

# **Value added approached to operations management in the consulting engineering industry**

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# ABSTRACT

The study examined project performance (PP), operations management performance (OMP) and operational personnel's interpretation of the value added (VA) concept with the focus falling on a consulting engineering company (service oriented organization). The primary objective of this research study was to assess these study elements and to determine whether a relationship exists between these elements in a consulting engineering company in South Africa.

A literature review was conducted to gain insight into these three study elements and to identify and discuss the different underlying elements and concepts. Afterwards an empirical study was conducted by using the knowledge gained from the literature review to develop a generic company and operations management value chain for a consulting engineering company as well as a questionnaire that could measure different aspects of these three main study elements. This questionnaire was distributed throughout a selected consulting engineering company in South Africa.

The data collected from the empirical study was statistically analysed and conclusions were drawn from the findings. The results on project performance indicated that overall project performance is of good quality, but that management is neglecting the company's financial side. The assessment of operations management indicated an average performance and that management focuses on executing a project in an efficient and professional manner, but are neglecting important elements that may affect project performance.

The assessment of the third study element, value added perceptions of operational personnel, indicated that operational personnel perceive that most value added to the company is created through the operations management department and that other departments are less important than the operations management department.

Examining the relationship off these three main study elements, it was concluded that the perceptions on strategic planning in a consulting engineering company do affect to some extent operations management performance elements, and that operations management performance elements do affect to some extent project performance elements.

It is the researcher's opinion that these results do not fully prove any relationship between these main study elements and therefore further studies are required.

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# LIST OF ABBREVIATIONS

<b>Acronym</b>	<b>Term</b>
CD	Company Departments
CSD	Client's Department
CE	Consulting Engineering
CEC	Consulting Engineering Company
CESA	Consulting Engineers South Africa
CRD	Corporate Services Department
CSP	Corporate Strategic Plan
ECSA	Engineering Council South Africa
EPA	Engineering Professional Act
FD	Financial Department
FMS	Flexible Manufacturing System
L	Loading
MCD	Marketing & Communications Department
OA	Operational Activities
OHC	Operational Hierarchy & Culture
OM	Operational Management
OMD	Operations Management Department
OMM	Operations Management Manager
OMP	Operations Management Performance
PM	Project Management
PPH	Project Performance and Health
PPM	Project Planning & Management
PSO	Professional Service Operations
PSOM	Professional Service Operations Management
RSA	Republic of South Africa
SDM	Strategic Department Management
SOP	Service Offering Process
T	Tooling
VA	Value Added

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# CHAPTER 1:

## NATURE AND SCOPE OF THIS STUDY

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### 1. INTRODUCTION

The world's population is growing exponentially and most of this growth is expected to occur in the developing and undeveloped countries. This growth creates and increases the demand for basic services (electricity, water, food, transportation, waste disposal, telecommunication, health-care and infrastructure). These are services that are already under pressure in developing countries due to the lack of funds, mall management and corruption. Furthermore, the UN is increasing this pressure to increase the quality of life of people worldwide. With the current surrounding environmental issues the task seems daunting (Amadei, 2004).

The consulting engineering industry in the world and the engineers they employ play an integral part in the economic, social and political spheres of each country (Amadei, 2004). Even though broader society is not always conscious of this fact, people rely on the technical expertise of engineers for their everyday living (Hecker, 1997:64).

Consulting engineering companies are professional firms that render services in the fields of electrical, electronic, mechanical or civil expertise, to name but a few of a vast range of services. These services could range from preliminary and detail designs to tender management and adjudications as well as business plans. As is the case with any professional services industry, consulting engineering requires educated and regulated skilled people in a vast range of fields. In South Africa, Consulting Engineers South Africa (CESA) and Engineering Council South Africa (ECSA) play an important role by governing and educating engineers as well as guiding Consulting Engineering companies.

According to Amadei (2004), developing countries are faced with many challenges. These include the growth of the population and the balance between quality of life and the environmental impact of acquiring this quality. Amadei (2004) further explains that for the past 150 years engineering practise has been based on a paradigm concerned with controlling nature. However, when entering the 21st century the paradigm must shift towards a more holistic approach to engineering. A great deal of research and development

worldwide are invested in renewable energy and more energy efficient technologies and techniques. This research has opened up new opportunities and challenges in the consulting engineering industry (Amadei, 2004).

In South Africa, as in the rest of the world, the spotlight falls on infrastructure and service delivery. In light of this Anon (2011) states that 83% of South Africa's CO<sub>2</sub> emissions are caused from the energy sector. South Africa contributes 1% globally to CO<sub>2</sub> emissions, which will quadruple before 2050. South Africa's economic growth rate is below average; however a strong growth rate is predicted for the rest of Africa. Together with a measure of engineering skills and many challenges such as corruption in Africa, this industry presents difficulties, but is rich in opportunities (Lotter, 2011).

Taking South Africa's economy, service delivery, infrastructure and challenges into account it is evident that consulting engineering companies play an important part in the 21st century. Therefore it is vital that these companies operate in a healthy competitive environment. It is also necessary that engineering projects are managed in such a manner to ensure that they are finished in time and within the budget. This will have a positive impact on South Africa economically, socially and politically.

With the help of governing bodies, such as CESA and the South African Government a way forward is to focus on the professionalisation of public services. This is coupled with the need for the increased infrastructure and planning, inspiring innovative planning by the government, the implementation of appropriate construction procurement models and the cultivation of a mutually trusting relationship between the private and public sector (Lotter, 2011).

Consulting engineering companies do not only have an important function to show the way forward and find solutions to future challenges. They also have a responsibility to do business ethically and to implement engineering projects in such way that it adds maximum value to the economic, social and environmental spheres of the country. When consulting engineering firms do not take this responsibility seriously it could lead to negative the economic growth, reduced service delivery and environmental hazards for South Africa.

Outside of the consulting engineering industry, consulting engineering companies have the potential and ability to contribute significantly to the development of an entrepreneurial and ethical climate inside the South African business sector.

The engineering industry is fast paced, limited in terms of resources (time and money) as well as environmentally and socially sensitive. Taking this situation into account consulting, there is only way for any consulting engineering company to stay competitive in this industry. This is to identify competitive advantages, develop business plans and structures around these advantages. It also entails creating a company structure that supports strategic initