objective coding scheme to the data, similar data can be grouped to enable analysis. Berg refers to this process as (qualitative) content analysis. Berg (p. 240) quotes Holsti in defining content analysis as “any technique for making inferences by systematically and objectively identifying special characteristics of messages”.

Berg (2008) states that in content analysis there are seven major elements in data which can be counted. These are words, themes, characters, paragraphs, items, concepts and semantics. The element which will be used in this study is concepts. Berg defines concepts as words which are grouped together into conceptual clusters to form ideas. Berg uses an example by (Babbie, 1998) and explains that crime, delinquency and fraud can be classified under the concept (category) of deviance. Such a concept element is also referred to as a meaning unit, which is defined as “the constellation of words or statements that relate to the same central meaning” (Graneheim & Lundman, 2004, p. 106).

Berg (2008) explains that coding is done using coding categories. Such coding categories can be determined deductively, thus before analysing the data based on theory, or inductively, thus based on the data. A combination of inductive and deductive coding categories can also be used.

When using inductive coding, more codes are developed as the data is reviewed. As the coding process continues, some codes are re-defined and similar codes are combined. The end result of this iterative process is a comprehensive list of codes, referred to as categories. An example of this is that the code “project scope” can be re-defined into two distinctly new codes such as “project scope change” and “project scope definition”.

During data analysis, coding is done for each meaning unit (Davis, 2014). This enables grouping of similar meaning units into categories and enables further analysis. The

frequency with which a specific concept is observed in the data is sometimes used as an indication of magnitude or importance of that concept (Berg, 2008). Berg however cautions researchers that descriptive statistics such as proportions and frequency distributions of categories should not be used as findings in themselves, since it does not necessarily reflect the nature of the data. Clearly showing category definitions, coding results and the analysis process, enables the reader to judge the trustworthiness of the findings.

The tool used for content analysis is Microsoft Excel. This was done by transferring content to text items and assigning a code to each text item. This enabled sorting, filtering, further analysis and processing of meaning units and their relevant code groups (categories).

### **3.4 Data Collection**

Data collection methods for this study include the review of literature (see section 2.3), as well as conducting interviews and surveys to collect empirical data from project professionals with knowledge and experience with projects in the South African petrochemical industry. The details will be discussed in sections 3.6 and 3.7.

### **3.5 Literature Analysis Design**

The analysis of project success factors from literature was done by first coding these into success factor categories. These categories were then analysed further to determine the relative importance of each. The aim was to compile 10 to 15 generic success factor categories from literature which could be used in, and compared to, the results of the interviews and survey.

#### **3.5.1 Coding of Success Factors**

The coding process involved a process of comparison and contrasting, enabling the grouping of similar success factors together and the elimination of duplication. This process would be repeated until the number of success factor categories formed was between 10 and 15. The author considers this a practically manageable number of categories, since they would be presented to survey participants.

#### **3.5.2 Determining Relative Importance of Success Factor Groups**

Two indicators were considered when comparing the relative importance of the success factor categories. The first indicator was frequency. This is the number of unique success factors per success factor category (Berg, 2008). A success factor category consisting of

many unique success factors may be considered more important to manage than those with fewer unique success factors, since this may indicate higher complexity or multiple facets included in that success factor category. The second was to consider the number of sources which identified success factors in each success factor category. It can be argued that success factor categories containing success factors from many different sources are more important or applicable in general than those containing success factors from one or two sources only.

## **3.6 Interview Design**

### **3.6.1 Design of interview questionnaire**

An interview questionnaire was compiled and can be found in Appendix C. The interview questionnaire had a dual purpose. Firstly, it was designed to capture data on project success factors in the South African petrochemical industry. Secondly, it was intended as a means of improving the quality of the web-based survey questionnaire which would be sent to a much larger group. It was important to confirm that the appropriate questions were asked in the survey and that a comprehensive list of success factors was presented to participants for evaluation.

Important definitions, such as distinguishing between project success and project management success, were included in the instructional text of the questionnaire to ensure that participants gave inputs based on the same definitions. This enabled gathering information on project management success and project success, as well as challenges for executing projects in the South African petrochemical industry.

Gathering data on causal relationships between success factors and regional and industry challenges was the final objective of the questionnaire. This was also discussed during the final interviews.

### **3.6.2 Preliminary interviews with participants**

Over a six week period, 10 one-hour interviews were conducted with potential participants who agreed to participate voluntarily. These were all senior, well experienced project professionals. Their experience in the project environment ranged from eight years to 39 years, with an average of 22.8 years. Table 3 shows the experience of interviewees.

**Table 3: Interviewee experience**

Interviewee	Years Project Experience
1	15
2	34
3	15
4	25
5	39
6	26
7	30
8	25
9	8
10	11

Structured interviews were conducted with set questions as a guideline for the discussion (see Appendix C for questions). Interview data was analysed and contributed to the development of the categories derived from the literature analysis. All interviewees agreed to also participate in the web-based survey which would be sent to them.

### 3.6.3 Final interviews

Final interviews were conducted with three senior participants. The purpose was to discuss the preliminary results of the study, to interpret the results, to discuss causal relationships and to validate the recommendations.

## 3.7 Survey Design

### 3.7.1 Development of web-based survey

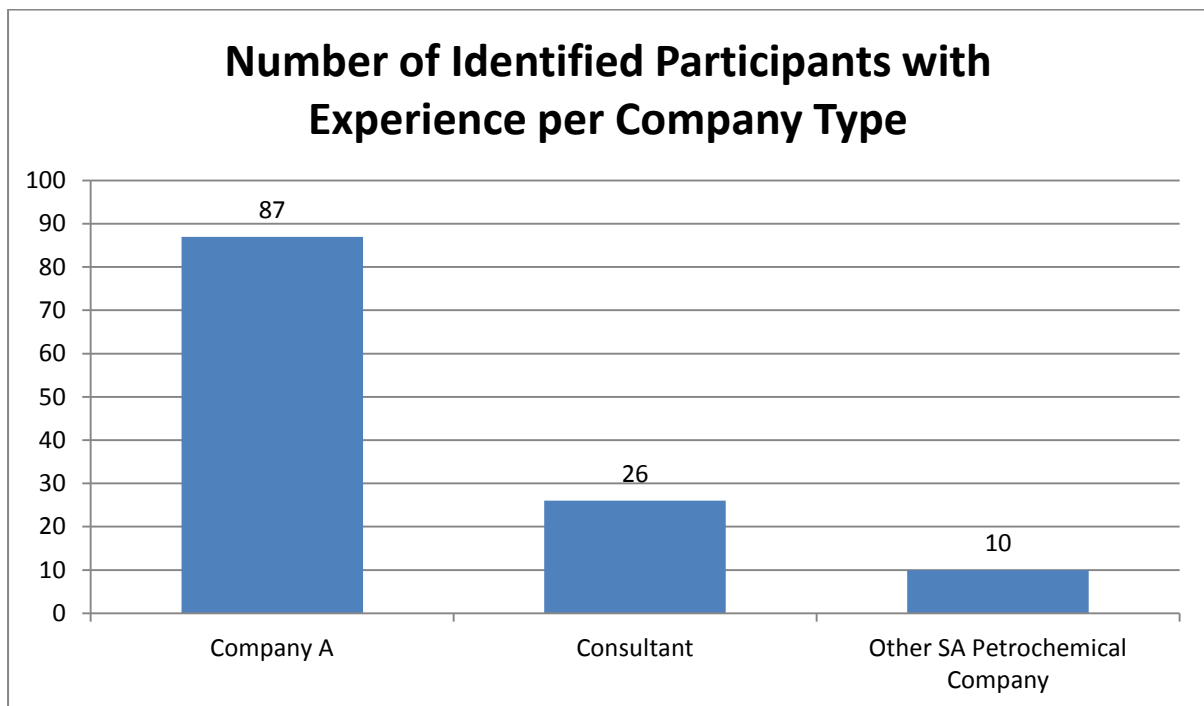
A web-based survey, using Surveygizmo.com, was developed to be used as a data gathering tool for this study. A link address to the survey website was emailed to potential participants with a cover-email describing the research objectives, the time required to participate, the potential advantages of participating, as well as the participation timeline. The same questions used in the interview questionnaire were used for the web-based survey, as well as the following additional questions:

1. Participants were asked to identify challenges unique to the South African petrochemical industry.
2. Participants were asked to additionally select the five most important success factors from the list of 12 generic success factor categories and prioritise them.

### 3.7.2 Sampling

Development of a meaningful potential participant sample was essential to ensure reliable results. Purposive sampling (Tongco, 2007) was used to select the potential participants to ensure a representative sample of the South African petrochemical industry. A sample of 104 potential participants was selected. Both the experience and the roles of potential participants were considered in developing the sample. This can also be considered a key informant sample (Marshall, 1996) which is a type of purposive sample which relates to subjects with specific expertise.

Inclusion of potential participants from Company A (a large South African petrochemical company), other South African petrochemical companies, as well as various project engineering consultant firms were considered important to obtain a representative sample. Figure 3 shows the identified participant composition. It should be noted that some potential participants have experience in working for more than one company type, for example, a participant may currently be employed by one South African petrochemical company, but was previously employed by another petrochemical company.



**Figure 3: Identified number of potential participants with experience per company type**

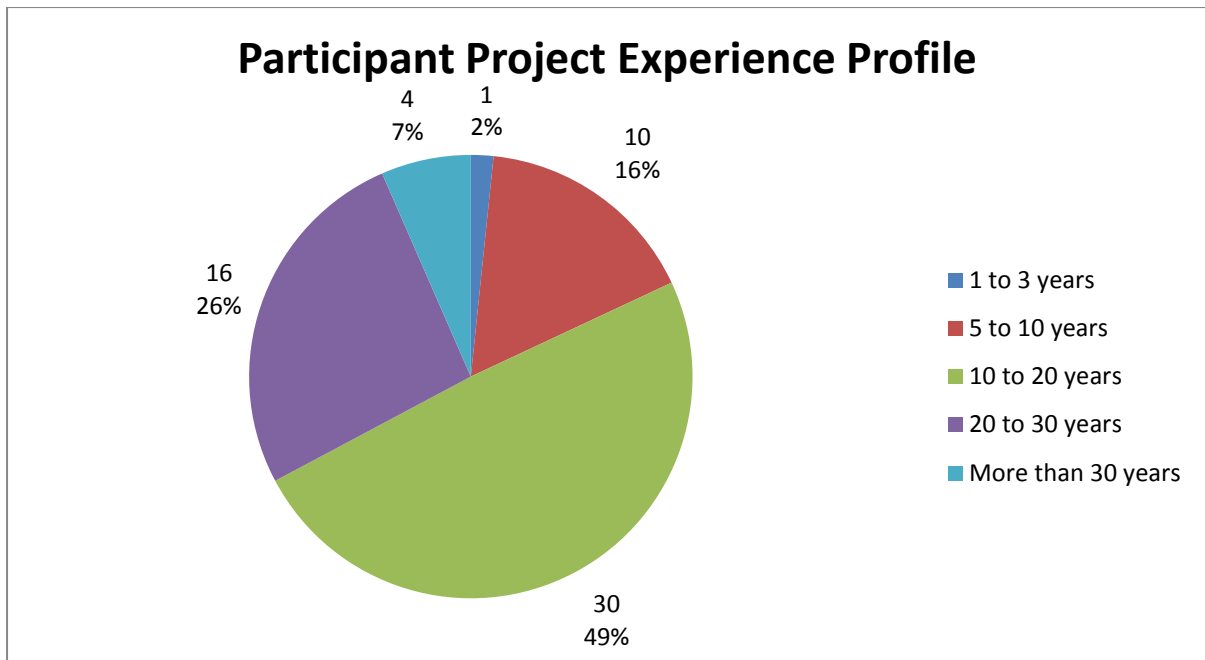
Inclusion of potential participants from as many project roles as possible was considered important to obtain a representative sample. The roles which were included are project managers, engineering managers, discipline engineers, commercial managers, project cost

estimators, portfolio managers, project sponsors, client representatives, commissioning personnel, operations and maintenance personnel, business analysts and construction managers.

Survey completion statistics were tracked on a daily basis. Potential participants were reminded by email of the request to participate on the day that a response was due. Some participants were also reminded verbally. The participation timeline was extended from two weeks to five weeks to achieve a better response rate, since the participation timeline stretched across a period of many public holidays and in which many potential participants took vacation leave. According to Nulty (2008) a response rate of 21% should be sufficient for a sample size of 100 participants to yield a 10% sampling error and an 80% confidence level.

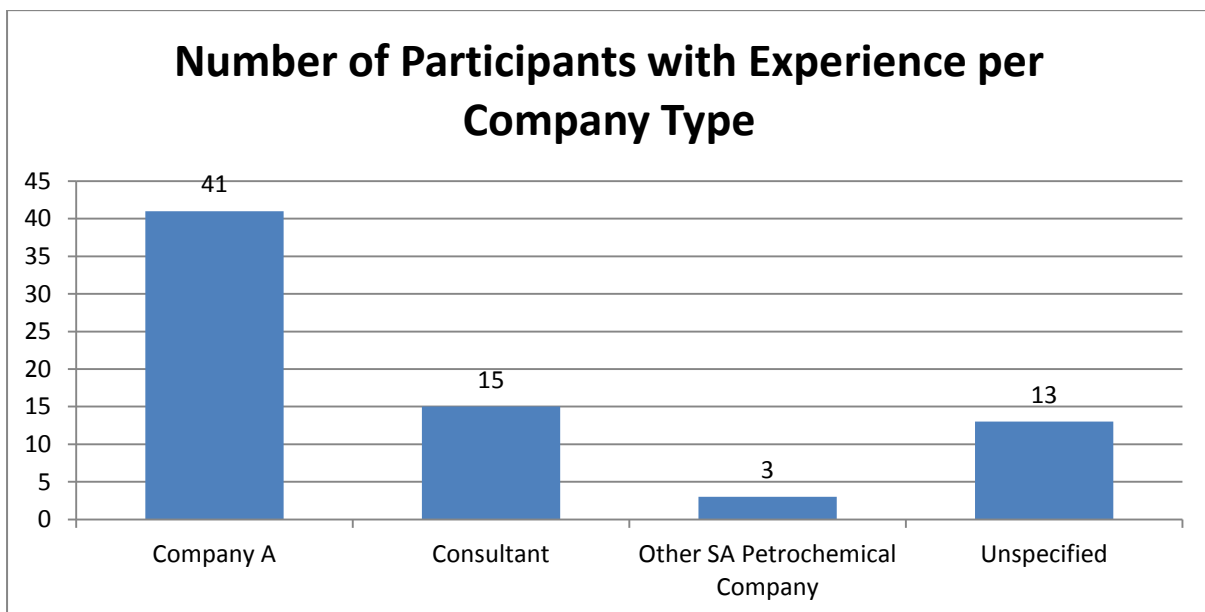
Of the 104 identified potential participants, 93 could be reached and were invited to participate in the web-based survey. Of those invited, 59 participated. This translates to a 63% response rate, which is considered sufficient. Data sets from the 12 interviews were also added, bringing the total number of participants to 61, since two interview participants did not participate in the web-based survey. Data sets for participants who were interviewed and who also completed a web-based survey, were analysed and combined where appropriate to remove duplication and ensure sound interpretation.

Considering experience, 50 participants, which equates to 82% of the sample, had more than 10 years project experience in the South African petrochemical industry. When using the mid-point of each experience category, the theoretical combined project experience for the sample is 1,067 years, with an average of 17.5 years per participant. Figure 4 shows the project experience profile in number of years for the sample. Participant experience details can be found in Appendix D.



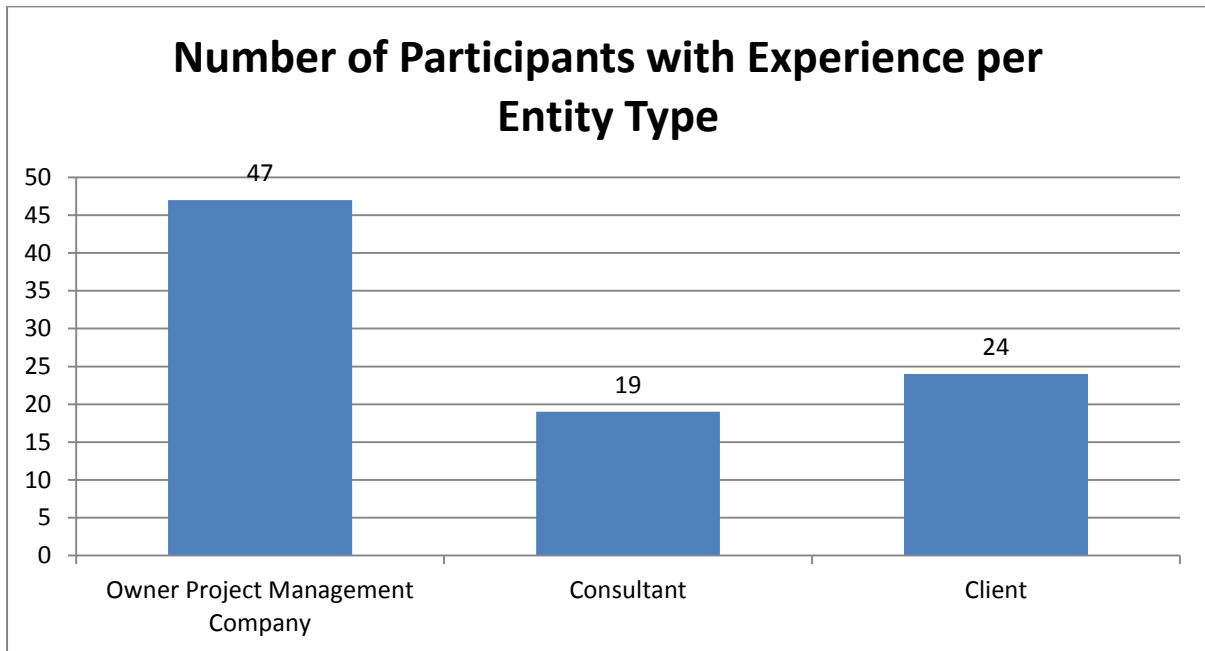
**Figure 4: Participant project experience profile**

In terms of company experience, 41 of the participants had experience working for Company A and 15 had experience working for engineering consultants executing projects in the South African petrochemical industry. Three of the participants had experience working for other South African petrochemical companies. Experience types could not be determined for 13 participants who chose to remain anonymous. Figure 5 shows the number of participants with experience per company type. Note that some participants had experience in more than one company type. In such cases, the additional company types were added to the statistics.



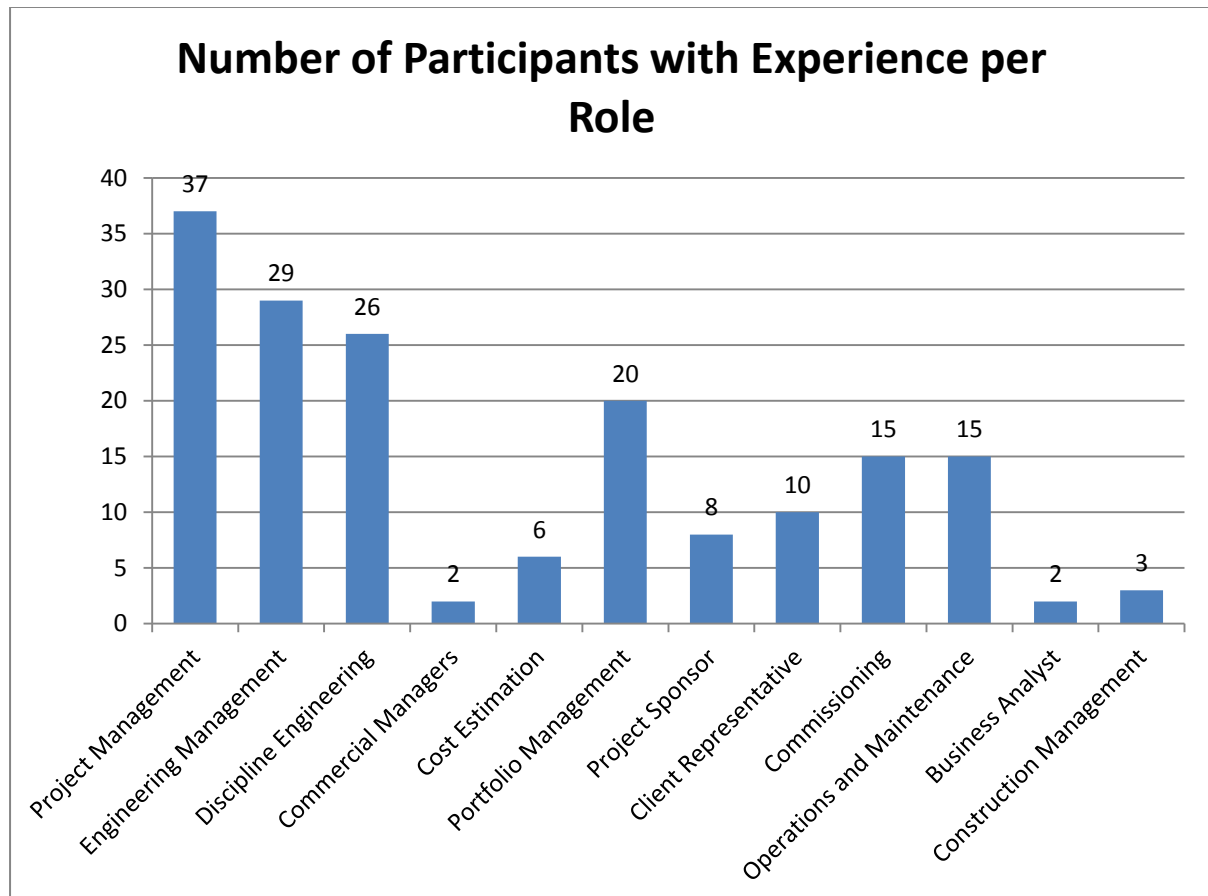
**Figure 5: Number of participants with experience per company type**

Of the 61 participants, 47, which equates to 77% of the sample, indicated that they have worked for an owner project management company. Further, 19 of the participants have worked for project consultants and 24 for project client organisations. This equates to 31% and 39% respectively. All three entity types were thus represented in the sample. This is illustrated in Figure 6 below. Note that some participants had experience in more than one entity type. In such cases, the additional entity types were added to the statistics.



**Figure 6: Number of participants with experience per entity type**

Of the participants, 61%, 48% and 43% had experience in project management, engineering management or an engineering discipline respectively. Many had experience in more than one of these three roles. More than 40% of project and engineering managers had a discipline engineering background. More than 15% of the participants had experience in client-related roles such as client representative, commissioning, operations and maintenance. Figure 7 below shows the number of participants who had experience in each role. Note that some participants had experience in more than one role. In such cases, the additional roles were added to the statistics.



**Figure 7: Number of participants with experience per role**

There is representation in the sample for all the critical project roles. Unfortunately, none of the participants had experience in project controls, It is however believed that project managers, who constitute more than 40% of the sample, have sufficient knowledge in this field for the purpose of this study.

### 3.7.3 Analysis of interview and survey data

Table 4 shows the research data which was analysed in detail.

**Table 4: Empirical data**

No	Data Set	Objectives	Methods Used
1	Participant experience in terms of years, company type and project roles.	To validate if the sample is representative.	Descriptive statistics.
2	Challenges on projects unique or dominant in the South African Petrochemical Industry, as identified and ranked by participants.	To explore the obstacles which projects need to overcome in the South African petrochemical industry.	Qualitative content analysis.
3	Project management success factors and project success factors, as identified and ranked by participants.	To identify specific success factors which participants believe contributed to success. To determine the relative importance of the identified success factors.	Qualitative content analysis.
4	Selection and ranking of generic project management success factors and project success factors by participants.	To determine the relative importance of the 12 generic success factor categories.	Qualitative content analysis.
5	Causal success factor relationships, based on interviews with participants.	To identify and understand causal relationships between the success factors and regional and industry challenges.	Qualitative content analysis.

The details of the analysis will be presented in sections 4.3 and 4.4, as well as in Appendices E, F and G.

#### **Challenges unique or dominant in the South African petrochemical industry**

Participants were asked to identify five (or less) challenges unique or dominant to the region and industry. These were coded and prioritised according to the number of challenges identified per code (thus frequency), also considering the number of participants who contributed one or more challenge per challenge category. Each challenge code was also classified as a regional or industry challenge, an owner controlled challenge or a project team controlled challenge.

#### **Participant Success Factors**

Participants were asked to name an example of a project that they were involved in which achieved project management success. Based on this project they were asked to list and prioritise five (or less) success factors which contributed to this success.

The success factors were scored based on their priority. The highest priority success factor from a participant's list was assigned five points, the second four points, the third three points, the fourth two points and the fifth one point. Where success factors belonged to

multiple success factor categories, the points were divided equally among the categories. The total score for each generic success factor category was calculated to indicate the relative importance of categories. For ease of comparison, total scores were normalised and expressed as percentages.

Participants were requested to do the same for a project which achieved project success in their opinion, even if it did not achieve its time-cost-quality objectives.

### **Evaluation of generic success factor categories**

Based on the same example of project management success, participants were asked to select and prioritise the five most important success factors from the 12 generic success factor categories. These success factors were scored based on their priority, similar to the participant success factors, thus the highest priority success factor from a participant's list was assigned five points, and the lowest one point. The total score for each generic success factor category was calculated to indicate relative importance of the categories. For ease of comparison, total scores were normalised and expressed as percentages.

Participants were asked to repeat the selection and prioritisation process, using the same example of a project which achieved project success. Scoring was done as for the generic project management success factor categories.

### **Causal relationships between success factor categories**

Relationships between success factor categories were discussed with four senior participants. Their average experience is calculated at 15.6 years, based on the midpoints of their experience groups.

## **3.8 Overview of Research Design**

Qualitative content analysis was used to extract success factors from literature and to consolidate them into 11 success factor categories using two coding cycles. These 11 success factor categories were ranked according to the number of sources who identified success factors in each category and the frequency of each category.

Empirical data was gathered from participants by means of interviews and web-based surveys. The data was processed using qualitative content analysis. Challenges unique to or dominant in the region and industry were identified and ranked, as well as success factors. The 11 success factor categories were refined by adding an additional success factor

category based on the coding of interview data to obtain 12 generic success factor categories. These 12 generic success factor categories were also ranked by participants during the survey.

The ranked success factors and challenges were evaluated using qualitative content analysis and other comparative analysis methods. This resulted in the prioritised Seven Core Success Factor categories.

Figure 8 summarises the research approach followed.

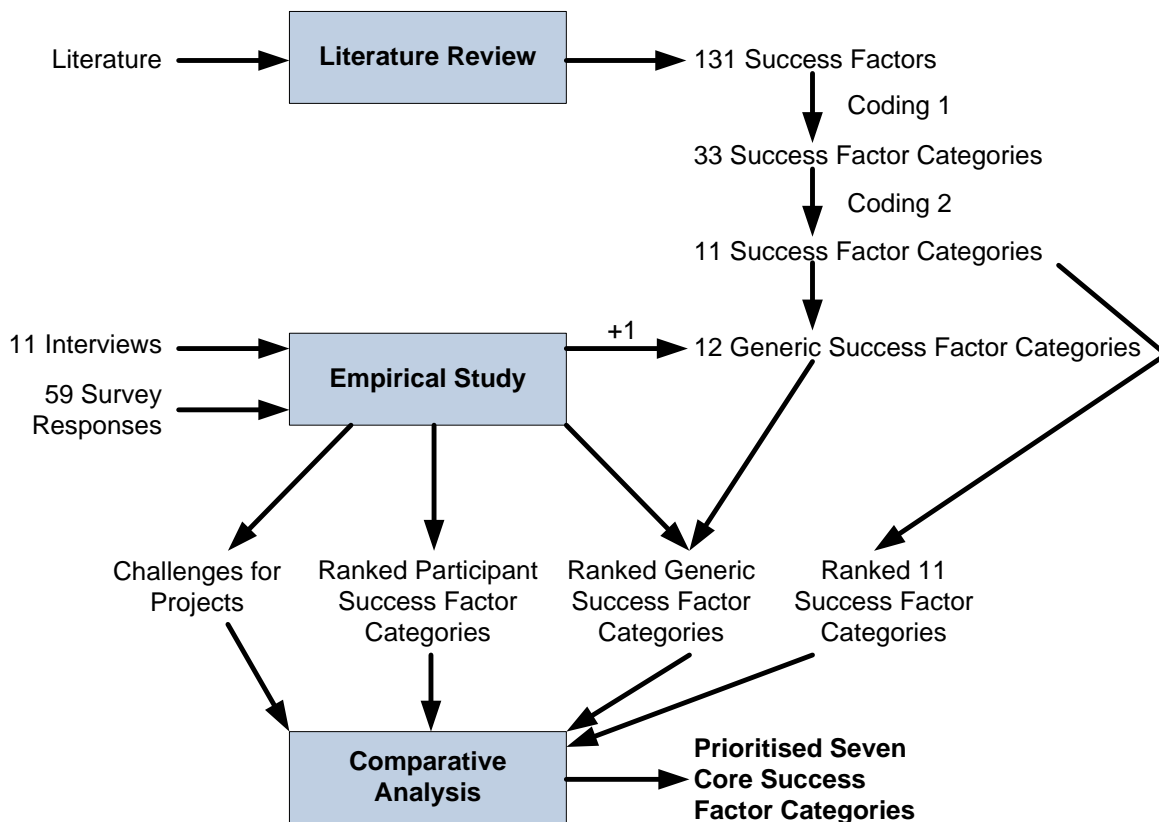


Figure 8: Flowchart of research approach

### 3.9 Limitations

The results from this study may also apply to projects in other industries within South Africa and there may even be some results which can be applied to projects in other regions and industries. Application of the results in other industries or regions has not been evaluated in this study.

The data provided by participants was not weighed based on the experience or competence level of each during the analysis process. All participant data was treated equally.

### **3.10 Validity and Trustworthiness**

Validity is usually associated with quantitative research. Credibility, dependability and transferability have been used in other qualitative research to describe the various aspects of trustworthiness (Graneheim & Lundman, 2004). These aspects will now be discussed.

#### **3.10.1 Credibility**

Graneheim and Lundman cite Polit and Hungler (1999) when defining credibility as how well data and the analysis processes address the intended focus of the study. They consider the use of an appropriate sample, the appropriate amount of data, a proper understanding of participants' inputs and recognition of findings by participants as important.

Considering the profile of participants in the eventual sample, the following should be noted:

- The average relevant experience per participant is 17.5 years. This is considered sufficient, since participants with experience exceeding 15 years are considered very senior in the South African petrochemical industry.
- The experience per company type cannot be fully confirmed since 13 participants chose to remain anonymous. More than 50% of the participants have experience working for Company A, and more than 20% for engineering consultants. There is a concern that other South African Petrochemical companies may not be strongly represented in the sample. However, based on the experience levels of those who did contribute and the fact that some of the anonymous participants may be from such companies, the sample is considered sufficient.
- Participants with experience in all relevant project roles, except project controls, are included in the sample. It is however believed that project managers, who constitute more than 40% of the sample, have sufficient knowledge in this field for the purpose of this study.

This type of sample is referred to as a key informant sample (Marshall, 1996).

The mobility of project resources between different companies and entities within the South African petrochemical industry is high, especially between different engineering consultants. This is demonstrated by the number of participants who have experience working for more

than one entity (consultant, client, or owner project management company) and improves the richness of the sample.

The use of a set questionnaire with clear questions during interviews and for the survey prompted focussed answers from participants. This supported gathering data in manageable quantities.

Care was taken not to lose the intended meanings of participants during the qualitative content analysis processes. Quotations from participants were included in the text, as well as in the appendices, to allow the reader to judge its appropriate use. Ambiguous data, although limited, was identified and indicated as such during the analysis process.

The outcomes, findings and recommendations of this study were discussed with three senior participants to gather additional perspectives and to obtain recognition of the process and results. This contributed to confirmability.

### **3.10.2 Dependability**

Dependability is defined as the degree of changes in data over time as well as the alterations made by the researcher during the analysis process (Graneheim & Lundman, 2004). The data collection period for this study was 5 weeks for surveys and the period between the first and the last interview was 3 months. The survey was conducted without any modifications to the questions or accompanying information. By asking consistent questions and by limiting the empirical data gathering period, enhanced the dependability of this study.

### **3.10.3 Transferability**

Some of the findings may also be applicable and beneficial to other industries in South Africa, such as the construction industry. Similarly, some findings may also be beneficial to petrochemical projects in other regions, especially in other developing economies, due to similarities with South Africa. As recommended by Graneheim and Lundman (2004), the analysis process, results and recommendations are documented clearly and openly to enable the reader to judge its potential value to other settings.

### **3.11 Evaluation of Ethics**

Sound research ethics principles were upheld throughout all stages of this dissertation. The possible consequences and ethical implications of this research were considered throughout the research process. The following principles listed by Bell and Bryman (2007) and the University of Cape Town (2013) were adhered to:

- No research participant was or shall be harmed.
- Participants were informed of what their participation would entail and their un-coerced consent was obtained prior to participation. They were allowed to refuse or withdraw their participation at any time. A voluntary participation contract was discussed with and signed by participants prior to conducting the interviews (see Appendix B). A similar document was presented on the first page of the survey for acceptance.
- The privacy of all participants and companies is protected.
- Confidentiality and anonymity will be upheld for participants, organisations and other affected parties. Participants were requested during initial engagement to identify any confidential or potentially confidential data when sharing it. Some participants requested that specific project information be desensitised. The author excluded such information from this dissertation.
- Honesty and transparency were upheld in all research actions.
- The main findings of the study will be shared with participants in the pursuit of reciprocity and mutual benefit.

### **3.12 Conclusion**

This research design for this study was presented in this chapter. It describes how the success factors identified from literature will be analysed, consolidated and ranked using qualitative content analysis. Secondly, it describes the interview and survey design, which includes the methods used for collection of data, sampling, analysis, consolidation and ranking. Due consideration is also given to limitations, trustworthiness and ethics. In the next chapter the detailed analysis process and results will be presented.

## **4. Data Analysis**

### **4.1 Introduction**

The previous chapter presented the research design for this study in terms of the analysis of literature, interview and survey data. This chapter will present details of the qualitative content analysis process, as well as the results.

### **4.2 Analysis of Literature**

In section 2.3 a total of 131 success factors were identified by reviewing previous research on this topic. Using qualitative content analysis, these success factors will be coded into success factor categories. The success factor categories will then be analysed to determine the relative importance of each group.

#### **4.2.1 Coding 1: Coding success factors into 33 success factor categories**

Using qualitative content analysis, the 131 success factors were coded into 33 success factor categories. This entailed grouping similar success factors together by creating suitable categories. As an example, the following four related success factors were identified: “project manager goal commitment”, “strong project commitment from all stakeholders and participants”, “project team commitment” and “top management commitment to project”. These were all coded as “Strong Commitment to Project”. Strong Commitment to Project thus became one of the 33 success factor categories.

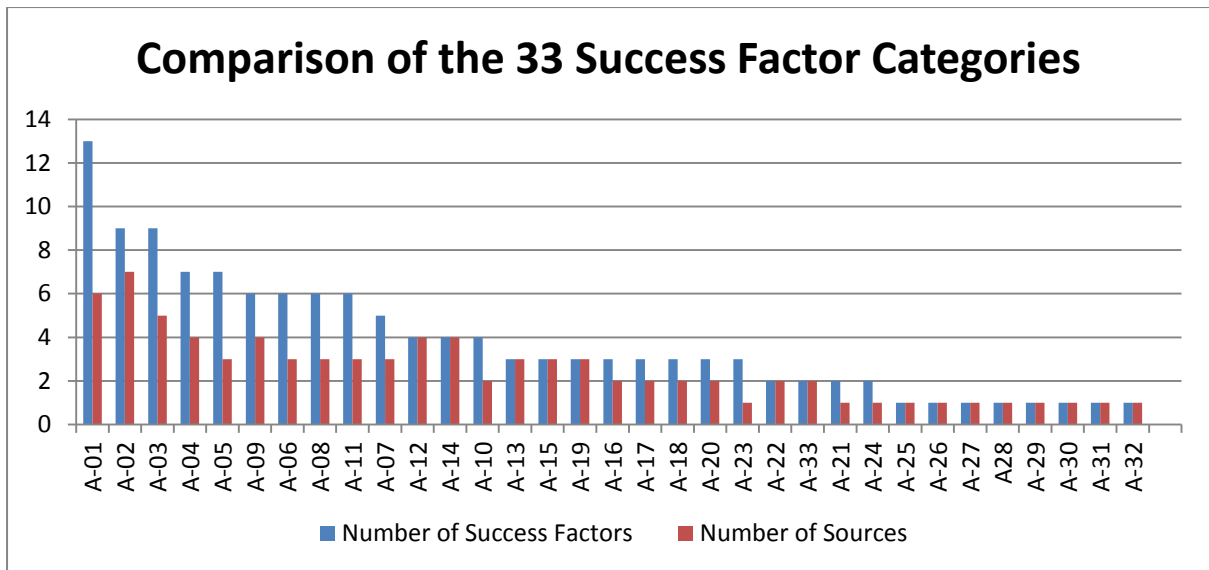
Table 5 shows a list of the 33 success factor categories. A table with the 131 identified success factors grouped into 33 success factor categories, as well as the category definitions, can be found in Table A-2 in Appendix A.

**Table 5: 33 success factor categories**

No	Success Factor	No	Success Factor
A-01	Clear and Realistic Project Objectives	A-18	Effective Contracting
A-02	Effective Project Controls	A-19	Good Flexibility and Adaptability
A-03	Proper Planning	A-20	Good Availability of Project Related Information
A-04	The Right Team	A-21	Sufficient Client Involvement
A-05	Effective Contractor Selection	A-22	Efficient Project Management Approach
A-06	Effective Stakeholder Management	A-23	Sufficient Client Competencies and Experience
A-07	Rich Communication	A-24	Effective Use of Project Management Systems and Tools
A-08	Healthy Relationships	A-25	Continuous Learning
A-09	Clear Understanding of Project Environment and Context	A-26	Ability of Project Team to Deal with Project Complexity
A-10	Effective Management of Politics	A-27	Clear Roles and Responsibilities
A-11	Clear Project Scope	A-28	Effective Decision Making
A-12	Strong Project Leadership	A-29	Highly Motivated Project Team
A-13	Utilising the Right Technology to Execute the Project	A-30	High Degree of Site and As-Is Verification
A-14	Strong Commitment to Project	A-31	Strong Top Management Support
A-15	Good Availability of Resources	A-32	Effective Change Management
A-16	Effective Risk Management	A-33	Effective Assumptions Management
A-17	Effective Cost Management		

As discussed in section 3.5.2, there are two indicators which were considered when comparing the relative importance success factor categories. The first was to consider the number of sources which identified success factors in each success factor category. The second indicator was frequency, thus the number of unique success factors per success factor category.

Figure 9 shows a comparison of these indicators. These are the 33 success factor categories arranged according to number of success factors per category (frequency) and then by the number of sources per category. See Table A-3 in Appendix A for details.



**Figure 9: Comparison of the 33 success factor categories**

From Figure 9 it can be seen that A-01 (Clear and Realistic Project Objectives), A-02 (Effective Project Controls), and A-03 (Proper Planning) were identified by five or more of the literature sources. These are also the success factor categories with the largest number of success factors grouped under them (thus the highest frequency). These may be considered the most important of the 33 success factor categories to manage. The importance decreases to the right.

The 33 success factor categories are considered a comprehensive list of success factors based on the sample of 131 success factors identified from various sources. Care was taken not to exclude identified success factors.

#### 4.2.2 Coding 2: Coding the 33 success factor categories further

Considering the purpose of this study, which is to determine the most critical project success factors in the South African petrochemical industry, proposed success factors needed to be presented to participants in the region and industry for evaluation. Presenting a list of 33 proposed success factors for evaluation to participants would not be practical and may yield unreliable results. The reason for this is that it takes a lot of time and patience to evaluate such a long list of factors. It was decided to further reduce the number of success factor categories by performing a second round of coding on the 33 success factor categories.

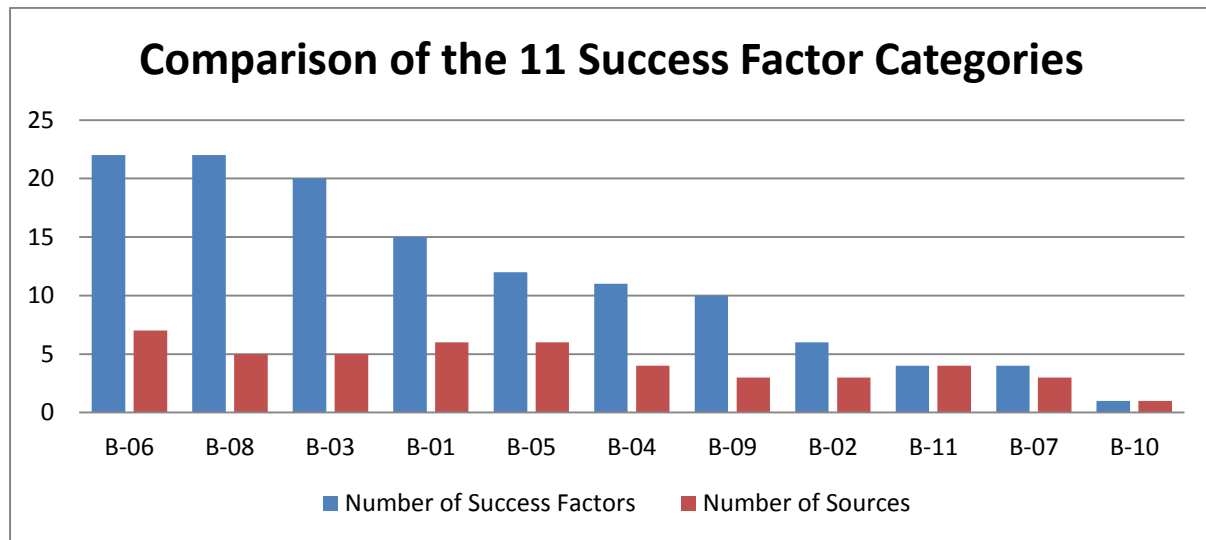
As an example, the success factor categories “effective cost management”, “effective project controls” and “proper planning” were all coded as “Effective Project Planning and Controls”.

This second round of coding resulted in 11 success factor categories. These categories are shown in Table 6.

**Table 6: The 11 success factor categories**

<b>B-01</b>	<b>Clear Realistic and Agreed Project Objectives</b>	<b>B-06</b>	<b>Effective Project Planning and Controls</b>
A-09	Clear Understanding of Project Environment and Context	A-17	Effective Cost Management
A-01	Clear and Realistic Project Objectives	A-02	Effective Project Controls
		A-03	Proper Planning
<b>B-02</b>	<b>Clear Project Scope</b>	<b>B-07</b>	<b>Effective Risk and Assumptions Management</b>
A-11	Clear Project Scope	A-16	Effective Risk Management
<b>B-03</b>	<b>An Effective Project Team</b>	A-33	Effective Assumptions Management
A-04	The Right Team	A-30	High Degree of Site and As-Is Verification
A-29	Highly Motivated Project Team	<b>B-08</b>	<b>Good Stakeholder and Communication Management</b>
A-26	Ability of Project Team to Deal with Project Complexity	A-06	Effective Stakeholder Management
A-19	Good Flexibility and Adaptability	A-08	Healthy Relationships
A-15	Good Availability of Resources	A-07	Rich Communication
A-14	Strong Commitment to Project	A-20	Good Availability of Project Related Information
A-25	Continuous Learning	<b>B-09</b>	<b>Effective Contracting</b>
A-28	Effective Decision Making	A-05	Effective Contractor Selection
<b>B-04</b>	<b>Strong Support for Project</b>	A-18	Effective Contracting
A-31	Strong Top Management Support	<b>B-10</b>	<b>Clear Roles and Responsibilities</b>
A-10	Effective Management of Politics	A-27	Clear Roles and Responsibilities
A-21	Sufficient Client Involvement	<b>B-11</b>	<b>Strong Project Leadership</b>
A-23	Sufficient Client Competencies and Experience	A-12	Strong Project Leadership
<b>B-05</b>	<b>Effective Project Management Approach</b>		
A-22	Efficient Project Management Approach		
A-13	Utilising the Right Technology to Execute the Project		
A-24	Effective Use of Project Management Systems and Tools		
A-32	Effective Change Management		

Figure 10 shows a comparison of the 11 success factor categories based on the frequency and number of sources represented per success factor category.



**Figure 10: Comparison of the 11 success factor categories**

From Figure 10 can be gathered that the following five success factor categories are the most important:

- B-06 - Effective Project Planning and Controls
- B-08 - Good Stakeholder and Communication Management
- B-03 - An Effective Project Team
- B-01- Clear Realistic and Agreed Project Objectives
- B-05 - Effective Project Management Approach

#### 4.2.3 Conclusion

Using qualitative content analysis, the 131 success factors identified from literature were coded into 33 success factor categories and prioritised. Prioritisation was done by considering the frequency of each success factor category and the number of sources which identified success factors in each category. Since the author considered the 33 success factor categories too many for practical engagement with participants, a second round of coding was performed which resulted in 11 success factor categories.

### **4.3 Analysis of Interview Data**

During the preliminary interviews, 94 success factors were identified and can be seen in Appendix E. Using qualitative content analysis, these 94 success factors were coded into the 11 success factor categories. There were three success factors which did not fit into any of the 11 success factor categories. This resulted in one additional success factor category named “Effective Construction Management”.

Two success factor categories were renamed due to the addition of new dimensions for that category. As an example, “Clear Project Scope” was renamed “Effective Scope and Engineering Management” due to the addition of success factors like “sound technical solution”, “proper technology governance” and “proper peer reviews”. Table 7 shows the resulting 12 Generic Success Factor Categories. Changes to the success factor category descriptions are indicated in blue text.

**Table 7: The 12 generic success factor categories**

<b>C-01</b>	<b>Clear Realistic and Agreed Project Objectives</b>	<b>C-06</b>	<b>Effective Project Planning and Controls</b>
A-09	Clear Understanding of Project Environment and Context	A-17	Effective Cost Management
A-01	Clear and Realistic Project Objectives Driving cost instead of schedule	A-02	Effective Project Controls
<b>C-02</b>	<b>Effective Scope and Engineering Management</b>	A-03	Proper Planning Realistic Plans Effective use of Benchmarking Detailed Cost Estimates Guarding against Premature Acceleration of Project
A-11	Clear Project Scope Proper Scope Definition (FEL) Sound Technical Solution Scope Freeze as Early as Possible Robust Business Solution Proper Technology / Technical Governance Proper peer reviews	<b>C-07</b>	<b>Effective Risk and Assumptions Management</b>
<b>C-03</b>	<b>An Effective Project Team</b>	A-16	Effective Risk Management
A-04	The Right Team	A-33	Effective Assumptions Management
A-29	Highly Motivated Project Team	A-30	High Degree of Site and As-Is Verification Focus on Safety
A-26	Ability of Project Team to Deal with Project Complexity	<b>C-08</b>	<b>Good Stakeholder and Communication Management</b>
A-19	Good Flexibility and Adaptability	A-06	Effective Stakeholder Management
A-15	Good Availability of Resources	A-08	Healthy Relationships
A-14	Strong Commitment to Project	A-07	Rich Communication
A-25	Continuous Learning	A-20	Good Availability of Project Related Information Transparency and Openness
A-28	Effective Decision Making Continuity of Team Proper Handover Procedures when Team Members Change Sufficient Team Experience	<b>C-09</b>	<b>Effective Contracting</b>
<b>C-04</b>	<b>Strong Support for Project</b>	A-05	Effective Contractor Selection
A-31	Strong Top Management Support	A-18	Effective Contracting Quality of Contractual Documents Local Content Management (in ZA)
A-10	Effective Management of Politics	<b>C-10</b>	<b>Effective project setup</b>
A-21	Sufficient Client Involvement	A-27	Clear Roles & Responsibilities Effective Co-location of Contractor and Owner Resources Effective Execution Strategy
A-23	Sufficient Client Competencies and Experience Strong Commissioning Team from Owner Accessibility, Presence & Involvement of Sponsor	<b>C-11</b>	<b>Strong Project Leadership</b>
<b>C-05</b>	<b>Effective Project Management Approach</b>	A-12	Strong Project Leadership Good Representation from Project Management, Engineering Management and Business. Good Personal Attribute Match to Project Requirements Experience and Skills of Leaders
A-22	Efficient Project Management Approach	<b>C-12</b>	<b>Effective Construction Management</b>
A-13	Utilising the Right Technology to Execute the Project		Strong Owner Construction Management Team Strong Contractor Construction Management Team Effective Mitigation of Issues Causing Low Construction Productivity
A-24	Effective Use of Project Management Systems and Tools		
A-32	Effective Change Management		

## 4.4 Analysis of Survey Data

Four aspects of the data were analysed, namely challenges in the region and industry, participant success factors, evaluation of generic success factor categories and causal relationships between success factors.

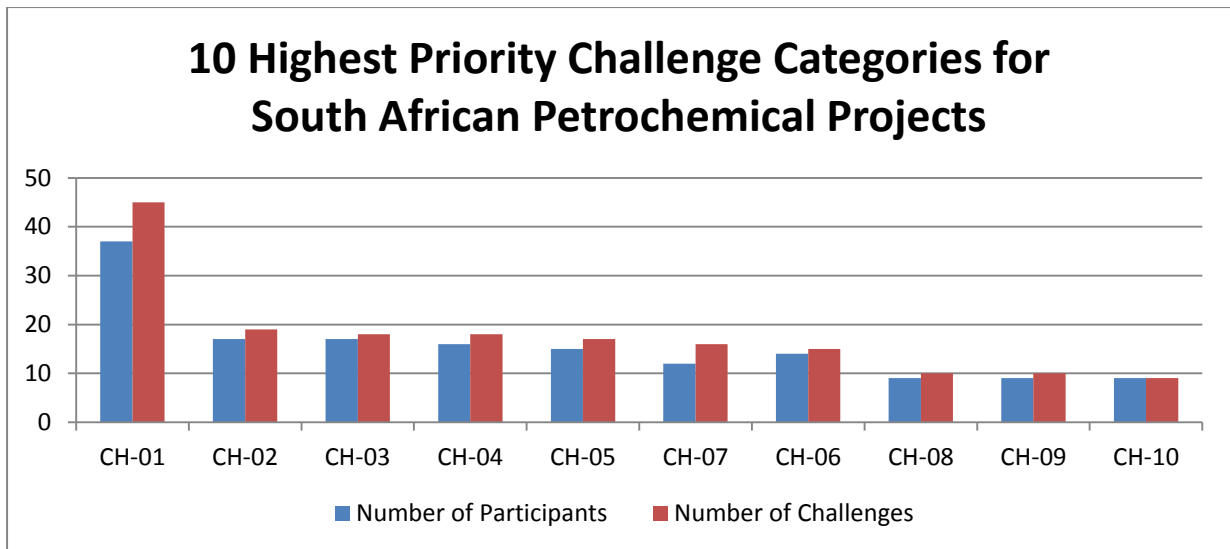
### 4.4.1 Challenges in the South African petrochemical industry

Participants identified 261 challenges unique or dominant in the South African petrochemical industry. These were coded and prioritised according to frequency and the number of participants represented per category as described in section 3.7.3. Table 8 and Figure 11 show the 10 challenge categories with the highest priorities for projects in the South African petrochemical industry, as well as type of challenge. A full list can be found in Appendix F.

**Table 8: 10 highest priority challenge categories**

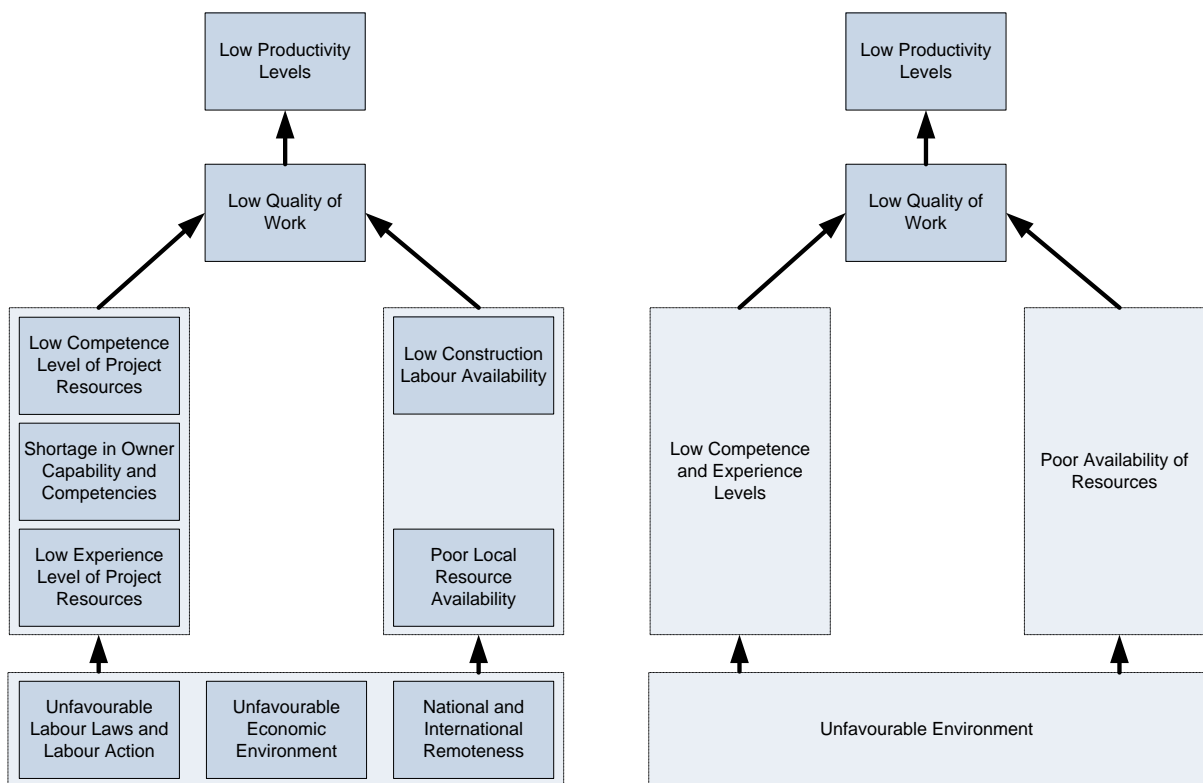
ID	Challenge	Region and Industry Specific	Owner Controlled	Project Team Controlled
CH-01	Low Competence Level of Project Resources	X		
CH-02	Low Construction Labour Availability	X		
CH-03	Low Productivity Levels	X		
CH-04	Unfavourable Labour Laws and Labour Action	X		
CH-05	Unfavourable Economic Environment	X		
CH-06	Low Experience Level of Project Resources	X		
CH-07	Poor Local Resource Availability	X		
CH-08	Shortage in Owner Capability and Competencies		X	
CH-09	National and International Remoteness of South African Petrochemical Projects	X		
CH-10	Low Quality of Work	X		X

Nine of the 10 challenges are typical to the region and industry. The shortage in owner capability and competencies is considered within the control of owners, since owners are considered to have the ability to source and appoint the required personnel with the right competencies. Although low quality work was observed widely throughout the region, there remains an amount of owner responsibility in controlling quality.



**Figure 11: 10 highest priority challenge categories**

The 10 highest priority challenges can be further consolidated into five general challenge categories, as depicted in Figure 12.



**Figure 12: General challenges for projects in the South African petrochemical industry**

Based on interview and survey data, the 10 highest priority challenges are discussed.

### **Low Competence Level of Project Resources**

The low competence level of project resources is considered the most challenging category. It was named by 37 of the participants, which equates to 61% of the sample, and contains 45 meaning units (challenges). Participants state that the competence level of project management, engineering and construction resources is low from both the contractor and the owner point of view. As an example, survey respondent 80 lists “Lack of engineering and project management skills” as a challenge.

For construction resources they name factors such as low skill level of existing construction and supervision labour force, low levels of skills development and lack of artisan training programmes at major petrochemical companies as the main contributors to this issue. As an example, survey respondent 61 lists “Poor skills at artisan and supervisory level” as a challenge.

For project and engineering resources the loss of competent resources to the international market, shortage of skills and experience at local engineering contractors, lack of formal training programmes for young engineers, shortage of basic project management skills like estimating, planning and project controls, turnover of key engineering resources and a poor South African primary and secondary education system as the main contributors to this issue.

### **Low Construction Labour Availability**

The poor availability of construction labour is considered the second most challenging category. It was named by 17 of the participants, which equates to 28% of the sample, and contains 19 sub-challenges. This challenge is closely related to the low competence level of project resources. There seems to be a high sensitivity to regional demand on construction resources. When construction projects take place concurrently in the same region, the available labour cannot always meet the increased demand. Survey respondent 47 states the challenge as: “Labour availability if there are more than one project in a region”.

Specialised construction skills are also in short supply. Only a small number of construction companies are active in the petrochemical industry and cannot always meet the demand. A fluctuating and generally low petrochemical construction workload makes it difficult for construction companies to establish and remain sustainable.

### **Low Productivity Levels**

Productivity, specifically labour productivity, is considered a major challenge in the South African petrochemical industry. It was also named by 17 of the participants, which equates to 28% of the sample, and contains 18 sub-challenges. Survey respondent 35 classifies the productivity as “extremely low”.

It is related to competence of the construction workforce and their supervision, permitting requirements and local labour legislation. It is considered by some participants as between three and six times lower than the world norm. This increases project costs and schedules significantly.

### **Unfavourable Labour Laws and Labour Action**

South African labour laws are considered by 26% of participants as a challenge to project execution. Work hours, wages and restrictions on imported labour are specific challenges. Labour unrest and strikes are regular occurrences across the country. Trade unions are very powerful and can cause standing time for weeks and even months for South African projects. This can have major cost and schedule impacts on projects. As an example, survey respondent 48 states: “The labour laws in South Africa are not creating a business environment that is conducive for international investment which in turn could provide an up skilling and capacity building in South Africa”.

### **Unfavourable Economic Environment**

This challenge category was referred to by 25% of participants and rates as the 5<sup>th</sup> most challenging. Specific challenges listed by participants include the availability of capital for projects, lack of South African investments by the petrochemical industry, declining market demand for petrochemical products and a weak, volatile local currency (South African Rand) and a very competitive marketplace. Survey respondent 64 specifically notes “Negative outlook of capital investment in South Africa due to government drive to own 25% of all investments by default” as a challenge.

### **Low Experience Level of Project Resources**

The experience level of local project resources is considered as low by 23% of the participants. This is closely related to the low competency level, the small South African petrochemical industry, the fluctuating workload and associated loss of competent and experienced resources to the international project environment. Survey respondent 77 lists “General shortage of experienced engineers and project managers” as a challenge.

### **Poor Local Resource Availability**

The poor availability of local resources refers to resources other than those related to construction labour. These local resources include the number of competent engineers, project managers and engineering contractors. It also refers to equipment, materials, and specialised fabricated items. Interviewee 3 lists “Small local petrochemical engineering and construction industry” as a significant challenge.

This challenge is closely related to the low competence level of project resources. Similar to low construction labour availability, only a small number of engineering contractors are active in the petrochemical industry and cannot always meet the demand. A fluctuating and generally low petrochemical project workload makes it difficult for engineering contractors to establish and remain sustainable.

### **Shortage in Owner Capability and Competencies**

15% of participants state that owner capabilities and competencies are insufficient for the successful execution of projects in the South African petrochemical industry. This relates to operations, project management and engineering personnel. This seems to be related to a general internal skills reduction within owner organisations, which in turn may be related to a general reduction in competency of resources in South Africa. Some participants also noted that some owners rely on external contractors for project management and engineering work.

Considering the challenges within the local engineering contractor and construction industry, interviewee 1 stated that owners need to strengthen their own organisation’s capabilities in terms of engineering and project management to ensure project management success.

### **National and International Remoteness of South African Petrochemical Projects**

15% of the participants noted this as a challenge to the region and industry. On a national level, conforming manufacturing facilities and material suppliers are spread thinly. This necessitates project team members to travel great distances to manage/oversee the fabrication process or to obtain materials. It also creates logistical challenges when transporting the completed equipment or materials from the facilities to site. Survey respondent 63 refers to this challenge as the “long logistical chain”. The fact that South Africa is far from the global manufacturing hubs creates similar issues when global sourcing is done. The remoteness of the South African petrochemical industry leads to increased project cost and schedule.

A secondary issue caused by the remoteness of the region and industry is that resources cannot easily operate within the international petrochemical industry. This shortage of international exposure curbs learning and development of resources within the South African petrochemical industry, which in turn contributes to the low competency and experience level of local resources.

### **Low Quality of Work**

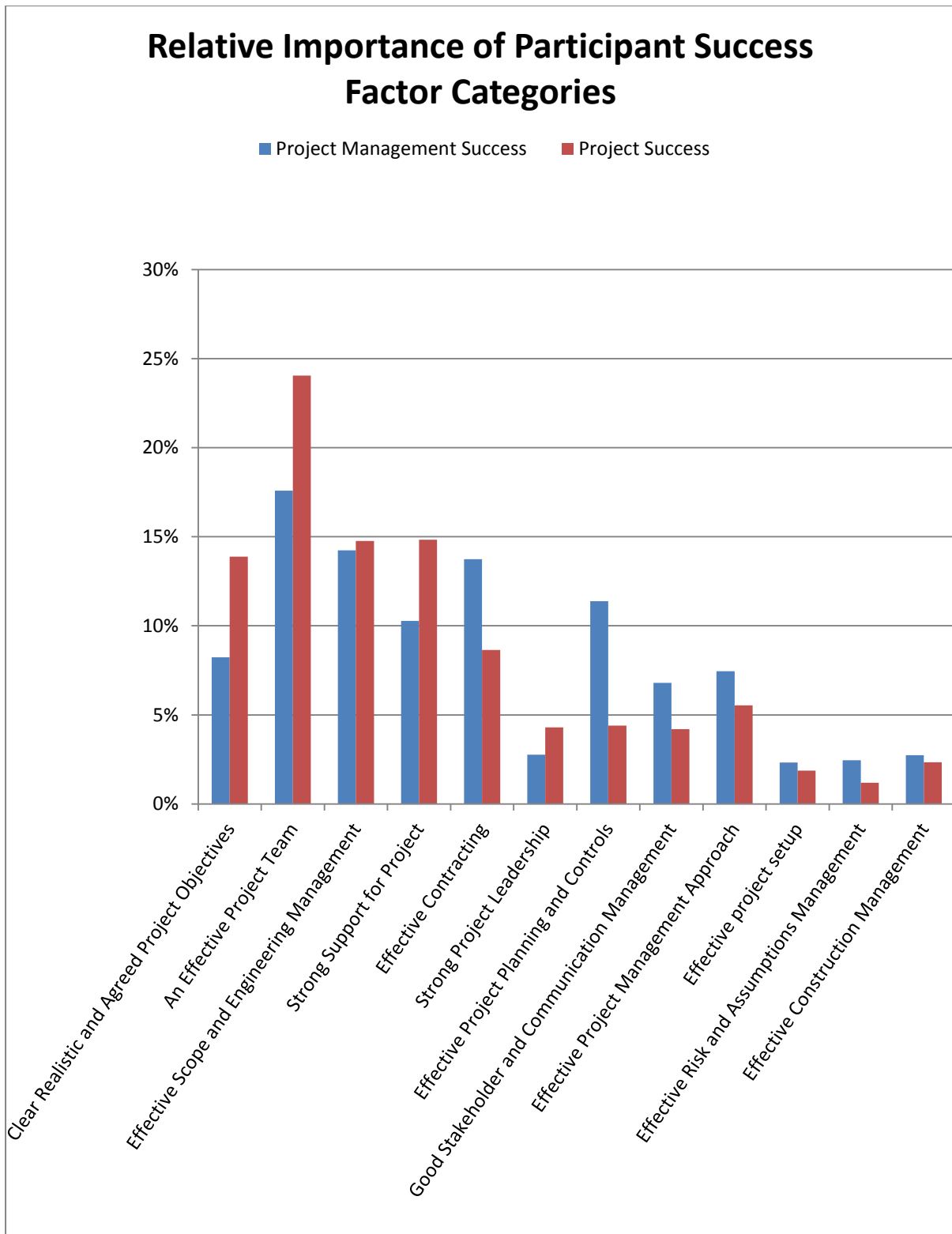
12% of participants see the low quality of work as a challenge for the South African petrochemical industry. This quality concern relates to engineering, construction labour and project management. It is again related to competency, experience and availability of project resources. Survey respondent 13 specifically lists “Quality issues related to lack of skills and supervision” as a challenge.

The details for the remaining 20 challenges can be found in Appendix F.

#### **4.4.2 Participant success factors**

Participants identified and prioritised 796 project management success factors based on their experience with projects. These were coded according to the 12 generic success factor categories and scored. A list can be found in Table G-1 in Appendix G.

Participants also identified and prioritised 675 project success factors. A list can be found in Table G-2 in Appendix G. These project success factors were also coded according to the 12 generic success factor categories and scored. The result is shown in Figure 13 with the total scores per category converted to percentages of either the overall total score for project management success factors, or of project success factors. For example, the sum of all the category total scores for project management success was 796, and the total category score for Effective Project Team was 140. Thus the percentage for that category was  $140 / 796 = 18\%$ .



**Figure 13: Participant success factor category importance**

From Figure 13 it can be seen that for project success, there is a significantly higher focus on clear realistic and agreed objectives, an effective project team and strong support for the project.

Based on the scores, the five most important success factors are:

1. An Effective Project Team
2. Effective Scope and Engineering Management
3. Strong Support for Project
4. Effective Contracting
5. Clear Realistic and Agreed Project Objectives

The details of the above success factor categories will be discussed based on data from participants.

### **Effective Project Team**

Based on the calculated scores, an effective project team is the strongest success factor. The success factors in this group, as identified by the participants, include team virtues such as dedication, commitment, teamwork, persistence, focus and innovation. It is also recommended that the team is well integrated, which entails integrating resources from the client into the project team.

Other success factors include ensuring that the team is well-aligned and that they are the right team for the project in terms of competence and experience. Ensuring a low turnover of project team members, maintaining good relationships with contractors and having a dedicated project manager and key project resources, are also highly recommend by participants.

Survey respondent 18 captures a large portion of the inputs by stating: “Focused, dedicated project team - not overloaded, no split priorities, mix between experienced and less so”.

### **Effective Scope and Engineering Management**

Based on the calculated scores, effective scope and engineering management is the second most important success factor. Specific success factors listed by participants include proper scope definition, avoiding scope changes, managing scope changes diligently should it be absolutely necessary. Participants also further recommended that only mature technologies be used in designs, that the engineering team conducts regular site visits, that engineering is done with a high quality focus and that greenfields sites be selected over brownfields sites where possible. As an example, survey respondent 5 stated that the fact that the “scope was understood and well defined”, contributed to project management success on a previous project.

### **Strong Support for Project**

Based on the scores, strong support for the project is the third most important. It refers to strong support from the client (and project sponsor), operations and maintenance personnel, client representatives and senior project management company personnel. Survey respondent 23 lists “Positive support from the operations teams” as a success factor. Strong support demonstrates that the client wants the project to be a success. During interviews, it was clear that projects do not always enjoy support from the whole client organisation, especially when the project objectives and benefits are not clearly communicated.

Specific success factors listed by participants include the full involvement of the client and client personnel in the project, having a strong and competent client team, commitment and support from senior management and support for making decisions quickly. Further factors listed are that continuity of key project and client project resources should be maintained as far as possible, client support with managing powerful stakeholders should be obtained and that sufficient authority should be delegated to the project manager.

### **Effective Contracting**

Based on the scores, effective contracting ranks fourth in terms of importance. Selecting the right contractors and then contracting effectively is the main theme of this success factor group. Specific success factors identified include selecting the best and not necessarily the cheapest contractor, which may also mean considering using competent and experienced international contractors. Survey respondent 73 refers to appointing a “strong engineering contractor” as a success factor.

Further, selecting the optimal contract type and securing well experienced contractor resources for the project, are also considered important. Participants also recommend integrating the contractor team with the project team and always maintaining good relationships with contractors.

### **Clear Realistic and Agreed Project Objectives**

Ensuring clear and agreed project objectives is ranked fifth in terms of importance. Success factors listed by participants include clear market objectives and business targets for the project in terms of size and performance, as well as a sound business case for doing the project. The project team should make an effort to understand the client’s requirements and priorities. The specifications which will be utilised must also be agreed upon with the client when starting the project. The objectives must be realistic (practically achievable), quantified,

understood and agreed upon by all stakeholders. Survey respondent 5 states that a “solid business case with clear business objectives at inception”, is critical for project success.

The detail for these five success factors and for the remaining seven success factors can be found in Table G-1 and Table G-2 in Appendix G.

#### 4.4.3 Evaluation of generic success factor categories

Participants selected and prioritised 280 project management success factors and 245 project success factors from the list of 12 generic success factor categories. These were grouped and scored separately. Figure 14 shows the comparison between the generic success factor categories. The total scores per category were converted to percentages of either the overall total score for project management success factors, or of project success factors.

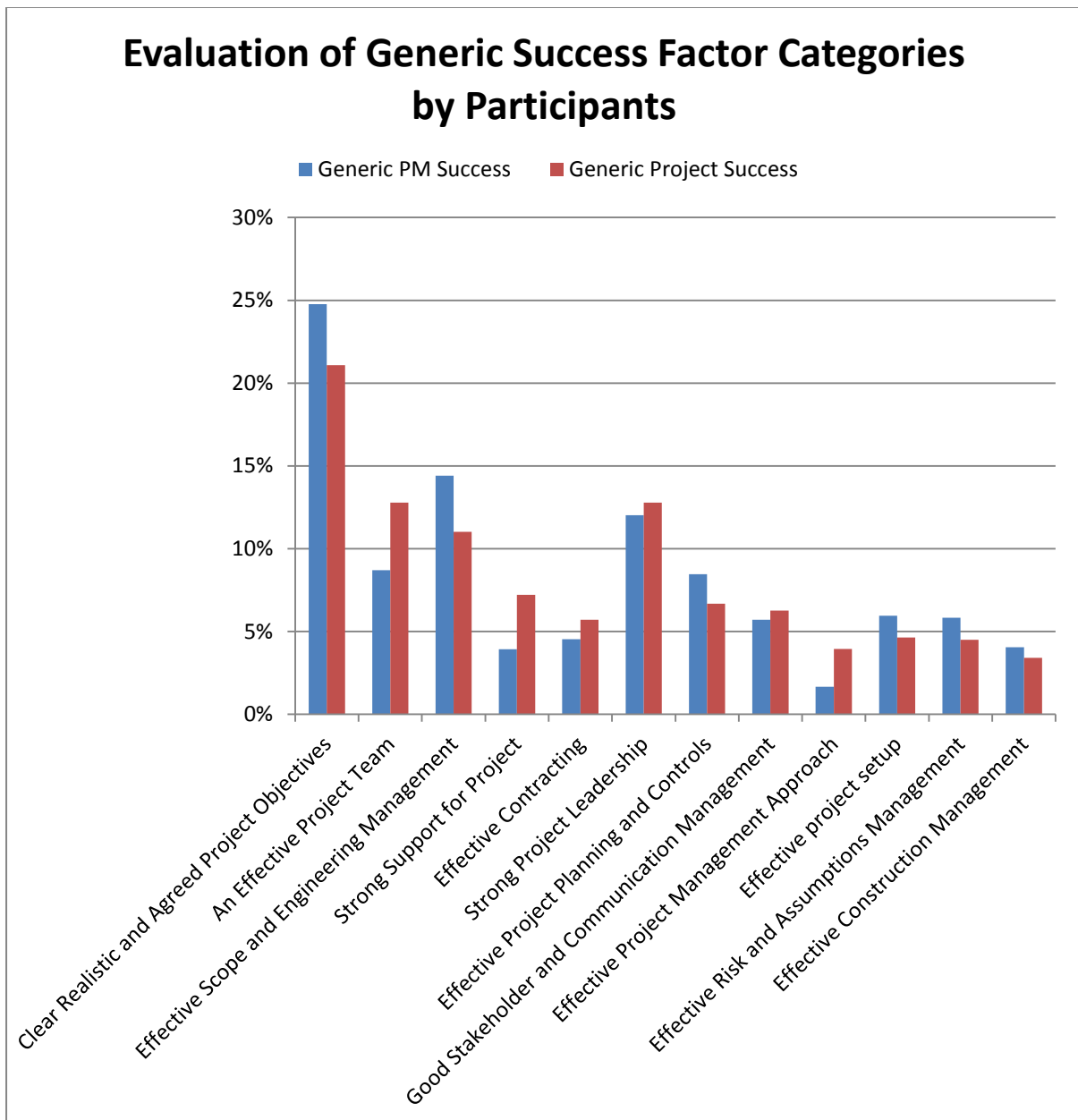
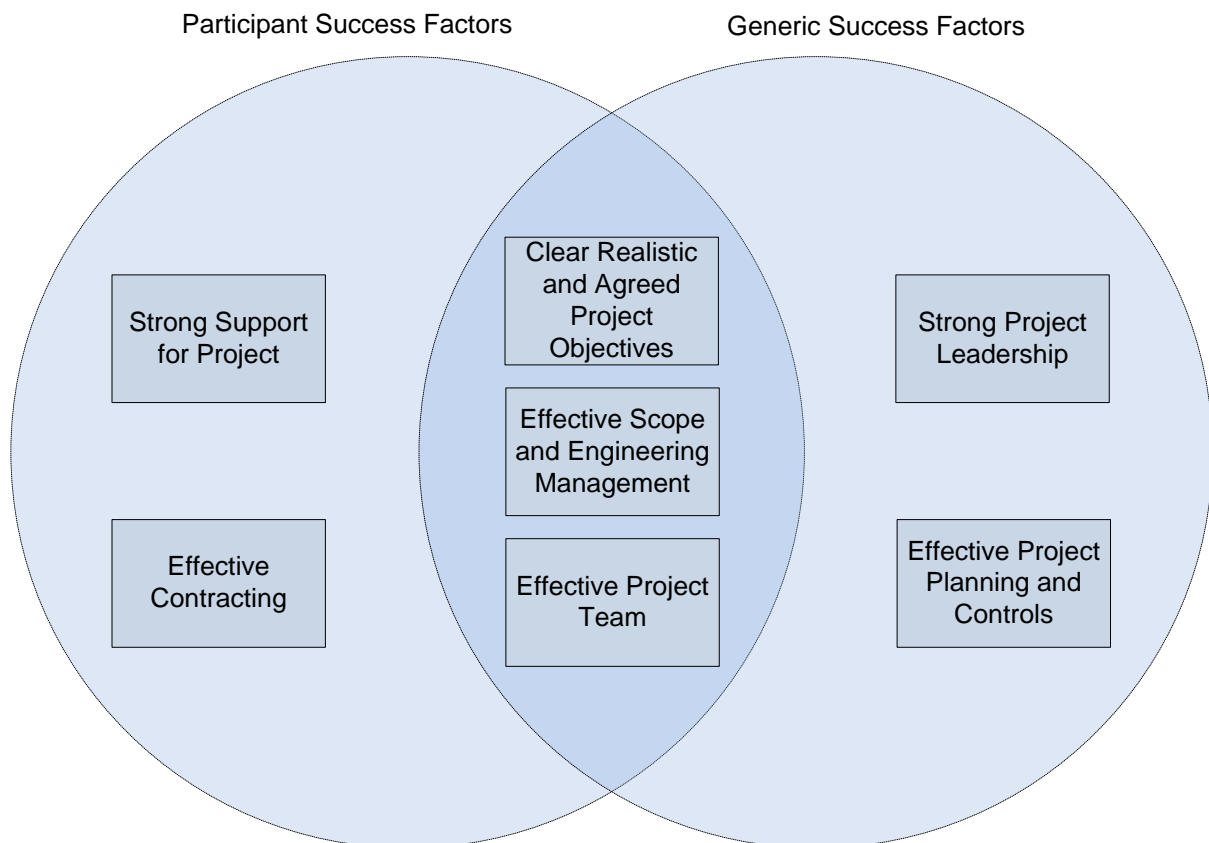


Figure 14: Participant evaluation of generic success factor categories

Based on this analysis, the five most important success factors are:

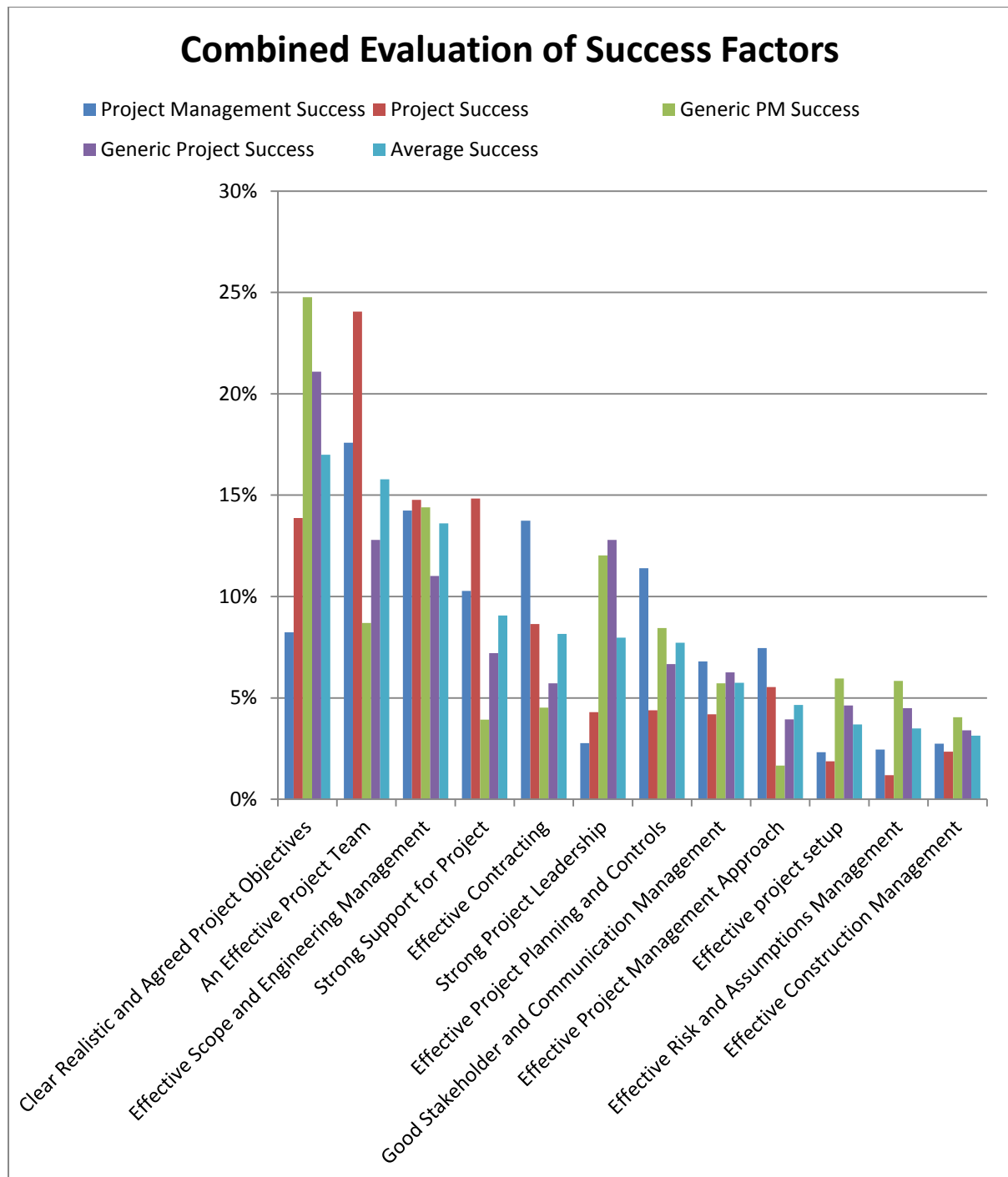
1. Clear Realistic and Agreed Project Objectives
2. Effective Scope and Engineering Management
3. Strong Project Leadership
4. An Effective Project Team
5. Effective Project Planning and Controls

Of the five most important participant success factor categories, three overlap with the five most important generic success factor categories. The three common success factor categories are clear realistic and agreed project objectives, effective scope and engineering management and an effective project team. The seven most important success factor categories are illustrated in Figure 15.



**Figure 15: Seven most important success factors**

Combining the results from the participant success factor categories and the evaluation of generic success factor categories by participants, the average importance of each generic success factor was calculated. Figure 16 shows the 12 generic success factor categories arranged according to the average importance. See Table G-3 in Appendix G for details.



**Figure 16: Combined project success factor evaluation**



When there is strong support for a project from the client and senior management, the probability is high that they will assign a suitably strong project management team. Strong project leadership will determine the effectiveness of the project management team. One participant stated that a lack of strong project leadership cripples a project team.

An effective project team is required to ensure the effectiveness of project planning and controls, contracting and scope and engineering management. An effective project team will also ensure that project objectives are clearly stated and agreed upon by the client and other stakeholders. This was also noted by Gemuenden and Lechler (1997) as discussed in section 2.6.

An effective engineering team evaluates the project objectives and ensures that the objectives are translated into specific technical specifications and also that these specifications and objectives are realistic. Feedback is provided to the client on the specific technical specifications and whether these are technically obtainable. This forms a reinforcing loop (R2), thus when technical objectives are clearer, it is easier to evaluate and agree on them from a technical perspective. Note that this may require updating the project objectives.

Similarly, an effective planning and controls team evaluates the project time and cost objectives, when considering the technical specifications and scope from the engineering team. Feedback is provided in terms of the achievability of the cost and schedule targets. This forms a reinforcing loop (R3), thus when cost and schedule objectives are clearer, it is easier to evaluate and agree on them. This may require updating of the project cost and schedule objectives to make them realistic.

Participants noted that should project objectives be agreed upon blindly by the project team without verifying their achievability, it is setting the project up for failure.

Effective contracting requires a properly defined scope as well as carefully controlled cost and schedule. Effective scope and engineering management is required to evaluate potential scope changes on the project and accept or reject them. Effective project cost and schedule control is required to track progress and deal with any accepted changes.

When scope management is done effectively, proposed changes are presented to the client for approval prior to implementation. This sensitises the client, the client's personnel and the

engineering team to not accept scope changes without due consideration of the merits. This should reduce unnecessary scope changes. This forms a reinforcing loop (R4).

## **4.5 Conclusion**

In this chapter the 131 success factors from literature were analysed using quantitative content analysis and coded into 11 success factor categories. When performing the same analysis on interview data, a 12<sup>th</sup> success factor category was added.

A total of 261 regional and industry challenges were identified from interview and survey data. Using quantitative content analysis, these challenges were coded into 30 challenge categories. The challenge categories were prioritised according to frequency and the number of participants who identified challenges in each category. The categories were further analysed and consolidated to five general challenge categories.

The 1,471 success factors identified by survey participants were also analysed using qualitative content analysis. These were coded into the 12 generic success factor categories and ranked in terms of relative importance. The 12 generic success factor categories were sufficiently comprehensive to absorb all success factors named by participants and did not require further updating.

As a separate evaluation, participants also ranked the 12 generic success factor categories which resulted in a similar ranked list. Causal relationships between the success factor categories were also analysed, consolidated and presented in a causal loop diagram.

The next chapter will discuss the analysis results and present the findings.

## 5. Discussion and Findings

### 5.1 Introduction

In the previous chapter, success factors as well as regional and industry challenges were analysed. This chapter will compare the analysis results and present the findings for this study.

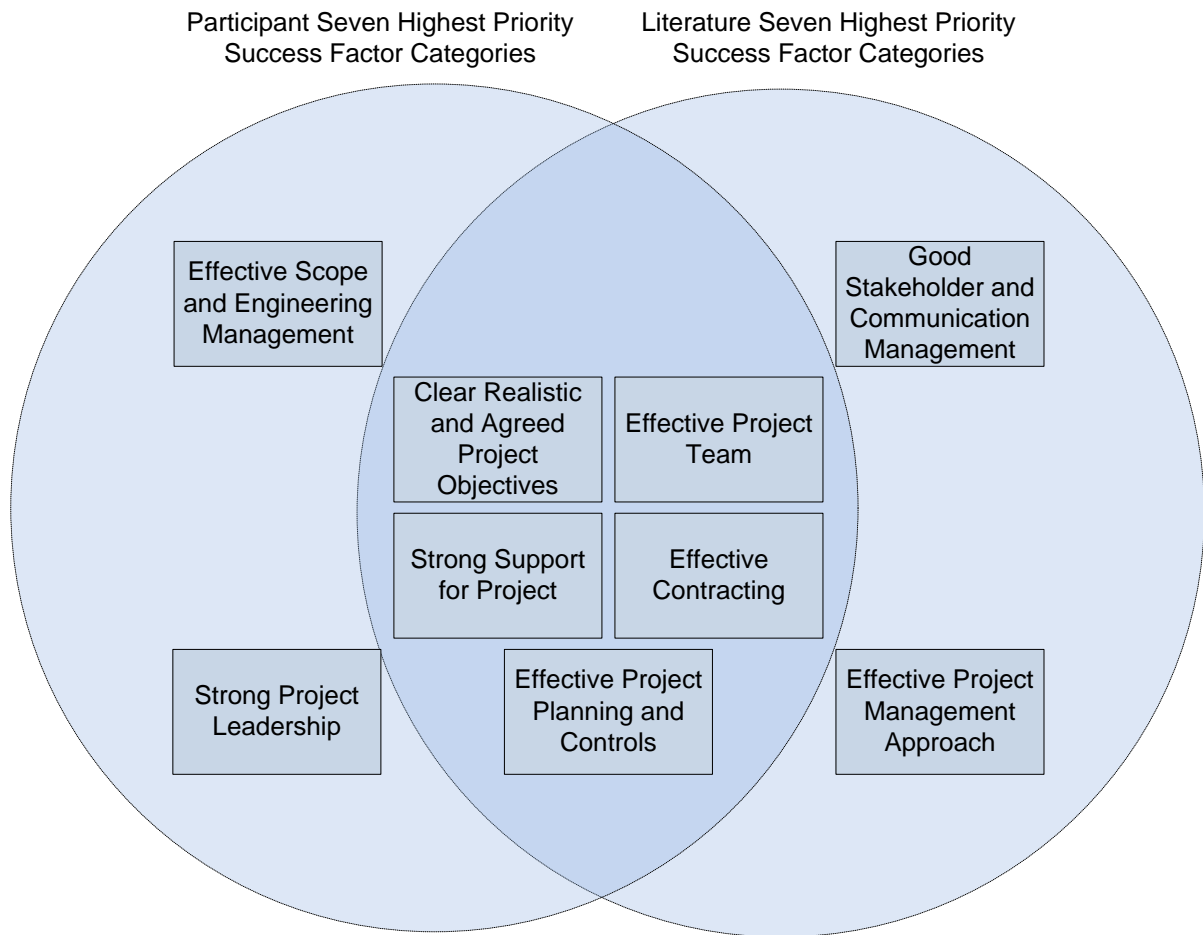
### 5.2 Comparison of Empirically Derived Success Factor Categories to those from Literature

Table 9 demonstrates the differences in ranking between success factors ranked by participants and success factors from the analysis of literature, with a ranking of one being the most important and 12 the least important. Note that effective construction management was not a resulting success factor category from the literature review analysis. Clear project scope was updated to effective scope and engineering management after the preliminary interviews with participants.

**Table 9: Comparison of success factor categories from empirical research and literature**

Generic Success Factor Categories	Ranking of Success Factor Categories by Participants based on Average Importance	Ranking of Success Factor Categories from Literature
Clear Realistic and Agreed Project Objectives	1	4
An Effective Project Team	2	3
Effective Scope and Engineering Management	3	8
Strong Support for Project	4	6
Effective Contracting	5	7
Strong Project Leadership	6	9
Effective Project Planning and Controls	7	1
Good Stakeholder and Communication Management	8	2
Effective Project Management Approach	9	5
Effective project setup	10	11
Effective Risk and Assumptions Management	11	10
Effective Construction Management	12	N.a.

There are significant differences in the ranking, however, when considering the seven highest priority success factor categories of each (indicated in orange), there are five factors in common as illustrated in Figure 18. From this it can be deduced that participants deem effective scope and engineering management and strong project leadership to play a more important role in the South African petrochemical industry than for projects globally. This is related to the challenges noted in section 4.4.1.



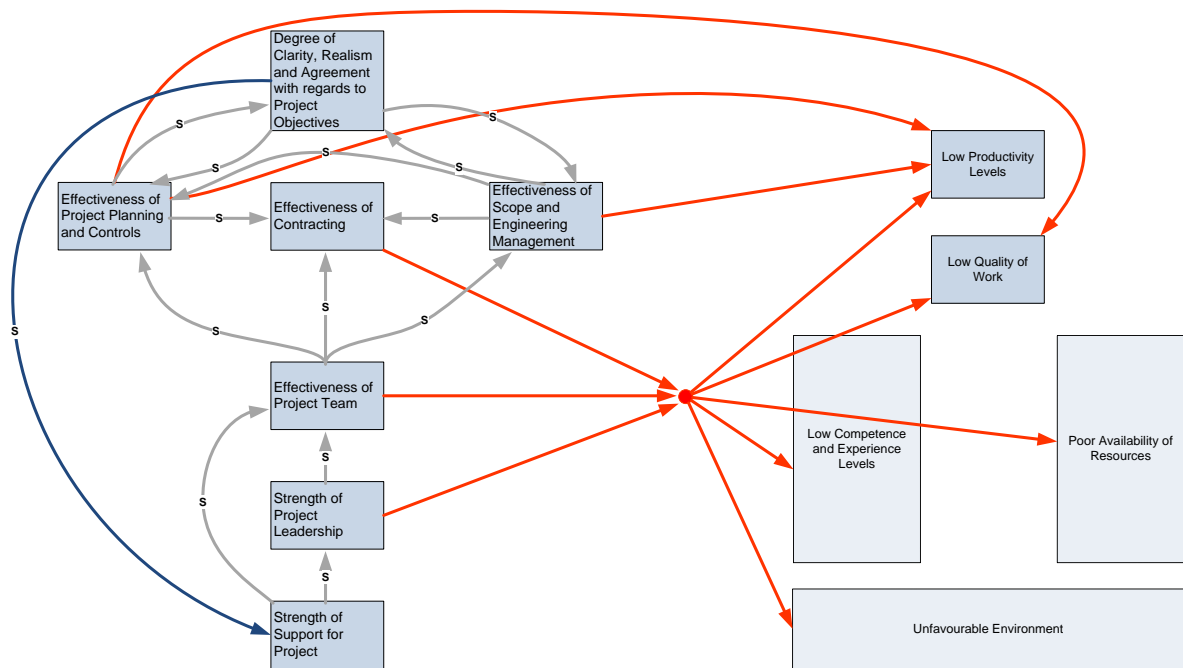
**Figure 18: Comparison of top seven success factors from participants and literature**

From Figure 18, when comparing the success factor categories from literature and for those ranked by participants in this study, there is strong support that it is essential to manage at least the following well:

- Ensuring that there are clear realistic and agreed project objectives
- Ensuring an effective project team
- Obtaining strong support for the project
- Ensuring effective contracting
- Ensuring effective project controls

### 5.3 Evaluation of Relationships between Success Factors and Regional Industry Challenges

The relationships between regional and industry challenges and some success factors were discussed during interviews with four senior participants. When comparing the five general challenges for projects in the South African petrochemical industry to the seven highest priority success factor categories as identified by participants, some clear relationships exist. These are indicated in Figure 19.



**Figure 19: Seven highest priority success factor categories compared to challenges**

An effective project team, strong project leadership and effective contracting can reduce the impact of all five general challenges. Participants recommended that this be done as follows:

- By making sufficient risk allowances in terms of cost and schedule
- Contracting well in advance for critical construction work to allow time for evaluation of labour competencies and training or re-contracting where required.
- Engineering and project management resources, as well as engineering contractors should also be sourced globally where the local available competent resources fall short. This is a time-consuming and expensive process and should be allowed for in terms of cost and schedule planning.
- An effective project team should be closely involved in project management, engineering and construction deliverables to ensure good quality.

- An effective project team can improve productivity by proactively facilitating the removal of obstacles to progress such as obtaining information, permits and resolving complex technical issues.
- It should be noted that strong support for the project directly drives two of these three success factors and indirectly drives the other. It can thus be considered equally, or even more important.

Effective scope and engineering management can improve especially construction productivity by ensuring that designs are correct and final before construction starts to avoid rework and field modifications.

Effective project planning and controls (including quality control) provides valuable intelligence to the project team in terms of progress and provides a warning when the contractors or the project team itself are not working the plan. This enables the senior team members to intervene as soon as the deviation occurs to attempt to improve the situation.

## **5.4 Prioritisation of Success Factors**

Considering Figure 19, the following is noted:

- The drivers for the system are strong support for the project, strong project leadership and an effective project team. Without having these in place, the whole system will deteriorate, which means project failure.
- Clear realistic and agreed project objectives has a strong feedback loop to strong support for the project as discussed in section 4.4.4.
- An effective project team must ensure effective scope and engineering management, as well as effective project planning and controls.
- Effective contracting is the main system outcome. It has little value to attempt to manage this directly since it requires all the other seven highest priority success factors to be managed well. It would be better to manage the other six success factors first.

Based on the above, the recommended priority of managing the success factors is:

1. Obtaining strong support for the project
2. Ensuring strong project leadership
3. Ensuring an effective project team

4. Ensuring that there are clear realistic and agreed project objectives
5. Ensuring effective scope and engineering management
6. Ensuring effective project planning and controls
7. Ensuring effective contracting

## **5.5 Conclusion**

In this chapter the analysis results were further considered to determine the priority in which the success factor categories must be managed. Considering the interrelationships between the different success factor categories, it was found that obtaining strong support for the project was the most important success factor. Second is ensuring strong project leadership, third ensuring an effective project team and forth ensuring that there are clear realistic and agreed project objectives. The next chapter will summarise the recommendations.

## **6. Recommendations and Conclusions**

### **6.1 Introduction**

In the previous chapter the results of the analysis were further considered to determine the priority in which the success factors must be managed. This chapter will summarise the findings of this study and also make recommendations for future research.

### **6.2 Recommendations**

The research question as stated in section 1.2 is:

What are the most critical factors that project managers need to manage effectively in the South African petrochemical industry to improve project success?

The answer to this question is that the following seven factors, listed in order of importance, need to be managed effectively in the South African petrochemical industry to improve project success:

1. Obtain strong support for the project
2. Ensure strong project leadership
3. Ensure an effective project team
4. Ensure that there are clear realistic and agreed project objectives
5. Ensure effective scope and engineering management
6. Ensure effective project planning and controls
7. Ensure effective contracting

In section 4.4.2 the details of some success factor groups, as stated by participants, were discussed. The most significant participant success factors will again be listed to provide specific details on what must be managed under each success factor group. This is shown in Table 10.

**Table 10: Recommended success factor priority and details**

<p><b>1. Obtain strong support for the project</b></p> <ul style="list-style-type: none"> <li>• Ensure strong support and involvement from the client (and project sponsor), operations and maintenance personnel, client representatives and senior project management company personnel.</li> <li>• Ensure a strong and competent client team is assigned to the project.</li> <li>• Maintain continuity of key project and client project resources</li> <li>• Obtain support for making decisions quickly.</li> <li>• Obtain client support for managing powerful stakeholders.</li> <li>• Ensure that sufficient authority is delegated to the project manager.</li> </ul>
<p><b>2. Ensure strong project leadership</b></p> <ul style="list-style-type: none"> <li>• Ensure the project is led by an experienced and competent project manager.</li> <li>• Ensure that the project and engineering manager have the required attributes.</li> <li>• Ensure that project leader provides clear direction and makes good decisions.</li> <li>• Ensure that the project manager is given the required authority.</li> </ul>
<p><b>3. Ensure an effective project team</b></p> <ul style="list-style-type: none"> <li>• Ensure the right team is selected for the project in terms of competence and experience.</li> <li>• Ensure a dedicated project manager and key project resources which are not shared with other projects.</li> <li>• Ensure that the team is well integrated with resources from the client.</li> <li>• Value virtues such as dedication, commitment, teamwork, persistence, focus and innovation when selecting the team.</li> <li>• Ensure that the team is well-aligned.</li> <li>• Ensure a low turnover of project team members</li> <li>• Maintain good relationships with contractors</li> </ul>
<p><b>4. Ensure that there are clear realistic and agreed project objectives</b></p> <ul style="list-style-type: none"> <li>• Ensure clear market objectives and business targets for the project in terms of size and performance.</li> <li>• Ensure that there is a sound business case for doing the project.</li> <li>• The project team should make an effort to understand the client's requirements and priorities.</li> <li>• Agree with the client on the specifications which will be utilised for the project when starting.</li> <li>• Ensure that the objectives are realistic (practically achievable), quantified, understood and agreed upon by all stakeholders.</li> </ul>
<p><b>5. Ensure effective scope and engineering management</b></p> <ul style="list-style-type: none"> <li>• Ensure proper scope definition.</li> <li>• Avoid scope changes.</li> <li>• Manage scope changes diligently should it be absolutely necessary.</li> <li>• Ensure that engineering is done with a high quality focus.</li> <li>• Ensure that the engineering team conducts regular site visits.</li> <li>• Use only mature technologies in designs.</li> <li>• Select greenfields sites over brownfields sites where possible.</li> </ul>

#### **6. Ensure effective project planning and controls**

- Ensure that good project controls (cost and schedule) are in place on the project and that it is done on an ongoing basis.
- Provide project control feedback to the team.
- Closely monitor cost and schedule on all contracts.
- Ensure that detailed planning is done.
- Ensure that planning is based on a well-defined scope.
- Ensure good quality assurance and control is done to be able to identify deviations early.

#### **7. Ensure effective project planning and controls**

- Select the best and not necessarily the cheapest contractor.
- Consider using competent and experienced international contractors.
- Select the optimal contract type.
- Secure well experienced contractor resources for the project.
- Integrate the contractor team with the project team.
- Maintaining good relationships with contractors.

### **6.3 Transferability of Findings**

As stated in section 3.10.3, some of the findings may also be applicable and beneficial to other industries in South Africa, such as the construction industry. Similarly, some findings may also be beneficial to petrochemical projects in other regions, especially in other developing economies, due to similarities with South Africa.

Results from this study will be shared with those contributing to it in the hope that it will benefit projects in which they are involved and to reward them for their knowledge contribution.

### **6.4 Future Research**

The findings of this study have potential benefits to other regions and industries. It may be an appropriate starting point for future research. This study may be of specific value to future research on project success factors for petrochemical projects in other developing economies. Such economies would include countries such as Brazil, India, Iran or Nigeria, which have active petrochemical industries.

The challenges identified in this study can also serve as a good starting point for future research on success factors for other industries within South Africa, since it is expected that many of them will be applicable to these industries as well.

## 6.5 Conclusion

The first objective of this study, which was to understand the current challenges which projects in the South African petrochemical industry face, was achieved successfully. Challenges were identified and analysed based on empirical data provided by interview and survey participants. The industry is faced with an unfavourable environment, low competence and experience levels, poor availability of project resources, low quality of work and low productivity. These challenges are a hindrance to project success.

The second objective was to better understand the factors which need to be managed to improve project success in the South African petrochemical industry. Participants identified and ranked various project and project management success factors. Data on project success factors was also gathered from literature. Using qualitative content analysis, success factor categories were identified and prioritised.

In conclusion, based on previous research and the perceptions of project professionals with relevant experience, the most critical success factors to manage for projects in the South African petrochemical industry are obtaining strong support for the project; ensuring strong project leadership; an effective project team; that there are clear realistic and agreed project objectives; effective scope and engineering management; effective project planning and controls; and effective contracting.

Playing one's own part well may have sufficed in the past, but it is the teamwork and partnering that bring project success in the years ahead (Chan et al., 2001, p. 99).

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## **Appendix A – Literature Review**

**Table A-1 – Identified success factors and sources**

No	Success Factor	Source	Cited in Source
1	Realistic and thorough definition of project - What	De Wit (1988)	Hayfield (1979)
2	Efficient manner of project execution - How	De Wit (1988)	Hayfield (1979)
3	Comprehension of project 'environment' - Context	De Wit (1988)	Hayfield (1979)
4	Selection of organisation realising project - By whom	De Wit (1988)	Hayfield (1979)
5	Formulation of sound project policies - Policies	De Wit (1988)	Hayfield (1979)
6	Clear and simple project organisation - Framework	De Wit (1988)	Hayfield (1979)
7	Selection of key personnel - Human Resources	De Wit (1988)	Hayfield (1979)
8	Efficient and dynamic management controls - Controls	De Wit (1988)	Hayfield (1979)
9	Reliable management information systems - Information	De Wit (1988)	Hayfield (1979)
10	Planning effort (for construction)	De Wit (1988)	Ashley (1986)
11	Planning effort (for design)	De Wit (1988)	Ashley (1986)
12	Project manager goal commitment	De Wit (1988)	Ashley (1986)
13	Project team motivation	De Wit (1988)	Ashley (1986)
14	Project manager technical capabilities	De Wit (1988)	Ashley (1986)
15	Scope and work definition	De Wit (1988)	Ashley (1986)
16	Control systems	De Wit (1988)	Ashley (1986)
17	Project definition	De Wit (1988)	Morris and Hough (1986)
18	Planning and design	De Wit (1988)	Morris and Hough (1986)
19	Politics	De Wit (1988)	Morris and Hough (1986)
20	Schedule duration	De Wit (1988)	Morris and Hough (1986)
21	Schedule urgency	De Wit (1988)	Morris and Hough (1986)
22	Finance	De Wit (1988)	Morris and Hough (1986)
23	Legal agreements	De Wit (1988)	Morris and Hough (1986)
24	Contracting	De Wit (1988)	Morris and Hough (1986)
25	Project management	De Wit (1988)	Morris and Hough (1986)
26	Human factors	De Wit (1988)	Morris and Hough (1986)
27	Favourable environment	De Wit (1988)	Sapolsky (1972)
28	Winning skill in bureaucratic politics through four strategies: differentiations, co-operation, moderation, managerial innovation	De Wit (1988)	Sapolsky (1972)
29	Ability to manage technological development	De Wit (1988)	Sapolsky (1972)
30	Rich project communications	Andersen et al. (2006)	
31	Stakeholder endorsement of project plans	Andersen et al. (2006)	
32	Well-structured and formal project approach	Andersen et al. (2006)	
33	Strong project commitment from all stakeholders and participants	Andersen et al. (2006)	
34	Early stakeholder influence	Andersen et al. (2006)	
35	Well understood and accepted project purpose	Andersen et al. (2006)	

No	Success Factor	Source	Cited in Source
36	Clear project constraints	Andersen et al. (2006)	
37	Project execution flexibility	Andersen et al. (2006)	
38	Influence over on-going project processes	Andersen et al. (2006)	
39	Project mission - Initial clearly defined goals and general directions	Chan et al. (1999)	Pinto and Slevin (1987)
40	Top management support - Willingness of top management to provide the necessary resources and authority/power for project success.	Chan et al. (1999)	Pinto and Slevin (1987)
41	Project schedule/plans - Detailed specification of the individual actions steps for project implementation.	Chan et al. (1999)	Pinto and Slevin (1987)
42	Client consultation - Communication, consultation, and active listening to all impacted parties.	Chan et al. (1999)	Pinto and Slevin (1987)
43	Personnel - Recruitment, selection and training of the necessary personnel for the project team.	Chan et al. (1999)	Pinto and Slevin (1987)
44	Technical tasks - Availability of the required technology and expertise to accomplish the specific technical action steps.	Chan et al. (1999)	Pinto and Slevin (1987)
45	Client acceptance - The act of "selling" the final project to its ultimate intended users.	Chan et al. (1999)	Pinto and Slevin (1987)
46	Monitoring and feedback - Timely provision of comprehensive control information at each stage in the implementation process.	Chan et al. (1999)	Pinto and Slevin (1987)
47	Communication - The provision of an appropriate network and necessary data to all key actors in the project implementation.	Chan et al. (1999)	Pinto and Slevin (1987)
48	Trouble shooting - Ability to handle unexpected crises and deviations from plan.	Chan et al. (1999)	Pinto and Slevin (1987)
49	Sufficiency of information	Chan et al. (1999)	Mohsini and Davidson (1992)
50	Time required to procure further information	Chan et al. (1999)	Mohsini and Davidson (1992)
51	Tasks' dependence upon others	Chan et al. (1999)	Mohsini and Davidson (1992)
52	Communication among project participants	Chan et al. (1999)	Mohsini and Davidson (1992)
53	Well defined scope	Chan et al. (1999)	Songer and Molenaar (1997)
54	Shared understanding of scope	Chan et al. (1999)	Songer and Molenaar (1997)
55	Owner construction sophistication	Chan et al. (1999)	Songer and Molenaar (1997)
56	Adequate owner staffing	Chan et al. (1999)	Songer and Molenaar (1997)
57	Established budget	Chan et al. (1999)	Songer and Molenaar (1997)
58	Quality of client brief	Chan et al. (1999)	Mo and Ng (1997)
59	Client experience	Chan et al. (1999)	Mo and Ng (1997)
60	Contractor experience	Chan et al. (1999)	Mo and Ng (1997)
61	Good working relationship	Chan et al. (1999)	Mo and Ng (1997)
62	Proper channel of communication	Chan et al. (1999)	Mo and Ng (1997)
63	End-users' input to project	Chan et al. (1999)	Deakin (1999)
64	Clear details of client's requirements stated at the outset	Chan et al. (1999)	Tam (1997)

No	Success Factor	Source	Cited in Source
65	Comprehensive pretender site investigation	Chan et al. (1999)	Leung (1999), Pearson and Skues (1999)
66	Clear understanding of project scope by client	Chan et al. (1999)	Ashley et al. (1987), Pinto and Slevin (1987), Songer and Molenaar (1997)
67	Prequalify potential tenderers	Chan et al. (1999)	
68	Assess contractors' proposals thoroughly.	Chan et al. (1999)	
69	Develop a clear client's brief	Chan et al. (1999)	Deakin (1999), Leung (1999), Pearson and Skues (1999)
70	Install effective monitoring and approval mechanisms for design changes	Chan et al. (1999)	Ashley et al. (1987), Deakin (1999), Pearson and Skues (1999)
71	Limit the change of client's requirements during construction	Chan et al. (1999)	
72	Design consultants should understand the construction process and develop a cost-effective design on time.	Chan et al. (1999)	Cheng (1995)
73	Mutual trust and respect between client and contractor	Chan et al. (1999)	Kok (1995), Ho (1996)
74	All project participants should share a clear understanding of financial and technical performance required	Chan et al. (1999)	Songer and Molenaar (1997)
75	Install adequate communication channel	Chan et al. (1999)	Mohsini and Davidson (1992), Kok (1995), Mo and Ng (1997)
76	Achieve a high degree of cooperation	Chan et al. (1999)	Cheng (1995)
77	Sharing common project goals	Chan et al. (1999)	Ashley et al. (1987)
78	Ability to resolve conflicts quickly	Chan et al. (1999)	
79	Project participants' understanding and acceptance of their roles, duties, risk and legal liability	Chan et al. (1999)	
80	Project team commitment	Chan et al. (1999)	
81	Client's competencies	Chan et al. (1999)	
82	Contractor competencies	Chan et al. (1999)	
83	Degree of top management support	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
84	The right project leader	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
85	The right project team	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
86	Degree of participation (involvement of team in decisions)	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
87	Effectiveness of planning and controlling	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
88	Effectiveness of communication	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
89	Degree of absence of conflict	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
90	Fixed project goals	Gemuenden and Lechler (1997)	Gemuenden and Lechler (1997)
91	Involvement of Stakeholders	Garbharran et al. (2012)	Nguyen et al. (2004)
92	Management of Stakeholder Needs	Garbharran et al. (2012)	Swan and Khalfan (2007)
93	Competent Project Manager	Garbharran et al. (2012)	Nguyen et al. (2004)

No	Success Factor	Source	Cited in Source
94	Availability of resources - People, funding, tools	Garbharran et al. (2012)	Newton (2005)
95	Comprehensive contract documentation	Garbharran et al. (2012)	Nguyen et al. (2004)
96	Adequate funding throughout the project.	Garbharran et al. (2012)	Johnson et al. (2006)
97	Utilisation of up-to-date technology	Garbharran et al. (2012)	Nguyen et al. (2004)
98	Proper emphasis on past experience	Garbharran et al. (2012)	Nguyen et al. (2004)
99	Competent teams	Garbharran et al. (2012)	Nguyen et al. (2004)
100	Awarding bids to the right project manager / contractor	Garbharran et al. (2012)	Nguyen et al. (2004)
101	Top management commitment to project	Garbharran et al. (2012)	Nguyen et al. (2004)
102	Clear objectives and scope	Garbharran et al. (2012)	Nguyen et al. (2004)
103	Political support	Garbharran et al. (2012)	Nguyen et al. (2004)
104	Flexibility and adaptability	Garbharran et al. (2012)	Nguyen et al. (2004)
105	Shared project vision	Garbharran et al. (2012)	Nguyen et al. (2004)
106	Constant update on project progress	Garbharran et al. (2012)	Nguyen et al. (2004)
107	Detailed communication plan	Garbharran et al. (2012)	Newton (2005)
108	Local direct involvement - Involvement of local community in project	Garbharran et al. (2012)	Nguyen et al. (2004)
109	Development of proper handover procedures	Garbharran et al. (2012)	Nguyen et al. (2004)
110	Adequacy of company-wide education on the concepts of risk management.	Cooke-Davies (2002)	
111	Maturity of an organisation's processes for assigning ownership of risks.	Cooke-Davies (2002)	
112	Adequacy with which a visible risk register is maintained.	Cooke-Davies (2002)	
113	Adequacy of an up-to-date risk management plan	Cooke-Davies (2002)	
114	Adequacy of documentation of organisational responsibilities on the project	Cooke-Davies (2002)	
115	Keep project (or project stage duration) as far below 3 years as possible (1 year is better).	Cooke-Davies (2002)	
116	Allow changes to scope only through a mature scope change control process.	Cooke-Davies (2002)	
117	Maintain the integrity of the performance measurement baseline.	Cooke-Davies (2002)	
118	The existence of an effective benefits delivery and management process that involves the mutual co-operation of project management and line management functions.	Cooke-Davies (2002)	
119	Portfolio- and programme management practices that allow the enterprise to resource fully a suite of projects that are thoughtfully and dynamically matched to the corporate strategy and business objectives.	Cooke-Davies (2002)	

No	Success Factor	Source	Cited in Source
120	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.	Cooke-Davies (2002)	
121	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.	Cooke-Davies (2002)	
122	A clear mission/vision and agreed goals with agreed success criteria and clear understanding of desired and expected values driving the project culture.	Steinfort and Walker (2007)	
123	Key stakeholder/key resource understanding of the goals/objectives with a clear and agreed statement of outcomes defined.	Steinfort and Walker (2007)	
124	Project plan and programme/method of work being resolved and agreed by all key parties, including provision of adequate reserves and contingencies.	Steinfort and Walker (2007)	
125	The feasibility of that plan (in terms of resources, contingencies, risks and outcomes) being resolved and signed off by all key players.	Steinfort and Walker (2007)	
126	Adequate resources being committed for the project based upon detail derived from an achievable project plan.	Steinfort and Walker (2007)	
127	Clearly stated and understood PM capacity, experience and staff/senior manager's support including project governance, dispute resolution procedures to engender trust behaviours.	Steinfort and Walker (2007)	
128	Adequate communication and project tools.	Steinfort and Walker (2007)	
129	Project competencies and PM skills, adequate and agreed organisation structure.	Steinfort and Walker (2007)	
130	Integrity, effective communication, commitment, support, team approach, mentoring, and learning	Steinfort and Walker (2007)	
131	External Influences such as political or cultural awareness and capability.	Steinfort and Walker (2007)	

**Table A-2: Success factors from literature coded into 33 success factor categories**

A-01	Clear and Realistic Project Objectives	A-02	Effective Project Controls	A-03	Proper Planning	A-04	The Right Team
The project objectives are clear, realistic, documented and agreed between all project participants.		Effective continuous monitoring and control of own and contractor costs and schedules.		Development and management of project schedules, taking into account all activities, their interdependencies, required resources and schedule risks.		Having an appropriately staffed, competent and well functioning project team.	
1. 17. 35. 39. 58. 64. 69. 74. 77. 90. 102. 105. 122. 123.	Realistic and thorough definition of project - What <a href="#">Project definition</a> Well understood and accepted project purpose <a href="#">Project mission</a> <a href="#">Quality of client brief</a> Clear details of client's requirements stated at the outset <a href="#">Develop a clear client's brief</a> All project participants should share a clear understanding of financial and technical performance required <a href="#">Sharing common project goals</a> Fixed project goals Clear objectives Shared project vision <a href="#">A clear mission/vision and agreed goals with agreed success criteria and clear understanding of desired and expected values driving the project culture.</a> Key stakeholder/key resource understanding of the goals/objectives with a clear and agreed statement of outcomes defined.	8. 16. 38. 46. 106. 87. 117. 120.	<a href="#">Efficient and dynamic management controls - Controls</a> <a href="#">Control systems</a> <a href="#">Influence over on-going project processes</a> <a href="#">Monitoring and feedback</a> <a href="#">Constant update on project progress</a> Effectiveness of controlling Maintain the integrity of the performance measurement baseline. 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.	20. 21. 41. 10. 11. 18. 87. 109. 115. 124. 125.	Schedule duration Schedule urgency Project schedule/plans Planning effort (for construction) Planning effort (for design) <a href="#">Planning and design</a> <a href="#">Effectiveness of planning - Schedule</a> Development of proper handover procedures <a href="#">Keep project (or project stage duration) as far below 3 years as possible (1 year is better).</a> Project plan and programme/method of work being resolved and agreed by all key parties, including provision of adequate reserves and contingencies. The feasibility of that plan (in terms of resources, contingencies, risks and outcomes) being resolved and signed off by all key players.	6. 7. 43. 44. 85. 99. 126. 129.	Clear and simple project organisation - Framework Selection of key personnel - Human Resources <a href="#">Personnel</a> Technical tasks - Expertise The right project team <a href="#">Competent teams</a> Adequate resources being committed for the project based upon detail derived from an achievable project plan. Project competencies and PM skills, adequate and agreed organisation structure.
A-05	Effective Contractor Selection	A-06	Effective Stakeholder Management	A-07	Rich Communication	A-08	Healthy Relationships
Selecting adequately resourced, skilled and experienced contractors to execute project.		Identification of stakeholders, development of management strategies for each and following the strategies.		Regular, effective communication with project team, the client, contractors and other stakeholders, according to a guided by a detailed communication plan.		Good working relationships, a high degree of cooperation, effective conflict management, trust and respect within the project team, with contractors, with the client and other stakeholders.	
4. 60. 72. 82. 67. 68. 100.	<a href="#">Selection of organisation realising project - By whom</a> <a href="#">Contractor experience</a> Design consultants should understand the construction process and develop a cost-effective design on time. Contractor competencies Prequalify potential tenderers Assess contractors' proposals thoroughly. Awarding bids to the right project manager / contractor	31. 34. 63. 91. 92. 108.	Stakeholder endorsement of project plans Early stakeholder influence End-users' input to project Involvement of Stakeholders Management of Stakeholder Needs Local direct involvement	30. 47. 52. 62. 75. 88. 107.	Rich project communications <a href="#">Communication</a> <a href="#">Communication among project participants</a> Proper channel of communication <a href="#">Install adequate communication channel</a> Effectiveness of communication Detailed communication plan	61. 73. 76. 78. 89. 26. 130.	Good working relationship Mutual trust and respect between client and contractor Achieve a high degree of cooperation Ability to resolve conflicts quickly Degree of absence of conflict Human factors Integrity, effective communication, commitment, support, team approach, mentoring, and learning.
A-09	Clear Understanding of Project Environment and Context	A-10	Effective Management of Politics	A-11	Clear Project Scope	A-12	Strong Project Leadership
When formulating the project objectives, compiling the project scope and while executing the project, all project participants should understand the project's external environment and the project context.		Having project leadership who can effectively function in the possibly highly political environment, who can shield the project team and project outcome from political fallout.		Translation of the project objectives to a clear, well defined project scope which is documented and agreed with the client and all relevant stakeholders.		Having a formally appointed project manager (and other managers) who is competent and who effectively leads and manages the project team to successfully complete the project.	
3. 27. 131. 119.	Comprehension of project 'environment' - Context Favourable environment External Influences such as political or cultural awareness and capability. Portfolio- and programme management practices that allow the enterprise to resource fully a suite of projects that are thoughtfully and dynamically matched to the corporate strategy and business objectives.	5. 19. 28. 103.	Formulation of sound project policies - Policies Politics Winning skill in bureaucratic politics through four strategies: differentiations, co-operation, moderation, managerial innovation Political support	15. 53. 54. 71. 102. 66.	Scope and work definition <a href="#">Well defined scope</a> Shared understanding of scope Limit the change of client's requirements during construction <a href="#">Clear scope</a> <a href="#">Clear understanding of project scope by client</a>	14. 84. 93. 127.	Project manager technical capabilities The right project leader Competent Project Manager Clearly stated and understood PM capacity, experience and staff/senior manager's support including project governance, dispute resolution procedures to engender trust behaviours.

<b>A-13</b>	<b>Utilising the Right Technology to Execute the Project</b>	<b>A-14</b>	<b>Strong Commitment to Project</b>	<b>A-15</b>	<b>Good Availability of Resources</b>	<b>A-16</b>	<b>Effective Risk Management</b>
Utilising the most effective tools/technology to manage and execute the project.		Highly committed project manager, project team, senior management, client, as well as other project participants.		Good availability of project financing, as well as competent personnel and contractors.		Identifying, documenting, analysing, managing and monitoring of project risks on a regular basis.	
29.	Ability to manage technological development	12.	Project manager goal commitment	22.	Finance	110.	Adequacy of company-wide education on the concepts of risk management.
44.	Technical tasks - Technology	33.	Strong project commitment from all stakeholders and participants	94.	Availability of resources - People, funding, tools	111.	Maturity of an organisation's processes for assigning ownership of risks.
97.	Utilisation of up-to-date technology	80.	Project team commitment	96.	Adequate funding throughout the project.	112.	Adequacy with which a visible risk register is maintained.
		101.	Top management commitment to project	118.	The existence of an effective benefits delivery and management process that involves the mutual co-operation of project management and line management functions.	113.	Adequacy of an up-to-date risk management plan
<b>A-17</b>	<b>Effective Cost Management</b>	<b>A-18</b>	<b>Effective Contracting</b>	<b>A-19</b>	<b>Good Flexibility and Adaptability</b>	<b>A-20</b>	<b>Good Availability of Project Related Information</b>
Development and management of the project budget, taking into account all activities, the project schedule, required resources and risks.		Following effective and thorough contracting practices and developing and maintaining proper contract documentation.		The ability to respond to unforeseen circumstances, as well as developing and implementing mitigation and contingency plans.		Ensuring that all required information is gathered, processed and effectively stored for easy referencing on the project. This relates to external and internal information.	
57.	Established budget	23.	Legal agreements	48.	Trouble shooting	49.	Sufficiency of information
87.	Effectiveness of planning - Cost	24.	Contracting	104.	Flexibility and adaptability	50.	Time required to procure further information
		95.	Comprehensive contract documentation	37.	Project execution flexibility	9.	Reliable management information systems - Information
<b>A-21</b>	<b>Sufficient Client Involvement</b>	<b>A-22</b>	<b>Efficient Project Management Approach</b>	<b>A-23</b>	<b>Sufficient Client Competencies and Experience</b>	<b>A-24</b>	<b>Effective Use of Project Management Systems and Tools</b>
The client is easily accessible and available for consultation on project matters.		A well-structured, formal project management approach which is aligned with best practices.		Client has the required personnel with the relevant competencies and experience to support the project team to implement the project.		The availability and effective use of project management systems and tools, and a good understanding thereof by the project team.	
42.	Client consultation	2.	Efficient manner of project execution - How	59.	Client experience	55.	Owner construction sophistication
45.	Client acceptance	25.	Project management	81.	Client's competencies	128.	Adequate communication and project tools.
		32.	Well-structured and formal project approach	56.	Adequate owner staffing		
<b>A-25</b>	<b>Continuous Learning</b>	<b>A-26</b>	<b>Ability of Project Team to Deal with Project Complexity</b>	<b>A-27</b>	<b>Clear Roles and Responsibilities</b>	<b>A-28</b>	<b>Effective Decision Making</b>
Sharing, documenting and using past experience to make better decisions.		Ability of Project Team to Deal with a large number of interdependent tasks and issues.		Roles and responsibilities of all project participants are documented in detail and agreed.		The ability of the project team and client to make good project decisions without undue delay or regular changed decisions.	
98.	Proper emphasis on past experience	51.	Tasks' dependence upon others	79.	Project participants' understanding and acceptance of their roles, duties, risk and legal liability	86.	Degree of participation (involvement of team in decisions)
121.	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.			114.	Adequacy of documentation of organisational responsibilities on the project		
<b>A-29</b>	<b>Highly Motivated Project Team</b>	<b>A-30</b>	<b>High Degree of Site and As-Is Verification</b>	<b>A-31</b>	<b>Strong Top Management Support</b>	<b>A-32</b>	<b>Effective Change Management</b>
Having a highly motivated project team who drives themselves hard to achieve success.		Ensuring that site related information which can affect the project is verified in the field.		Strong support for the project and project team from top management.		Effective monitoring, documenting and approving of project changes.	
13.	Project team motivation	65.	Comprehensive pretender site investigation	40.	Top management support	70.	Install effective monitoring and approval mechanisms for design changes
				83.	Degree of top management support	116.	Allow changes to scope only through a mature scope change control process.
<b>A-33</b>	<b>Effective Assumptions Management</b>						
Documenting, clarifying, investigating, monitoring and managing all project assumptions.							
36.	Clear project constraints						

Note 1: Success factor 44 has been split into 2 separate success factors, namely expertise and technology. Success factor 87 has been divided into 3 separate success factors, namely effectiveness of controlling, of schedule planning and of cost planning. Success factor 102 has been split in 2 separate success factors, namely clear objectives and clear scope. This increases the 131 success factors to a total of 135 success factors in the table above.

Note 2: Blue text denotes success factors which are duplicate or similar to other success factors in the category. There are a total of 32 duplicate success factors.

Note 3: Black success factors are unique. There a total of 103 unique success factors.

**Table A-3: Comparison of the 33 success factor categories (descending by number of sources)**

No	Success Factor	Definition	Number of Success Factors	Number of Sources
A-02	Effective Project Controls	Effective continuous monitoring and control of own and contractor costs and schedules.	9	7
A-01	Clear and Realistic Project Objectives	The project objectives are clear, realistic, documented and agreed between all project participants.	13	6
A-03	Proper Planning	Development and management of project schedules, taking into account all activities, their interdependencies, required resources and schedule risks.	9	5
A-04	Rich Communication	Regular, effective communication with project team, the client, contractors and other stakeholders, according to a guided by a detailed communication plan.	7	4
A-09	The Right Team	Having an appropriately staffed, competent and well functioning project team.	6	4
A-12	Strong Project Leadership	Having a formally appointed project manager (and other managers) who is competent and who effectively leads and manages the project team to successfully complete the project.	4	4
A-14	Strong Commitment to Project	Highly committed project manager, project team, senior management, client, as well as other project participants.	4	4
A-05	Effective Contractor Selection	Selecting adequately resourced, skilled and experienced contractors to execute project.	7	3
A-06	Effective Stakeholder Management	Identification of stakeholders, development of management strategies for each and following the strategies.	6	3
A-08	Healthy Relationships	Good working relationships, a high degree of cooperation, effective conflict management, trust and respect within the project team, with contractors, with the client and other stakeholders.	6	3
A-11	Clear Project Scope	Translation of the project objectives to a clear, well defined project scope which is documented and agreed with the client and all relevant stakeholders.	6	3
A-07	Effective Use of Project Management Systems and Tools	The availability and effective use of project management systems and tools, and a good understanding thereof by the project team.	5	3
A-13	Utilising the Right Technology to Execute the Project	Utilising the most effective tools/technology to manage and execute the project.	3	3
A-15	Effective Cost Management	Development and management of the project budget, taking into account all activities, the project schedule, required resources and risks.	3	3
A-19	Good Flexibility and Adaptability	The ability to respond to unforeseen circumstances, as well as developing and implementing mitigation and contingency plans.	3	3
A-10	Effective Management of Politics	Having project leadership who can effectively function in the possibly highly political environment, who can shield the project team and project outcome from political fallout.	4	2
A-16	Efficient Project Management Approach	A well-structured, formal project management approach which is aligned with best practices.	3	2
A-17	Good Availability of Resources	Good availability of project financing, as well as competent personnel and contractors.	3	2
A-18	Effective Contracting	Following effective and thorough contracting practices and developing and maintaining proper contract documentation.	3	2
A-20	Good Availability of Project Related Information	Ensuring that all required information is gathered, processed and effectively stored for easy referencing on the project. This relates to external and internal information.	3	2
A-22	Effective Assumptions Management	Documenting, clarifying, investigating, monitoring and managing all project assumptions.	2	2
A-33	Strong Top Management Support	Strong support for the project and project team from top management.	2	2
A-23	Sufficient Client Competencies and Experience	Client has the required personnel with the relevant competencies and experience to support the project team to implement the project.	3	1
A-21	Sufficient Client Involvement	The client is easily accessible and available for consultation on project matters.	2	1
A-24	Clear Understanding of Project Environment and Context	When formulating the project objectives, compiling the project scope and while executing the project, all project participants should understand the project's external environment and the project context.	2	1
A-25	Highly Motivated Project Team	Having a highly motivated project team who drives themselves hard to achieve success.	1	1
A-26	Ability of Project Team to Deal with Project Complexity	Ability of Project Team to Deal with a large number of interdependent tasks and issues.	1	1
A-27	Clear Roles and Responsibilities	Roles and responsibilities of all project participants are documented in detail and agreed.	1	1
A28	Effective Decision Making	The ability of the project team and client to make good project decisions without undue delay or regular changed decisions.	1	1
A-29	Continuous Learning	Sharing, documenting and using past experience to make better decisions.	1	1
A-30	High Degree of Site and As-Is Verification	Ensuring that site related information which can affect the project is verified in the field.	1	1
A-31	Effective Quality Management	Adherence to an effective quality management system to ensure that project deliverables are without defects and that any deviations are investigated and prevented.	1	1
A-32	Effective Risk Management	Identifying, documenting, analysing, managing and monitoring of project risks on a regular basis.	1	1
A-34	Effective Change Management	Effective monitoring, documenting and approving of project changes.	1	1

## **Appendix B – Voluntary Participation Contract**

## **Voluntary Participation in Research Project Success Factors in the South African Petrochemical Industry**

**Dear Project Professional**

You are requested to participate in this research study conducted as part of a Master's degree by Mr Geo Grobbelaar at the University of Cape Town. You were selected as a possible participant in this study due to your knowledge, experience and involvement in petrochemical projects in South Africa.

### **Research Objective**

There are certain factors which need to be managed effectively on projects to improve the probability of project success. The objective of this study is to identify the most common critical success factors for petrochemical engineering projects in South Africa, identify the causal relationships between them and to recommend the priority in which these factors should be managed.

### **Participation Agreement**

Participation in this research is completely voluntary and you may withdraw your participation at any time without the need to provide an explanation. Selecting not to participate or withdrawing participation will have no negative consequences for you. Your privacy and anonymity will be protected at all times. The same applies to organisations and other affected parties. You are requested to identify sensitive or confidential information when sharing it to enable me to consult with you on how such data may be utilised, or if it should be discarded.

Participation data will be stored in a password protected document, on a password protected computer. All hardcopy data will be properly secured and will be destroyed once transferred to the password protected document.

The main findings of the study will be shared with all participants after completion, trusting that it will be beneficial in providing insight into project success factors in the South African petrochemical industry and lead to improved project success.

### **Consent**

I, \_\_\_\_\_ (the participant) hereby consent to voluntarily participate in this research study and understand that I may withdraw at any time if I should choose so.

\_\_\_\_\_  
Signed by Participant

\_\_\_\_\_  
Date

I, Geo Grobbelaar (the researcher) hereby commit to adhere to this participation agreement and to protect the privacy and anonymity of the participant at all times. Thanking you in advance.

\_\_\_\_\_  
Signed by Researcher

\_\_\_\_\_  
Date

## **Appendix C – Interview Questionnaire**

# Research Questionnaire

Rev A

## Project Success Factors in the South African Petrochemical Industry

### Part 1 of 6 – Participant Background

1. How many years' experience do you have in the projects environment?
  - a. 0-3 years
  - b. 3-5 years
  - c. 5-10 years
  - d. 10-20 years
  - e. > 20 years
  
2. How many of those years have been in the Petrochemical Industry?
  - a. 0-3 years
  - b. 3-5 years
  - c. 5-10 years
  - d. 10-20 years
  - e. > 20 years
  
3. How many of those years have been in the South African Petrochemical Industry?
  - a. 0-3 years
  - b. 3-5 years
  - c. 5-10 years
  - d. 10-20 years
  - e. > 20 years
  
4. What have been your role/s in projects?
  - a. Project Manager
  - b. Engineering Manager
  - c. Engineering Discipline Lead
  - d. Discipline Engineer
  - e. Commercial/Legal
  - f. Estimator
  - g. Portfolio Manager
  - h. Sponsor
  - i. Client Representative
  - j. Other, please specify \_\_\_\_\_
  
5. In what capacities have you been involved in projects?
  - a. Employer
  - b. Contractor
  - c. Client (Business)

**Part 2 of 6 – Project Management Success: Achieving the traditional time, cost, quality objectives**

Important Definition: *Project Management Success is achieving the traditional time, cost, and quality objectives of a project (Pinto & Slevin, 1987).*

1. Identify an example of a successful project according to the strict time-cost-quality success criteria.

a. Approximate Project Value in South African Rands: \_\_\_\_\_

b. Short Description (optional): \_\_\_\_\_

c. Project Name (optional): \_\_\_\_\_

2. Provide details of the project's performance in terms of time-cost-quality which made it successful. Please mark selection/s with an X.

Completed approximately on time	<input type="checkbox"/>	Completed within budget	<input type="checkbox"/>	Performs according to target	<input type="checkbox"/>
Completed early	<input type="checkbox"/>	Completed under budget	<input type="checkbox"/>	Performs better than target	<input type="checkbox"/>
Complete late	<input type="checkbox"/>	Completed over budget	<input type="checkbox"/>	Performs worse than target	<input type="checkbox"/>

3. What were the 5 most critical success factors which contributed to this time-cost-quality success?

a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

d. \_\_\_\_\_

e. \_\_\_\_\_

4. Please prioritise the items above by ranking them from 1 to 5, with 1 being the most important. Do this by writing the numbers to the right of the success factors above.

**Part 3 of 6 - Project Management Failure – Not Achieving the traditional time, cost, quality objectives**

1. Identify an example of a failed project according to the strict time-cost-quality criteria.
  - a. Approximate Project Value: \_\_\_\_\_
  - b. Short Description (optional): \_\_\_\_\_
  - c. Project Name (optional): \_\_\_\_\_

2. Provide details of the project's performance in terms of time-cost-quality which made it a failure. Please mark selection/s with an X.

Completed approximately on time	<input type="checkbox"/>	Completed within budget	<input type="checkbox"/>	Performs according to target	<input type="checkbox"/>
Completed early	<input type="checkbox"/>	Completed under budget	<input type="checkbox"/>	Performs better than target	<input type="checkbox"/>
Complete late	<input type="checkbox"/>	Completed over budget	<input type="checkbox"/>	Performs worse than target	<input type="checkbox"/>

3. What 5 factors contributed to this time-cost-quality failure?
  - a. \_\_\_\_\_
  - b. \_\_\_\_\_
  - c. \_\_\_\_\_
  - d. \_\_\_\_\_
  - e. \_\_\_\_\_
4. Please prioritise the items above by ranking them from 1 to 5, with 1 being the factor contributing the most to the time-cost-quality failure. Do this by writing the numbers to the right of the success factors above.

**Part 4 of 6 – Project Success : Delivers sufficient benefits to the client and other stakeholders**

Important Definition: *Project Success is when a project delivers sufficient benefits to the client and other stakeholders* (Pinto & Slevin, 1987).

1. Identify an example of a successful project which brought great benefit to all stakeholders, regardless if it was completed on time, within budget or according to specifications.

a. Approximate Project Value: \_\_\_\_\_

b. Short Description (optional): \_\_\_\_\_

c. Project Name (optional): \_\_\_\_\_

2. Why do you view this project as a success?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

3. Provide details of the project's performance in terms of time-cost-quality. Please mark selection/s with an X.

Completed approximately on time		Completed within budget		Performs according to target	
Completed early		Completed under budget		Performs better than target	
Complete late		Completed over budget		Performs worse than target	

4. What were the 5 most critical success factors which contributed to the project's success?

a. \_\_\_\_\_

b. \_\_\_\_\_

c. \_\_\_\_\_

d. \_\_\_\_\_

e. \_\_\_\_\_

5. Please prioritise the items above by ranking them from 1 to 5, with 1 being the most important. Do this by writing the numbers to the right of the success factors above.

**Part 5 of 6 - Project Failure – Project does not deliver sufficient benefits to the client and other stakeholders**

1. Identify an example of a failed project, thus one that did not deliver sufficient benefits to the client and other stakeholders.
  - a. Approximate Project Value: \_\_\_\_\_
  - b. Short Description (optional): \_\_\_\_\_
  - c. Project Name (optional): \_\_\_\_\_

2. Why do you view this project as a failure?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

5. Provide details of the project's performance in terms of time-cost-quality. Please mark selection/s with an X.

Completed approximately on time		Completed within budget		Performs according to target	
Completed early		Completed under budget		Performs better than target	
Complete late		Completed over budget		Performs worse than target	

3. What 5 factors contributed to the project failure?

- a. \_\_\_\_\_
- b. \_\_\_\_\_
- c. \_\_\_\_\_
- d. \_\_\_\_\_
- e. \_\_\_\_\_

4. Please prioritise the items above by ranking them from 1 to 5, with 1 being the factor contributing the most to the project failure. Do this by writing the numbers to the right of the success factors above.

**Part 6 of 6 – Causal Relationships between Success Factors**

1. Are there any relationships between the success/failure factors which were identified?

## **Appendix D – Research Design Data**

Table D-1: Participant data

ID	Experience			Project Roles												Entity Types		
	Experience in the projects environment?	Experience in the Petrochemical Industry?	Experience in the South African Petrochemical Industry?	Project Manager	Engineering Manager	Engineering Discipline Lead	Discipline Engineer	Commercial/Legal	Estimator	Portfolio Manager	Sponsor	Client Representative	Commissioning	Operations	Other	Owner Project Management Company	Contractor	Client (Business)
<b>Total</b>				<b>37</b>	<b>29</b>	<b>20</b>	<b>21</b>	<b>2</b>	<b>6</b>	<b>20</b>	<b>8</b>	<b>10</b>	<b>15</b>	<b>15</b>		<b>47</b>	<b>19</b>	<b>24</b>
3	10 to 20 years	10 to 20 years	10 to 20 years					X								X		
4	20 to 30 years	20 to 30 years	20 to 30 years	X						X						X		
5	20 to 30 years	20 to 30 years	20 to 30 years		X	X	X						X			X		
7	20 to 30 years	10 to 20 years	10 to 20 years	X						X						X		
9	10 to 20 years	10 to 20 years	10 to 20 years	X						X						X		
10	20 to 30 years	10 to 20 years	10 to 20 years	X	X												X	X
11	More than 30 years	20 to 30 years	20 to 30 years	X	X											X		X
12	10 to 20 years	10 to 20 years	10 to 20 years		X					X			X	X		X		X
13	20 to 30 years	20 to 30 years	10 to 20 years	X	X	X	X	X	X	X	X	X	X	X		X	X	X
14	10 to 20 years	10 to 20 years	10 to 20 years		X	X								X		X	X	
15	20 to 30 years	20 to 30 years	20 to 30 years	X												X		
16	10 to 20 years	5 to 10 years	5 to 10 years	X						X	X							X
18	10 to 20 years	10 to 20 years	10 to 20 years		X	X	X			X					Business Analysis		X	X
19	1 to 3 years	1 to 3 years	1 to 3 years	X												X		
21	20 to 30 years	5 to 10 years	5 to 10 years	X							X		X	X		X	X	X
22	10 to 20 years	10 to 20 years	10 to 20 years	X	X					X				X		X		
23	5 to 10 years	More than 20 years	More than 30 years									X	X	X				
25	20 to 30 years	20 to 30 years	20 to 30 years	X								X				X		
26	10 to 20 years	10 to 20 years	10 to 20 years		X	X	X						X			X		
27	More than 30 years	More than 20 years	More than 30 years	X	X					X						X		
28	10 to 20 years	10 to 20 years	10 to 20 years	X							X			X		X		X
29	10 to 20 years	10 to 20 years	10 to 20 years		X					X			X	X		X		X

ID	Experience			Project Roles											Entity Types			
	Experience in the projects environment?	Experience in the Petrochemical Industry?	Experience in the South African Petrochemical Industry?	Project Manager	Engineering Manager	Engineering Discipline Lead	Discipline Engineer	Commercial/Legal	Estimator	Portfolio Manager	Sponsor	Client Representative	Commissioning	Operations	Other	Owner Project Management Company	Contractor	Client (Business)
31	10 to 20 years	5 to 10 years	5 to 10 years												Construction Manager	X		
32	20 to 30 years	10 to 20 years	10 to 20 years		X					X						X		
33	10 to 20 years	10 to 20 years	10 to 20 years	X	X	X	X		X			X	X			X		X
34	20 to 30 years	10 to 20 years	10 to 20 years							X		X			Business Analysis			X
35	10 to 20 years	10 to 20 years	10 to 20 years	X	X	X				X						X		
36	20 to 30 years	5 to 10 years	5 to 10 years	X	X											X		
43	20 to 30 years	20 to 30 years	20 to 30 years			X	X				X		X	X				X
45	5 to 10 years	5 to 10 years	5 to 10 years	X	X	X	X										X	
46	20 to 30 years	10 to 20 years	10 to 20 years	X										X		X		X
47	10 to 20 years	3 to 5 years	3 to 5 years		X											X		
48	10 to 20 years	10 to 20 years	10 to 20 years	X												X		
49	10 to 20 years	10 to 20 years	10 to 20 years	X	X											X	X	
50	10 to 20 years	10 to 20 years	10 to 20 years	X												X	X	X
51	5 to 10 years	5 to 10 years	5 to 10 years	X			X		X					X			X	
52	5 to 10 years	5 to 10 years	5 to 10 years	X		X	X			X		X			Project Engineer, Acting Department Head	X	X	X
53	10 to 20 years	10 to 20 years	10 to 20 years	X	X	X										X	X	
54	10 to 20 years	10 to 20 years	10 to 20 years		X	X	X									X		
55	10 to 20 years	10 to 20 years	10 to 20 years							X						X		
56	10 to 20 years	10 to 20 years	10 to 20 years	X	X		X		X								X	
58	5 to 10 years	10 to 20 years	10 to 20 years									X						X
60	10 to 20 years	10 to 20 years	10 to 20 years		X	X	X										X	

ID	Experience			Project Roles											Entity Types			
	Experience in the projects environment?	Experience in the Petrochemical Industry?	Experience in the South African Petrochemical Industry?	Project Manager	Engineering Manager	Engineering Discipline Lead	Discipline Engineer	Commercial/Legal	Estimator	Portfolio Manager	Sponsor	Client Representative	Commissioning	Operations	Other	Owner Project Management Company	Contractor	Client (Business)
61	20 to 30 years	20 to 30 years	20 to 30 years	X											Project Engineer	X	X	X
63	10 to 20 years	10 to 20 years	10 to 20 years			X	X			X	X	X	X	X		X	X	X
64	10 to 20 years	10 to 20 years	10 to 20 years	X	X							X		X		X		X
65	20 to 30 years	20 to 30 years	20 to 30 years	X						X			X	X		X		X
66	5 to 10 years	5 to 10 years	5 to 10 years	X	X	X	X										X	
69	5 to 10 years	5 to 10 years	5 to 10 years			X	X									X		
71	10 to 20 years	10 to 20 years	10 to 20 years								X		X	X		X		X
73	10 to 20 years	10 to 20 years	10 to 20 years	X	X	X	X			X						X		
74	5 to 10 years	5 to 10 years	5 to 10 years				X									X		
75	20 to 30 years	20 to 30 years	20 to 30 years	X		X	X				X	X	X			X	X	
76	More than 30 years	10 to 20 years	10 to 20 years	X	X		X						X		Construction Manager	X	X	X
77	10 to 20 years	10 to 20 years	10 to 20 years	X	X		X											X
79	10 to 20 years	10 to 20 years	10 to 20 years	X	X		X											X
80	5 to 10 years	5 to 10 years	5 to 10 years			X										X		
81	10 to 20 years	5 to 10 years	5 to 10 years												Construction Manager	X	X	
82	More than 30 years	20 to 30 years	20 to 30 years						X						QS	X		
83	10 to 20 years	10 to 20 years	10 to 20 years	X		X				X						X		
84	5 to 10 years	5 to 10 years	5 to 10 years	X	X				X	X		X				X		

Note 1: Survey respondent 23 submitted conflicting data. Five to 10 years' experience was used.

Note 2: Interviewee 3 and 11 (ID 83 and 84) completed only paper questionnaires. Their data was inserted manually.

## **Appendix E – Success Factors Identified During Interviews**

**Table E-1 – Success factors identified during interviews**

No	Success Factor
1	Good Alignment on Project Charter between Sponsor, client representatives and project manager with regards to specifications, performance, cost, quality and schedule of the project.
2	Ensure direct feedback and control of Engineering Contractor progress and issues
3	Effective breakdown of project scope to enable effective scope and change management
4	Continuity of PMT resources
5	Continuity of project management responsibility (not good to change project teams)
6	Selecting the right contractors
7	Ensuring that contractors operate in their efficiency zone, thus the optimal location with regards to their home offices, the site, the client and the Employer.
8	Proper handover procedures when project resources change.
9	Development of detailed project scope and contracting documents.
10	Experienced owners team
11	Presence of owner in contractor offices (good line of sight)
12	Sound Technical Solution
13	PM has good project management and business attributes
14	Effective contracting strategies
15	Strong construction management team from contractor
16	Strong construction management team from owner
17	Scope freeze early in the project
18	Effective mitigation of issues causing low construction productivity
19	Strong commissioning management team from owner
20	Accessibility, Presence and involvement of Sponsor
21	Good understanding the of the business needs
22	The project must be a robust business solution
23	Effective execution strategy
24	Effective stakeholder analysis and management
25	High % Greenfields nature of project
26	Using proven technology for the project in terms of scope
27	Selection of the appropriate specifications
28	Attributes of PM and EM
29	Positive attitude towards project from most stakeholders
30	Driving cost instead of schedule
31	Realistic schedules
32	Good project definition
33	Proper project setup
34	Rapour with client (good relationship and collaborative feeling)
35	Rapour with team (good relationship and collaborative feeling)
36	Transparency and Openness with client
37	Buy in into project objectives
38	Good communication
39	Proper scope definition

No	Success Factor
40	Proper FEL
41	Develop PEP early, sign off at high level
42	Proven and accurate feedback on progress and cost.
43	Plan your work and work your plan
44	Stakeholder management
45	Logistics planning
46	Local content management (in ZA)
47	Early involvement of QA/QC
48	Realistic commitments
49	Proper change management
50	Good scope management
51	Well experienced team
52	Relationship with EC
53	Minimum interference from client (business)
54	Co-location of owner and EC resources
55	Good construction contractor (to ensure good construction productivity)
56	Teamwork
57	Good understanding of scope
58	Understanding the business drivers for the project
59	Well-resourced team
60	Understanding stakeholders
61	Good assumption management
62	More engineering earlier
63	Proper scope definition
64	Scope freeze
65	Ensuring good productivity
66	Construction productivity
67	The use of benchmarking
68	Do the right things at the right time
69	Estimation quality
70	Understand and manage productivity factors
71	Effective project controls
72	Strong owners team
73	Good owner construction management capability
74	Detailed, focussed planning
75	Effective contracting strategy
76	Good FEL
77	Good change management
78	Scope freeze
79	Good owner involvement
80	Early commissioning thinking
81	Team continuity

No	Success Factor
82	Focus on quality, rather than cost and schedule
83	Safety focus
84	Good project and leader match
85	A team with the right experience
86	Good change management
87	Realistic commitments
88	Proper technology / technical governance
89	A skilled team
90	Sustainable and maintainable systems: used, usable, trainable, practical
91	Clear business objectives
92	Good peer reviews
93	Guarding against premature acceleration of project
94	Good leadership from PM, engineering and business

**Appendix F – Challenges in the South African  
Petrochemical Industry**

**Table F-1: Challenges identified by participants for projects in the South African petrochemical industry**

No	Participant ID	Challenge
<b>CH-01</b>	<b>Low Competence Level of Project Resources</b>	
1	3	Skills of labour
2	4	Skills development
3	7	Skills shortage
4	9	Competency of construction work force
5	5	Insufficient engineering capability
6	9	Competency ability of engineering companies
7	10	Craft skills dropping
8	11	Artisans: low skill levels and experience
9	11	Supervisors: low skill levels and experience
10	12	Skilled labour force
11	15	Skilled resources Engineering
12	19	Competency of workforce
13	26	Lack of competence (project and engineering) both employer and contractor point of view
14	28	Skills and knowledge from workforce
15	48	Lack of skill and productivity of the basic construction/fabrication work force. As a result, the cost of quality and predictability of the project outcomes are not on par with international norms.
16	80	Lack of engineering and project management skills
17	34	Labour force competency
18	35	Lack of competent resources - internal (employer) & external (service providers)
19	43	Schooling poor for many citizens
20	45	Lack of training for craftsman
21	53	Lack of artisan training programmes at major petrochemical companies
22	82	Competencies of people
23	16	Skills shortage from service providers
24	25	Availability of competent Construction Contractors
25	47	Engineering skills shortage
26	50	Availability of contractors that can be trusted, not enough service providers in South Africa
27	71	Availability of competent people to execute projects from EM to PM to CC
28	29	Low skill level of labour force - specific to construction
29	31	Skilled labour inadequacy
30	32	Lacking skills of construction workers
31	36	Lack of skills in local Engineering Contractors
32	36	Lack of skills in local construction contractors
33	43	Unstructured EIT training delivering Engineers with skills gaps
34	43	Lack of basic project skills like estimating, project controls and planning
35	43	Shortage of construction related skills
36	46	Shortage of skills, especially in certain disciplines
37	47	Linked to engineering skills - non-continuity of key resources
38	55	Contractor skills reduction - poor competency
39	58	Hired labour skills and competencies
40	61	Poor skills at artisan and supervisory level
41	66	Skills shortage among engineering disciplines
42	69	Limited skills available in certain disciplines
43	79	Shortage of skills in Engineering, Planning and Construction Management

44	80	Lack of construction skills
45	65	craftsmen not good enough
<b>CH-02</b>	<b>Low Construction Labour Availability</b>	
46	5	Availability of sufficient craft labour
47	5	Availability of craft skill
48	79	Good experienced contractors to fabricate and install
49	11	Limited work force
50	14	Limited pool of experienced craft labour
51	18	Shortage of specialised skills - specialised welding, refractory, etc.
52	19	Limited available workforce
53	21	Availability of qualified experienced artisans, especially during a shutdown
54	23	Shortage of artisans with the required skills
55	27	Lack of competent artisan resources
56	47	Labour availability if there are more than one project in a region
57	66	Availability of a competent construction labour force
58	76	Labour pool in region
59	33	Limited construction companies
60	50	Availability of experienced resources
61	54	Sufficient construction resources
62	56	Availability of resources specifically natural gas
63	81	Specialist Artisans
64	56	Availability of Engineering Consultants and Construction Contractors to complete projects.
<b>CH-03</b>	<b>Low Productivity Levels</b>	
65	4	Productivity
66	7	Labour productivity
67	9	Lower productivity than the world norm
68	13	Low levels of Productivity
69	15	Low productivity of construction labour
70	28	Productivity
71	29	Low productivity of labour force - specific to construction
72	32	Productivity during construction phase
73	35	Productivity is extremely low
74	49	Productivity of Construction contractors are continually dropping
75	55	Labour productivity
76	64	Labour Productivity
77	65	Safety adherence influence productivity drastically.
78	71	Productivity issues
79	73	Understanding labour productivity for South Africa
80	82	Labour productivity
81	71	Ability to work in live plants
82	63	Labour laws and labour productivity in RSA - hire & fire, BEE.

<b>CH-04 Unfavourable Labour Laws and Labour Action</b>		
83	3	Labour/unions
84	4	Strikes
85	5	Strike action
86	19	IR challenges (can't implement incentive schemes etc. because of site wide strikes)
87	28	Labour unrest
88	63	Labour laws and labour productivity in RSA - hire & fire, BEE.
89	48	The labour laws in South Africa are not creating a business environment that is conducive for international investment which in turn could provide a up skilling and capacity building in RSA
90	31	Unplanned labour strikes
91	52	Labour Laws, Local Content and Unions, Shortage of well-trained blue-collar workers
92	58	Labour unrest
93	80	Labour laws, strikes
94	76	Strikes in areas
95	61	Onerous regulatory framework - Trade Unions, hours of work, Client regulations
96	79	BEE resource pressure
97	79	BEE procurement directives
98	81	Legislature
99	81	Governmental interferences
100	83	Labour laws makes the use of external human resources challenging
<b>CH-05 Unfavourable Economic Environment</b>		
101	14	Limited Capital
102	15	Economic environment.
103	21	Local investment vs international investment by the petrochemical industry
104	22	Budgetary constraints - As corporates tighten up on cost in an attempt to drive profitability upwards in a declining market demand situation
105	23	Rand / Dollar exchange rate for the international purchasing of equipment.
106	63	Relatively low sustainable spend in comparison to the regional centres (Europe & USA) - results in low skills build up in the country.
107	34	Octane demand
108	54	Rand Dollar exchange rate impact on cost
109	60	Volatile exchange rate
110	60	Low GDP growth and domestic demand
111	64	Negative outlook of capital investment in SA due to government drive to own 25% of investment by default
112	66	Tighter margins driven by a more competitive market place leads to poor quality and unrealistic schedules
113	73	Alignment of the industry with government planning/strategy (gas, in country refining capacity, shale gas, power)
114	75	Cleaner fuels
115	75	Economically viable processes
116	76	High housing cost in region
117	83	25% Government share in all large industrial projects
<b>CH-06 Low Experience Level of Project Resources</b>		
118	10	Experience levels of engineer dropping at an alarming rate
119	5	Experienced Project Control professionals (cost, estimating, planning, QS, etc)
120	14	Inexperienced resources
121	16	Poor project planners without experience
122	16	Project leaders without experience

123	21	Shortage of experienced role players throughout the spectrum of team members
124	22	People resources - Reduction in experienced staffing as older people exit Companies replaced by new inexperienced
125	33	Limited knowledge / experience of some EC's / CC's
126	45	Inexperienced Engineers
127	53	Project planners lack practical experience
128	54	Lack of design experience
129	60	Lack of experience (engineering and tradesmen)
130	64	Engineering Experience
131	77	General shortage of experienced engineers and project managers
132	46	Limited experience, high turnover of personnel (again in more prevalent certain disciplines)
<b>CH-07</b>	<b>Poor Local Resource Availability</b>	
133	26	Insufficient amount of resources
134	27	Needing to import from overseas certain equipment and materials.
135	27	Lack of first world construction equipment resources for large/mega projects.
136	27	Lack of certain competent supplier representatives that can assist with project development.
137	48	The supply of petrochemical equipment, material and specialized fabrication requirements is not available in South Africa, causing long delivery, costly QA/QC and logistics that impact both schedule and cost of the project.
138	51	Fabrication Facilities and International Influence
139	56	Availability of Engineering Consultants and Construction Contractors to complete projects.
140	65	Resource availability - same pool of resources
141	69	Limited local suppliers/vendors
142	77	Shortage of engineers and project managers with experience in Petrochemical projects
143	7	Limited number of service providers
144	27	Lack of well trained and competent project managers and engineering managers.
145	45	Too many engineering contractors
146	77	Use of foreign engineering companies and suppliers without proper integration to SA environment
147	83	Limited pool of competent resources
148	84	Small local petrochemical engineering and construction industry
<b>CH-08</b>	<b>Shortage in Owner Capability and Competencies</b>	
149	9	Owner own capability and competencies
150	18	General level of education/skills in operating personnel - for example, operators on European plants are more highly skilled than locally
151	23	Management decisions take too long for the execution of projects.
152	26	Lack of competence (project and engineering) both employer and contractor point of view
153	55	Skills reduction - own resources
154	35	Lack of competent resources - internal (employer) & external (service providers)
155	49	Employer estimating abilities are lacking depth and predictability
156	49	Employer control over construction contracts are lacking depth
157	53	Lack of practical experience in employers environment as more and more work is done by contractors
158	73	Engineering Resources to support operating facilities small project portfolios effectively

<b>CH-09</b>	<b>National and International Remoteness of South African Petrochemical Projects</b>	
159	7	Remoteness from major sources of materials and technology supplies
160	10	Lack of international project exposure
161	36	Distance from major equipment suppliers
162	33	Suppliers a large amount of time extreme distances away
163	36	Distance from Technology suppliers
164	47	Logistical challenge if it is far from manufacturing facilities
165	56	Distance between where resource can be found and where it is required
166	63	Long logistical chain - RSA is far from the global operational and manufacturing hubs. General project best practices are not easily applied in RSA.
167	74	isolation
168	84	Isolated geographic location
<b>CH-10</b>	<b>Low Quality of Work</b>	
169	12	Quality of Engineering
170	16	Quality of work assurance from service providers
171	13	Quality issues related to lack of skills and supervision
172	25	Quality of Engineering
173	64	Labour Quality
174	31	Drawing changes during construction
175	65	Detail design packages lacks quality
176	83	Quality of Labour (Construction)
177	83	Quality of Labour (Engineering and Project Management)
<b>CH-11</b>	<b>Ineffective Planning and Control</b>	
178	9	Ability to plan the work and work the plan
179	12	Planning
180	14	Time constrains
181	23	Shutdowns too short for the proper execution of projects.
182	66	Lack of understanding of poor productivity when planning construction projects, i.e. permitting procedures, skills
183	52	Generally poor front-end loading, estimates and scoping of projects
184	82	Rushed schedules
185	10	Execution and project cost over runs
186	55	Schedule predictability
<b>CH-12</b>	<b>Management Inefficiencies</b>	
187	35	Management interventions - trial & error approach
188	35	Reactive rather than proactive approach
189	58	Discipline
190	61	Cumbersome and very costly management structures on projects
191	61	Long chain of command, slow reaction, slow decisions
192	3	Locus of control
193	10	Lack of Engineering systems and design procedures
194	14	Lack of upfront screening of projects and prioritization thereof
195	84	Poor understanding and utilisation of management and engineering systems by contractors.

<b>CH-13 High Cost of Projects</b>		
196	49	Construction cost and rates are current un-predictable and grow outside the norms
197	54	Contractor companies are very expensive (lack of enough competition)
198	56	Additional cost to complete projects in the petrochemical environment
199	61	High cost of engineering compared to Asia
200	79	Capital - petrochemical projects are extremely expensive
201	47	Linked to labour availability - high increases in labour costs
202	12	Capital intensive
<b>CH-14 Stringent Procedures, Permitting, Specifications and Standards</b>		
203	25	Stringent Specs & Standards
204	28	Safety policies at petrochemical plants
205	55	Owner company imposed constraints (including safety/permitting) which limit available working hours to less than 6 hours in an 8 hour day
206	51	Cost and time to comply with local requirements i.e. Employer Requirements
207	53	Employer specifications perceived to be statutory requirements
208	75	Environmentally approved processes
209	84	Specialised technical requirements and specifications
<b>CH-15 Ineffective Supervision</b>		
210	3	First line supervision
211	11	Supervisor: labour ratio is low (1:4) versus 1:7
212	25	Lack of suitable supervision
213	49	Construction supervision skills are lacking
214	65	Supervision lacking
215	29	Inability of construction contractors to properly manage their workforce
<b>CH-16 Unfavourable Legislation</b>		
216	22	Legislation - Project constraints and timing delays as a result of more stringent NERSA and Government legislation governing Oil Industry
217	23	Politics can influence projects.
218	34	CF Specifications
219	43	Conflicting country aims and legislation
220	74	government
<b>CH-17 Difficult and Expensive Logistics due to Underdeveloped Infrastructure</b>		
221	4	Infrastructure
222	18	Challenges in infrastructure - movement of large pieces of equipment etc.
223	22	Supply Chain Constraints - Constrained SA infrastructure in terms of Supply Chain - Single Industry pipeline high TPT costs
224	69	Transportation limits/difficulties
225	74	Logistics

<b>CH-18</b>	<b>Low South African Workload</b>	
226	48	Not enough work in RSA available to development & sustain a solid/core EC/EPC team with experience - causing resources to jump ship often for short term gains. This often results in in EC resources with limited experience at their company, lack of solid teamwork and inability to replicate their ECs international track record.
227	45	Limited number of petrochemical capital projects
228	63	Small market dynamics look different to large market dynamics - low sustainable spend. The market cannot achieve true efficiency in the absence of the scale to sustain a number of significant players - and therefore requires interventionist behaviour from the major Petrochemical operating companies.
229	73	Low project backlog across the country
230	7	A limited customer base
<b>CH-19</b>	<b>Loss of Competent and Experienced Local Resources to International Market</b>	
231	15	Retaining skilled people in RSA
232	81	Loss of skill and expertise
233	52	Loss of experienced personnel over last decade+ has left many challenges. Young engineers missing a proper design background due to early management roles
234	48	Many skilled PM practitioners left RSA to international opportunities due to political, economic and sometimes Affirmative Action reasons - diluting the pool of available resources available in South Africa.
235	50	Experienced people are leaving South Africa and may increase in future
<b>CH-20</b>	<b>High Turnover of Personnel</b>	
236	32	Turnover of key project personnel
237	35	High turn-over of resources on projects
238	46	Limited experience, high turnover of personnel (again in more prevalent certain disciplines)
239	82	Turnover of personnel
240	84	Constant migration of resources between companies
<b>CH-21</b>	<b>Safety</b>	
241	4	Safety
242	13	Safety awareness due to lack of knowledge and low levels of skills in the workforce
243	15	Safety
244	25	Safety
<b>CH-22</b>	<b>People's Attitude</b>	
245	3	Attitude of contractors
246	58	Full time employees commitment and reliability
247	76	People want to work from home
248	76	If they need to work away from home they will rather work near sea
<b>CH-23</b>	<b>Strained Relationships</b>	
249	50	A culture of "them and us" between contractors and their clients, causing distrust and not enhancing teamwork
250	52	Overall it seems that there is a strong Employer vs Contractor culture and not a collaborative approach to project execution
251	52	Overall little understanding between Client and Contractor on their "drivers" - Also contributing to a non-collaborative approach.
252	58	Trust

<b>CH-24</b>	<b>Poor Scope Definition</b>	
253	32	Poor scope definition giving rise to late and costly changes on projects
254	26	Underestimating scope involved from an engineering and execution point of view
<b>CH-25</b>	<b>Inaccurate Cost Estimation</b>	
255	32	Poor cost estimating data bases
256	82	Cost is not optimised in FEL
<b>CH-26</b>	<b>Low Levels of Client Involvement</b>	
257	12	Operations involvement
<b>CH-27</b>	<b>Unfavourable Geographic Factors</b>	
258	31	Weather impacts
<b>CH-28</b>	<b>Brownfields Environments</b>	
259	31	Complexities due to working in brown fields environment
<b>CH-29</b>	<b>Limited Continuous Learning</b>	
260	50	Limited availability of lessons learned from other companies in the same field, both in SA and abroad
<b>CH-30</b>	<b>Contractor and Supplier Performance</b>	
261	60	Vendor commitments and adherence to schedule including quality

Note 1: Yellow blocks indicate where an identified challenge was duplicated since it belongs in two challenge groups. Both are accounted for in the statistics.

Note 2: Red blocks indicate where a participant is in apparent disagreement with the majority of participants.

## **Appendix G – Evaluation of Success Factors**

**Table G-1 – Coded participant project management success factors**

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
63	2	A realistic schedule	1	2	1.0
19	3	Achievable key milestones	1	1	3.0
43	5	Clear and unchanging scope	1	2	2.5
10	5	Clear Business Objectives	1	1	5.0
18	5	Clear business targets for the project - size, performance requirements	1	1	5.0
15	5	Clear direction and needs identified by the business partner. (Business charter)	1	1	5.0
10	4	Clear market objectives and agreed scope with business	1	1	4.0
46	4	Clear objective statement	1	1	4.0
36	5	Clear project specifications upfront	1	1	5.0
43	4	Clearly defined charter and objectives	1	1	4.0
7	3	common or congruent objectives	1	1	3.0
54	2	Good business case	1	1	2.0
84	5	Project team's understanding of project charter	1	1	5.0
34	5	Realistic Charter	1	1	5.0
81	5	Realistic project goals and objectives	1	1	5.0
48	5	Solid business case with clear business objectives at inception	1	1	5.0
3	2	This money will make money	1	1	2.0
63	3	A good basic engineering package	2	1	3.0
43	5	Clear and unchanging scope	2	2	2.5
31	5	Completed designs and AFC drawings before start of construction	2	2	2.5
75	4	Defined scope of work	2	1	4.0
27	5	Defining the scope fully prior to project final authorisation.	2	3	1.7
53	1	Effective scope management	2	1	1.0
19	4	Engineering far enough developed before contracts are placed.	2	3	1.3
27	4	Excellent technology provider for the technology portion of the basic engineering technical package.	2	2	2.0
77	2	Experience of applicable legislations, policies and procedures	2	2	1.0
4	4	Fixed scope	2	1	4.0
5	2	Fully piloted technology (First of kind)	2	1	2.0
9	3	Good engineering quality	2	1	3.0
34	4	Good FEL	2	3	1.3
15	4	Good FEL Phase. High quality engineering deliverables	2	3	1.3
32	1	Good focus on FEL phases of project	2	3	0.3
53	5	Good front end loading	2	3	1.7
69	4	Good front-end loading	2	3	1.3
84	3	Good scope and quality management	2	2	1.5
83	4	Greenfields preferred	2	1	4.0
28	1	Informal site visits	2	2	0.5
71	5	Known scope	2	1	5.0
9	4	On time engineering	2	2	2.0
76	3	Project breakdown structure	2	2	1.5
52	4	Proper planning and scoping of project	2	2	2.0
65	5	Proper scope definition and enforce contract requirements.	2	2	2.5
80	2	Proven technology	2	1	2.0
25	4	Quality of Engineering	2	1	4.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
83	3	Replication is good	2	1	3.0
4	2	Rigid scope and cost management	2	2	1.0
49	3	Scope and responsibilities were well understood by both parties	2	3	1.0
48	4	Scope frozen at Gate 3 and not allowed to change (not even for proposed secondary improvements)	2	1	4.0
26	5	Scope was understood and well defined	2	1	5.0
49	5	Scope was well defined	2	1	5.0
11	4	Started construction when detail engineering was almost complete	2	3	1.3
49	4	Strict scope control was enforced	2	1	4.0
74	3	strong technical support	2	1	3.0
69	3	Technically not too complicated	2	1	3.0
32	4	Using an international expert on Waste management process technologies	2	1	4.0
83	1	Utilisation of vendor specifications	2	1	1.0
14	4	Well defined scope	2	1	4.0
19	5	Well defined Scope	2	1	5.0
13	1	Well defined scope ( comprehensive FEED and Cost estimate)	2	1	1.0
21	5	Well defined scope transferred into an achievable project programme	2	2	2.5
82	5	Well defined scope, early in the project	2	2	2.5
36	4	Well-developed Facility Breakdown Structure leading into the WBS - Clear scope	2	1	4.0
52	5	"One team" approach by Contractor and Client	3	3	1.7
63	4	A highly motivated project team - success was a big deal to all involved (EC & client)	3	1	4.0
66	4	A motivated Project Team that is rewarded/recognised for good performance	3	2	2.0
23	5	A well-integrated project team.	3	1	5.0
83	5	Attributes of Project Manager and Engineering Manager	3	2	2.5
79	1	Best engineers on project	3	1	1.0
76	1	Brown and greenfield experience	3	2	0.5
26	4	Cohesiveness and continuity of core team members through project engineering and execution phase.	3	1	4.0
71	4	Collaborative teamwork between projects, engineering and ops	3	2	2.0
74	2	Commitment	3	2	1.0
47	1	Continuity of key resources	3	1	1.0
65	2	Core team throughout the project	3	1	2.0
61	2	Correctly resourced team - highly skilled through management down to artisan level	3	3	0.7
10	1	Dedicated and committed team both from EC and PMT	3	2	0.5
75	5	Dedicated Project Manager	3	2	2.5
31	2	Dedicated project team members	3	1	2.0
9	1	Dedicated team	3	1	1.0
33	5	Dedicated team (Teams [EC, CC and Owner] were involved in more than one project as a team)	3	2	2.5
53	4	Discipline engineers accepting accountability	3	1	4.0
25	5	Excellent Teamwork at all levels	3	1	5.0
13	4	Exceptional project leadership and dedicated team	3	2	2.0
12	5	Experienced Project Team	3	1	5.0
13	3	Experienced project team ( both client and contractor)	3	3	1.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
52	1	Experienced resources	3	2	0.5
16	4	experienced team performing work	3	1	4.0
46	3	Experienced engineering and project team (also previous experience together)	3	2	1.5
18	4	Focused, dedicated project team - not overloaded, no split priorities, mix between experienced and less so	3	1	4.0
48	3	Focussed <a href="#">Owner Project Management Company</a> / <a href="#">Client</a> task team dedicated to the project	3	3	1.0
43	3	Good Engineering discipline support	3	1	3.0
75	2	Good project team	3	1	2.0
34	1	Good teamwork	3	1	1.0
82	3	Good Teamwork	3	1	3.0
50	4	Good teamwork between fabricator, service providers, project team and management of <a href="#">Owner</a>	3	3	1.3
73	1	High performing team (working effectively together not against each other)	3	1	1.0
61	3	Innovation - thinking "out of the box" yet addressing critical risks	3	2	1.5
47	3	It was the second time the project team completed a project of the same nature (experience)	3	1	3.0
56	4	Key people on the project team from both <a href="#">EC</a> and <a href="#">Owner Project Management Company</a> were maintained from previous project.	3	3	1.3
56	1	Lessons learned from previous project (SNI) completed by the same project time was implemented	3	1	1.0
7	1	minimum undue influence to team members	3	1	1.0
10	3	No changes to key personnel i.e. PM and EM	3	1	3.0
64	5	Ownership by Owner PMT	3	2	2.5
35	2	PM's line manager/supervisor was a well experienced PM offering guidance	3	2	1.0
76	5	Project and owner team members	3	2	2.5
35	4	Project had a dedicated PM with dedicated project support services	3	1	4.0
76	4	Project team execution experience	3	1	4.0
56	5	Project team experience with cross country pipelines both <a href="#">Owner Project Management Company</a> , <a href="#">Client</a> and the <a href="#">EC</a>	3	2	2.5
84	4	Project team must be hands-on and aligned	3	1	4.0
35	3	Project team was motivated; no dis-illusions about the future	3	1	3.0
77	5	Project was wholly undertaken by in-house engineering & local contractors	3	2	2.5
54	5	Proper project team structure	3	1	5.0
73	2	Staff retention (not losing key staff members through the project phases)	3	1	2.0
82	4	Strong PMT	3	1	4.0
81	4	Team Work	3	1	4.0
21	1	Team work - absolute win-win situation for all. No hidden agenda's	3	1	1.0
7	5	Teamwork	3	1	5.0
32	3	Very cohesive PMT	3	1	3.0
16	1	well aligned team	3	1	1.0
53	3	Willingness of previous engineering resources to support their replacement	3	1	3.0
66	4	A motivated Project Team that is	4	2	2.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
		rewarded/recognised for good performance			
3	5	Attitude of the business	4	1	5.0
66	5	Client and Contractor continually involving the end user/business in progress	4	2	2.5
71	4	Collaborative teamwork between projects, engineering and ops	4	2	2.0
74	2	Commitment	4	2	1.0
36	1	Constant interaction with contractor	4	2	0.5
15	3	Continuity of key role players	4	2	1.5
31	1	Dedicated support from the business representatives	4	1	1.0
5	1	Early involvement of Commissioning specialists from Operations	4	1	1.0
4	1	Early owner involvement	4	1	1.0
13	3	Experienced project team ( both client and contractor)	4	3	1.0
48	3	Focussed <a href="#">Owner Project Management Company /Client</a> task team dedicated to the project	4	3	1.0
65	4	Fully involved client/owner and commissioning team. Highly supportive and committed.	4	1	4.0
69	5	Good communication between Stakeholders and a lot of involvement from the Business (Client)	4	2	2.5
34	3	Good Sponsor involvement	4	1	3.0
50	4	Good teamwork between fabricator, service providers, project team and management of <a href="#">Owner</a>	4	3	1.3
18	1	Involved decision makers - knowledgeable, accountable sponsor from senior management	4	1	1.0
9	5	Management commitment and support	4	1	5.0
21	2	Management involvement - Sponsor, Client, Contractor and Sub Contractor	4	2	1.0
15	1	No discontinuity in project life cycle. (Capital approved timeously)	4	1	1.0
52	2	Open and early involvement of Operations and Maintenance teams	4	1	2.0
12	2	Operations Involvement	4	1	2.0
64	5	Ownership by Owner PMT	4	2	2.5
35	5	PM was given the authority associated with the position; reduced 'red-tape'	4	2	2.5
35	2	PM's line manager/supervisor was a well experienced PM offering guidance	4	2	1.0
23	4	Positive support from the operations teams.	4	1	4.0
76	5	Project and owner team members	4	2	2.5
26	3	Proper business involvement from conceptual stage throughout	4	1	3.0
33	4	Sponsor / business involvement	4	1	4.0
74	5	Strong sponsor presence	4	1	5.0
80	3	Strong business support	4	1	3.0
5	5	Strong owner team	4	1	5.0
83	2	Support from stakeholders for project	4	1	2.0
47	5	Very hands on and involved management and project sponsor	4	1	5.0
13	2	Absolute focus on Change Management (dedicated resource)	5	1	2.0
58	2	Action plans to recover - time/dates/owner	5	2	1.0
43	2	Construction considered in FEL	5	4	0.5
43	2	Construction considered in FEL	5	4	0.5
58	4	Daily project progress meetings	5	1	4.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
27	5	Defining the scope fully prior to project final authorisation.	5	3	1.7
27	3	Developed a detail level 3 execution schedule prior to final authorisation.	5	2	1.5
4	5	Early decision-making	5	1	5.0
46	1	Effective change control	5	1	1.0
19	4	Engineering far enough developed before contracts are placed.	5	3	1.3
13	5	Fast decision making protocols	5	1	5.0
28	4	Follow up on action items and due dates	5	1	4.0
34	4	Good FEL	5	3	1.3
15	4	Good FEL Phase. High quality engineering deliverables	5	3	1.3
32	1	Good focus on FEL phases of project	5	3	0.3
53	5	Good front end loading	5	3	1.7
69	4	Good front-end loading	5	3	1.3
34	2	Good project Management	5	1	2.0
5	3	LSTK contract, properly administered for change management	5	2	1.5
51	5	Management and control of the project	5	2	2.5
9	4	On time engineering	5	2	2.0
79	4	Procurement followed by in-fabrication shop quality control by client	5	2	2.0
76	3	Project breakdown structure	5	2	1.5
14	1	Proper change management-	5	1	1.0
33	3	Regular progress feedback per discipline	5	2	1.5
10	2	Stage gate process with clear deliverables per gate	5	1	2.0
11	4	Started construction when detail engineering was almost complete	5	3	1.3
9	2	Strict change management	5	1	2.0
18	2	Very good governance - internal in lines of communication and decision making as well as external to the project	5	1	2.0
28	2	Weekly official feedback sessions.	5	1	2.0
82	5	Well defined scope, early in the project	5	2	2.5
23	2	A project manager that kept a close eye on the finances.	6	1	2.0
63	2	A realistic schedule	6	2	1.0
58	2	Action plans to recover - time/dates/owner	6	2	1.0
11	5	Good project control	6	1	5.0
50	5	Low tolerance of non-conformance of not adhering to technical requirements	6	1	5.0
14	5	Upfront planning	6	1	5.0
12	4	Detail Planning	6	1	4.0
58	1	Cost control/weekly meetings	6	1	1.0
27	5	Defining the scope fully prior to project final authorisation.	6	3	1.7
25	1	Detail construction planning	6	2	0.5
64	4	Good project controls (including engineering) implemented	6	1	4.0
27	3	Developed a detail level 3 execution schedule prior to final authorisation.	6	2	1.5
77	4	High quality of workmanship resulted in minimum rework	6	1	4.0
50	3	Effective planning and control during installation	6	2	1.5
47	4	Enough know-how to allow for a budget that catered for unforeseen problems	6	2	2.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
47	2	Enough know-how to develop a schedule that allowed for unforeseen problems	6	2	1.0
54	1	Good cost control	6	1	1.0
34	4	Good FEL	6	3	1.3
15	4	Good FEL Phase. High quality engineering deliverables	6	3	1.3
32	1	Good focus on FEL phases of project	6	3	0.3
53	5	Good front end loading	6	3	1.7
69	4	Good front-end loading	6	3	1.3
18	3	Broad involvement, good use of external reviewers to ensure quality - technical, project, estimating, construction etc.	6	1	3.0
19	1	Good planning and progress measurements.	6	1	1.0
36	3	Closely monitored schedule performance of EPC contractor	6	1	3.0
65	3	Cost and cost control throughout the project.	6	1	3.0
84	3	Good scope and quality management	6	2	1.5
51	3	Having a plan B and C if required to implement	6	2	1.5
56	3	Cost and schedule was managed and controlled on an ongoing bases	6	1	3.0
58	3	Early identification of non-conformances / project deviations/threats	6	1	3.0
75	3	Good planning and execution	6	1	3.0
79	4	Procurement followed by in-fabrication shop quality control by client	6	2	2.0
52	4	Proper planning and scoping of project	6	2	2.0
12	1	Quality focus - Handover	6	2	0.5
36	2	Regular costing meetings with contractor	6	1	2.0
33	3	Regular progress feedback per discipline	6	2	1.5
4	2	Rigid scope and cost management	6	2	1.0
16	3	Schedule reviews x 4	6	1	3.0
50	2	Strict adherence to SHE adherence, creating a culture of conformance to requirements early in the project	6	1	2.0
49	1	The complete scope was estimated	6	1	1.0
51	5	Management and control of the project	6	2	2.5
21	3	Upfront planning with all parties involved	6	2	1.5
21	5	Well defined scope transferred into an achievable project programme	6	2	2.5
76	1	Brown and greenfield experience	7	2	0.5
21	4	Early identification of all possible risks and planning taking it into account	7	1	4.0
47	4	Enough know-how to allow for a budget that catered for unforeseen problems	7	2	2.0
47	2	Enough know-how to develop a schedule that allowed for unforeseen problems	7	2	1.0
77	2	Experience of applicable legislations, policies and procedures	7	2	1.0
66	3	Good Client and Contractor relationship with a common understanding of the Risk Factors and working together to mitigate	7	3	1.0
51	3	Having a plan B and C if required to implement	7	2	1.5
51	4	Identification of Risk items and management	7	1	4.0
61	3	Innovation - thinking "out of the box" yet addressing critical risks	7	2	1.5
43	1	Risk management set up in FEL	7	1	1.0
27	2	Understood the risks on the project and allowed for the necessary cost and schedule contingency.	7	1	2.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
52	5	"One team" approach by Contractor and Client	8	3	1.7
66	5	Client and Contractor continually involving the end user/business in progress	8	2	2.5
61	4	Client/EPC Contractor relationship - transparent and fully co-operative	8	2	2.0
32	5	Close relationship with the Client (Business)	8	1	5.0
36	1	Constant interaction with contractor	8	2	0.5
15	3	Continuity of key role players	8	2	1.5
52	3	Excellent daily communication. As soon as a challenge came up, it was communicated and addressed	8	1	3.0
46	2	Good alignment between client, project team and main engineering contractor	8	1	2.0
66	3	Good Client and Contractor relationship with a common understanding of the Risk Factors and working together to mitigate	8	3	1.0
54	3	Good communication	8	1	3.0
82	2	Good Communication	8	1	2.0
50	1	Good communication between project team, client, contractor and general public	8	1	1.0
46	5	Good communication between stakeholders	8	1	5.0
69	5	Good communication between Stakeholders and a lot of involvement from the Business (Client)	8	2	2.5
63	5	Good project relationships (EC, client & OEM's)	8	1	5.0
77	3	Good working relationships from a number of previous projects	8	1	3.0
7	2	Openness and truthful communication	8	1	2.0
23	3	Regular and positive communication.	8	1	3.0
61	1	Short lines of communication - very effective decision making	8	1	1.0
28	3	Strict but fair in all discussions	8	1	3.0
81	3	Successful interface management	8	1	3.0
21	3	Upfront planning with all parties involved	8	2	1.5
11	2	"Experienced" workforce from a recent project	9	1	2.0
52	5	"One team" approach by Contractor and Client	9	3	1.7
64	3	All contracted parties committed to make the project work	9	1	3.0
56	2	Appointed an experienced Contractor knowledgeable with cross country pipeline construction	9	1	2.0
3	4	Attitude of the EPC contractor	9	1	4.0
79	5	Best fabricators selected - not the cheapest fabricators	9	1	5.0
79	3	Best installation contractor selected - again, not the cheapest contractor	9	1	3.0
71	3	'better' choice of construction contractors	9	1	3.0
27	1	Clear, concise and approved contract strategy/plan prior to final authorisation.	9	1	1.0
28	5	Client and fabricator worked as a team	9	1	5.0
61	4	Client/EPC Contractor relationship - transparent and fully co-operative	9	2	2.0
75	1	Commitment from contractor	9	1	1.0
26	2	Committed, experienced and proud EPCm contractor involved since Conceptual stage	9	1	2.0
4	3	Competent contractors	9	1	3.0
19	2	Competent contractors	9	1	2.0
26	1	Contracting strategy supported success	9	1	1.0
79	2	Contracting strategy with good incentive for early	9	1	2.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
		finish and safety statistics			
61	5	Correct Contract Strategy - EPC as opposed to EPCm	9	1	5.0
61	2	Correctly resourced team - highly skilled through management down to artisan level	9	3	0.7
10	1	Dedicated and committed team both from EC and PMT	9	2	0.5
33	5	Dedicated team (Teams [EC, CC and Owner] were involved in more than one project as a team	9	2	2.5
53	2	Effective contracting	9	1	2.0
19	4	Engineering far enough developed before contracts are placed.	9	3	1.3
3	3	EPC strategy	9	1	3.0
27	4	Excellent technology provider for the technology portion of the basic engineering technical package.	9	2	2.0
11	3	Experienced international engineering contractor	9	1	3.0
13	3	Experienced project team ( both client and contractor)	9	3	1.0
52	1	Experienced resources	9	2	0.5
46	3	Experienced engineering and project team (also previous experience together)	9	2	1.5
32	2	Forming one team with the Engineering Contractor (EC)	9	1	2.0
66	3	Good Client and Contractor relationship with a common understanding of the Risk Factors and working together to mitigate	9	3	1.0
7	4	Good service provider team	9	1	4.0
50	4	Good teamwork between fabricator, service providers, project team and management of Owner	9	3	1.3
56	4	Key people on the project team from both EC and Owner Project Management Company were maintained from previous project.	9	3	1.3
5	3	LSTK contract, properly administered for change management	9	2	1.5
21	2	Management involvement - Sponsor, Client, Contractor and Sub Contractor	9	2	1.0
56	5	Project team experience with cross country pipelines both Owner Project Management Company, Client and the EC	9	2	2.5
77	5	Project was wholly undertaken by in-house engineering & local contractors	9	2	2.5
16	2	Proper installation contractor	9	1	2.0
65	5	Proper scope definition and enforce contract requirements.	9	2	2.5
73	4	Quality Engineering Contractor	9	1	4.0
15	2	Right Contracting strategy	9	1	2.0
49	3	Scope and responsibilities were well understood by both parties	9	3	1.0
82	1	Sole source contracting strategy	9	1	1.0
5	4	Strong EC Joint Venture	9	1	4.0
12	3	Trained labour force	9	1	3.0
80	5	Using a renowned overseas EC	9	1	5.0
48	2	Utilised same EC/EPC contractors and equipment suppliers who performed same work within last 24 months (retained lessons learnt)	9	1	2.0
61	2	Correctly resourced team - highly skilled through management down to artisan level	10	3	0.7

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
75	5	Dedicated Project Manager	10	2	2.5
48	3	Focussed <a href="#">Owner Project Management Company /Client</a> task team dedicated to the project	10	3	1.0
56	4	Key people on the project team from both EC and <a href="#">Owner Project Management Company</a> were maintained from previous project.	10	3	1.3
58	5	Roles and responsibilities	10	1	5.0
76	2	Roles and responsibilities	10	1	2.0
49	3	Scope and responsibilities were well understood by both parties	10	3	1.0
14	2	Well aligned project team- client and contractor teams	10	1	2.0
14	3	Well defined roles and responsibilities- client and contractor teams	10	1	3.0
83	5	Attributes of Project Manager and Engineering Manager	11	2	2.5
73	5	Clear direction and project decision making	11	1	5.0
13	4	Exceptional project leadership and dedicated team	11	2	2.0
35	5	PM was given the authority associated with the position; reduced 'red-tape'	11	2	2.5
65	1	Project was lead from the front by PM.	11	1	1.0
16	5	Proper project manager	11	1	5.0
74	4	strong leadership	11	1	4.0
31	4	Acceptable labour productivity rate	12	1	4.0
31	5	Completed designs and AFC drawings before start of construction	12	2	2.5
43	2	Construction considered in FEL	12	4	0.5
43	2	Construction considered in FEL	12	4	0.5
25	1	Detail construction planning	12	2	0.5
50	3	Effective planning and control during installation	12	2	1.5
28	1	Informal site visits	12	2	0.5
25	2	Modularization	12	1	2.0
12	1	Quality focus - Handover	12	2	0.5
25	3	Quality of pre-manufacturing	12	1	3.0
11	4	Started construction when detail engineering was almost complete	12	3	1.3
49	2	Strict construction control was enforced	12	1	2.0
31	3	Timely resolution of site problems	12	1	3.0
80	4	Greenfields	13	1	4.0

Note 1: Colour scales used to indicate relative importance.

Note 2: Spelling corrected where appropriate. Care was taken to preserve statement intent.

Note 3: Blue text indicates where data was desensitized.

Note 4: Category descriptions can be found in section 4.3. .

Note 5: ID refers to the participant ID.

**Table G-2 – Coded and prioritized participant project success factors**

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
7	4	Understanding owner requirements	1	1	4.0
7	3	Understanding project drivers	1	1	3.0
7	5	Wider initial consultation	1	2	2.5
10	5	Right business drivers	1	1	5.0
14	4	Aligned project team	1	2	2.0
14	1	Realistic target dates	1	2	0.5
18	5	Project team understanding of business priorities	1	1	5.0
25	5	Well defined project objectives	1	1	5.0
26	5	Concept agreed with business	1	1	5.0
28	5	Clear picture of deliverables needed	1	3	1.7
34	3	High level of expert involvement to identify low hanging fruit	1	2	1.5
36	5	Clear objective	1	1	5.0
43	5	Clearly defined objectives	1	1	5.0
46	5	Clear business objective	1	1	5.0
46	1	Strong business case	1	1	1.0
49	4	The value which the project adds to business	1	1	4.0
51	5	Clear Objectives an goals	1	1	5.0
61	5	Relaxation of end date by Client, and no cost constraints	1	1	5.0
63	2	Recognition of shared intentions and goals.	1	2	1.0
66	4	Fit for purpose design and execution	1	4	1.0
66	5	Reduced operational cost significantly with greater margins as a result	1	2	2.5
73	4	clear direction and business case	1	1	4.0
79	5	Very good business case	1	1	5.0
80	5	Clear project mandate from the client	1	1	5.0
80	4	Clear, well understood project objectives for the PMT	1	1	4.0
83	1	Elaborate owner specifications	1	1	1.0
83	2	Robust business case	1	1	2.0
83	3	The right project	1	1	3.0
5	5	Mature technology	2	1	5.0
5	2	Sound engineering	2	1	2.0
9	3	Engineering on time	2	2	1.5
9	4	Good engineering	2	1	4.0
10	4	Mature technology providers	2	1	4.0
13	2	Good scope management	2	1	2.0
14	5	Well defined scope	2	1	5.0
15	4	Good FEL	2	3	1.3
16	1	well scoped	2	1	1.0
18	4	Good understanding of the technology - involvement of broad spectrum of specialists	2	1	4.0
21	5	Well defined scope	2	1	5.0
23	5	Scope of work was clearly identified.	2	1	5.0
25	3	Quality of engineering	2	1	3.0
26	4	Scope well defined	2	1	4.0
27	4	Very good defined scope.	2	1	4.0
28	5	Clear picture of deliverables needed	2	3	1.7
31	4	less design queries	2	1	4.0
32	1	Good research as to what technology to be used	2	1	1.0
34	3	High level of expert involvement to identify low hanging fruit	2	2	1.5
36	4	Known (proven) technology implemented	2	1	4.0
43	2	No scope changes	2	1	2.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
43	1	Technology vendor with proven track record	2	1	1.0
45	5	Experienced engineering team	2	2	2.5
45	2	Well established technology	2	1	2.0
47	4	Various package units were identified during basic engineering and Owner specs were not imposed on manufacturers nor was there high involvement by the owner on site	2	1	4.0
49	3	The quality of the delivered project	2	1	3.0
50	2	Low tolerance to not achieving technical requirements	2	1	2.0
51	4	The supplier/PM had full control and understood the project objectives	2	2	2.0
53	4	Accurate and detailed execution works information	2	2	2.0
53	5	Good front end loading	2	3	1.7
54	4	Good knowledge of brown fields plant	2	2	2.0
61	3	Highly skilled and effective specialist contribution to remedy of defects	2	1	3.0
66	4	Fit for purpose design and execution	2	4	1.0
66	5	Reduced operational cost significantly with greater margins as a result	2	2	2.5
75	4	Defined Scope of Work	2	1	4.0
76	2	No scope changes	2	1	2.0
3	3	Attitude of the people from contractor and the PMT	3	2	1.5
3	4	commitment of the teams to work together	3	2	2.0
4	4	Competent Project team	3	1	4.0
4	2	Project team/contractor accepts responsibility and accountability	3	2	1.0
7	1	good teamwork	3	1	1.0
9	2	dedicate team	3	1	2.0
10	3	Experience and Competent PMT	3	1	3.0
10	2	No changes to key personnel from Feasibility to Commissioning	3	2	1.0
11	3	Got required human resources	3	1	3.0
11	4	Quick and effective decision making	3	2	2.0
11	5	The team trusted each other and work was started without all i's and t's still subject to negotiation	3	2	2.5
12	5	Experienced Project Team	3	1	5.0
13	3	Experienced project team	3	1	3.0
13	4	Integrated team	3	2	2.0
13	1	Rigorous change management and capital trending	3	2	0.5
14	4	Aligned project team	3	2	2.0
14	3	Strong team- resources from both client and contractor	3	3	1.0
15	2	Continuity of team	3	2	1.0
15	1	Good co-operation between Project and commissioning team	3	2	0.5
15	5	Right Team (experienced)	3	1	5.0
16	5	good team	3	1	5.0
16	4	willingness to sort out issues	3	1	4.0
18	1	Experienced project management resources	3	1	1.0
21	3	Efficient teamwork between Client and EC project teams	3	2	1.5
21	1	Limited key resource turnover	3	3	0.3
26	3	Experienced engineering team	3	1	3.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
27	5	Managed the project totally by <a href="#">Owner Project Management Company</a> execution team, not by an engineering contractor.	3	2	2.5
28	2	fair but firm relationship	3	2	1.0
32	4	Close relationship between PMT and Business	3	2	2.0
32	3	Strong technical (disciplines) team	3	1	3.0
33	3	Driven and committed team	3	1	3.0
34	5	Committed team	3	1	5.0
34	4	Urgency to achieve success	3	3	1.3
35	4	Dedicated PM with dedicated project support services	3	1	4.0
35	5	Experienced employer PMT	3	1	5.0
36	1	Commitment	3	2	0.5
43	3	Good integration between Engineering disciplines and business reps	3	2	1.5
43	4	Team continuity	3	2	2.0
45	4	Experienced construction team	3	2	2.0
45	5	Experienced engineering team	3	2	2.5
45	1	Experienced project controls	3	2	0.5
45	3	Experienced project management team	3	2	1.5
46	2	Competent resources	3	1	2.0
46	3	Dedicated team	3	1	3.0
47	5	Continuity of key resources from a previous similar project	3	2	2.5
48	1	Communication effective within the PMT	3	2	0.5
48	5	The <a href="#">Owner</a> project team was dedicated and skilled	3	1	5.0
50	5	Stable project team with little personnel turnover	3	2	2.5
52	2	Ability of the team to "make important decisions" and "take responsibility" in a short space of time	3	2	1.0
52	1	Commitment by every team and operations member to support the project	3	2	0.5
53	2	Owners representative team actively involved at EC office and on site in all phases of the project	3	3	0.7
54	3	Fast tracking - bypassing unnecessary governance	3	2	1.5
54	2	Good team	3	1	2.0
54	5	Innovative thinking	3	1	5.0
61	1	Additional resources and management focus to mitigate late delivery	3	3	0.3
63	5	Great client EC relationship	3	2	2.5
63	4	Highly motivated project team	3	1	4.0
65	5	To complete the project notwithstanding all difficulties.	3	3	1.7
71	5	Competency of people	3	1	5.0
73	1	talented and capable project team	3	1	1.0
75	1	Dedication of project team	3	1	1.0
76	4	Project team	3	1	4.0
76	5	Project team execution experience	3	1	5.0
77	4	Project Team with relevant knowledge and experience	3	1	4.0
79	4	Strong project team	3	1	4.0
81	5	Persistence by Project Team	3	1	5.0
81	4	Team Commitment	3	2	2.0
81	3	Team Work	3	2	1.5
3	4	commitment of the teams to work together	4	2	2.0
3	5	relationships at senior levels	4	2	2.5

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
4	5	Owner involvement and ownership	4	1	5.0
9	5	Management support	4	1	5.0
10	2	No changes to key personnel from Feasibility to Commissioning	4	2	1.0
11	4	Quick and effective decision making	4	2	2.0
12	4	Management support	4	1	4.0
12	3	Operations involvement	4	1	3.0
13	4	Integrated team	4	2	2.0
14	3	Strong team- resources from both client and contractor	4	3	1.0
15	2	Continuity of team	4	2	1.0
15	1	Good co-operation between Project and commissioning team	4	2	0.5
18	2	Involved sponsor - understood business drivers and was willing to support project decisions, defend in management levels	4	1	2.0
21	4	Client also had a desire to make the project a success - teamwork	4	1	4.0
21	2	Clients understanding and participation with foreign supplier issues	4	2	1.0
21	1	Limited key resource turnover	4	3	0.3
23	4	Quick decision taken by Management for the execution of the project.	4	1	4.0
27	5	Managed the project totally by <a href="#">Owner Project Management Company</a> execution team, not by an engineering contractor.	4	2	2.5
32	4	Close relationship between PMT and Business	4	2	2.0
33	4	Project sponsor that opened diary for important discussions and site visits	4	1	4.0
34	4	Urgency to achieve success	4	3	1.3
35	3	Strong senior management support	4	1	3.0
36	2	Business support	4	1	2.0
36	1	Commitment	4	2	0.5
43	3	Good integration between Engineering disciplines and business reps	4	2	1.5
43	4	Team continuity	4	2	2.0
46	4	Support from senior stakeholders (across business units)	4	1	4.0
47	5	Continuity of key resources from a previous similar project	4	2	2.5
48	2	Management support to the PMT	4	1	2.0
49	5	The performance of the plant	4	1	5.0
50	1	Good support from owner management	4	1	1.0
50	5	Stable project team with little personnel turnover	4	2	2.5
52	2	Ability of the team to "make important decisions" and "take responsibility" in a short space of time	4	2	1.0
52	1	Commitment by every team and operations member to support the project	4	2	0.5
52	5	Strong stakeholder buy-in	4	2	2.5
54	3	Fast tracking - bypassing unnecessary governance	4	2	1.5
54	4	Good knowledge of brown fields plant	4	2	2.0
61	1	Additional resources and management focus to mitigate late delivery	4	3	0.3
65	5	To complete the project notwithstanding all difficulties.	4	3	1.7
73	5	full support by management	4	1	5.0
79	3	Project was well supported by management	4	1	3.0

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
80	3	Excellent project support from business	4	1	3.0
81	4	Team Commitment	4	2	2.0
81	3	Team Work	4	2	1.5
5	4	Project management approach to contracting	5	2	2.0
5	3	Strong owner team	5	1	3.0
9	3	Engineering on time	5	2	1.5
9	1	Good change control	5	1	1.0
14	2	Strong project management- time, costs & quality	5	1	2.0
15	4	Good FEL	5	3	1.3
15	3	Proper planning and executing Planning	5	2	1.5
23	1	Project manager kept the team informed of the cost.	5	3	0.3
28	5	Clear picture of deliverables needed	5	3	1.7
28	3	Diligent feedback on action items	5	1	3.0
28	1	Weekly progress feedback at fabricator	5	3	0.3
31	5	Equipment delivery on time	5	2	2.5
33	1	Well managed monthly meetings	5	1	1.0
45	3	Experienced project management team	5	2	1.5
53	4	Accurate and detailed execution works information	5	2	2.0
53	5	Good front end loading	5	3	1.7
61	4	Very quick resolution to defects	5	2	2.0
66	4	Fit for purpose design and execution	5	4	1.0
75	3	Planned execution strategy	5	1	3.0
76	3	Good execution plan	5	1	3.0
77	2	Effective PM systems and processes	5	1	2.0
50	4	Good planning and control	6	1	4.0
16	3	new approach to quality (GO procedure)	6	1	3.0
47	3	Very strict schedule management	6	1	3.0
48	3	Deviations from the original plan were properly managed (identified, explored, addressed)	6	1	3.0
12	2	Planning	6	1	2.0
25	2	Quality of manufacturing	6	1	2.0
61	4	Very quick resolution to defects	6	2	2.0
53	5	Good front end loading	6	3	1.7
15	3	Proper planning and executing Planning	6	2	1.5
15	4	Good FEL	6	3	1.3
4	1	Good planning	6	1	1.0
12	1	Quality focus	6	1	1.0
25	1	Cost focus	6	1	1.0
54	1	Tight cost and schedule control	6	1	1.0
13	1	Rigorous change management and capital trending	6	2	0.5
14	1	Realistic target dates	6	2	0.5
45	1	Experienced project controls	6	2	0.5
23	1	Project manager kept the team informed of the cost.	6	3	0.3
28	1	Weekly progress feedback at fabricator	6	3	0.3
18	3	Good management of assumptions and risks	7	1	3.0
27	2	Understood the risks and associated cost contingency.	7	1	2.0
47	1	Budget allowed for enough eventualities	7	1	1.0
47	2	Effective risk management	7	1	2.0
3	5	relationships at senior levels	8	2	2.5
7	5	Wider initial consultation	8	2	2.5

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
23	2	Positive and constructive team work and communication by all shareholders.	8	1	2.0
23	1	Project manager kept the team informed of the cost.	8	3	0.3
28	2	Fair but firm relationship	8	2	1.0
48	1	Communication effective within the PMT	8	2	0.5
49	2	The involvement of various stakeholders	8	1	2.0
50	3	Good communication between all stakeholders	8	1	3.0
52	4	Strong communication between all three stakeholders - especially the end-user	8	1	4.0
52	5	Strong stakeholder buy-in	8	2	2.5
63	2	Recognition of shared intentions and goals.	8	2	1.0
77	1	Effective communications amongst all parties involved	8	1	1.0
77	3	effective management of the project stakeholders	8	1	3.0
79	2	Good communication	8	1	2.0
79	1	Good stakeholder engagement	8	1	1.0
3	3	Attitude of the people from contractor and the PMT	9	2	1.5
4	3	Competent contractor	9	1	3.0
4	2	Project team/contractor accepts responsibility and accountability	9	2	1.0
5	4	Project management approach to contracting	9	2	2.0
10	1	Experienced work force with no LTI	9	1	1.0
11	2	Experienced international engineering contractor	9	1	2.0
11	5	The team trusted each other and work was started without all i's and t's still subject to negotiation	9	2	2.5
14	3	Strong team- resources from both client and contractor	9	3	1.0
21	2	Clients understanding and participation with foreign supplier issues	9	2	1.0
21	3	Efficient teamwork between Client and EC project teams	9	2	1.5
21	1	Limited key resource turnover	9	3	0.3
23	3	Skilled artisans used in the execution of the project	9	2	1.5
26	2	Contracting strategy for execution LSTK	9	1	2.0
27	3	Competent artisans and supervision.	9	2	1.5
27	1	Very good support from the technology provider.	9	1	1.0
31	3	experienced construction contractor	9	1	3.0
32	2	Competent Managing contractor	9	1	2.0
34	4	Urgency to achieve success	9	3	1.3
35	2	Experienced service provider (and sub-contractors)	9	1	2.0
36	3	Large international involvement	9	1	3.0
48	4	The fabricator had the skill to fabricate the vessel	9	1	4.0
51	4	The supplier/PM had full control and understood the project objectives	9	2	2.0
53	2	Owners representative team actively involved at EC office and on site in all phases of the project	9	3	0.7
53	3	Roll over from BE to DE engineering using the same EC	9	1	3.0
61	1	Additional resources and management focus to mitigate late delivery	9	3	0.3
63	5	Great client EC relationship	9	2	2.5

ID	Original Score	Success Factor	Category	Number of Duplicates	Calculated Score
63	3	Willingness to manage the spirit of the project and not just the letter of the contract.	9	1	3.0
65	5	To complete the project notwithstanding all difficulties.	9	3	1.7
73	2	competent labour force	9	1	2.0
73	3	strong engineering contractor	9	1	3.0
75	2	Procurement	9	1	2.0
7	2	Good project setup	10	1	2.0
28	4	Responsibilities well defined	10	1	4.0
33	5	Some team members "re-located" to site offices	10	1	5.0
53	2	Owners representative team actively involved at EC office and on site in all phases of the project	10	3	0.7
76	1	Team understand their roles on project	10	1	1.0
13	5	Leadership	11	1	5.0
16	2	new project manager	11	1	2.0
25	4	Excellent project leadership	11	1	4.0
32	5	Strong project leadership	11	1	5.0
52	3	Strong Leadership on Project Management level	11	1	3.0
75	5	Project Leader	11	1	5.0
77	5	Experienced project manager	11	1	5.0
23	3	Skilled artisans used in the execution of the project	12	2	1.5
27	3	Competent artisans and supervision.	12	2	1.5
28	1	Weekly progress feedback at fabricator	12	3	0.3
31	2	acceptable contractor productivity	12	1	2.0
31	1	adequate resource allocation as part of supervision	12	1	1.0
31	5	Equipment delivery on time	12	2	2.5
33	2	Project management (EC and <a href="#">Owner Project Management Company</a> ) team 3 days per week on site (compulsory)	12	1	2.0
45	4	Experienced construction team	12	2	2.0
61	2	Ramp-up in Construction Management focus and involvement	12	1	2.0
66	4	Fit for purpose design and execution	12	4	1.0

Note 1: Colour scales used to indicate relative importance.

Note 2: Spelling corrected where appropriate. Care was taken to preserve statement intent.

Note 3: Blue text indicates where data was desensitized.

Note 4: Category descriptions can be found in section 4.3. .

Note 5: ID refers to the participant ID.

**Table G-3 – Combined evaluation of success factors (prioritised according to average success)**

Success Factor No	Success Factor Category	Participant SF Evaluation		Generic SF Evaluation		Combined Evaluation
		Project Management Success	Project Success	Generic PM Success	Generic Project Success	Average Success
1	Clear Realistic and Agreed Project Objectives	8%	14%	25%	21%	17.0%
3	An Effective Project Team	18%	24%	9%	13%	15.8%
2	Effective Scope and Engineering Management	14%	15%	14%	11%	13.6%
4	Strong Support for Project	10%	15%	4%	7%	9.1%
9	Effective Contracting	14%	9%	5%	6%	8.2%
11	Strong Project Leadership	3%	4%	12%	13%	8.0%
6	Effective Project Planning and Controls	11%	4%	8%	7%	7.7%
8	Good Stakeholder and Communication Management	7%	4%	6%	6%	5.7%
5	Effective Project Management Approach	7%	6%	2%	4%	4.6%
10	Effective project setup	2%	2%	6%	5%	3.7%
7	Effective Risk and Assumptions Management	2%	1%	6%	4%	3.5%
12	Effective Construction Management	3%	2%	4%	3%	3.1%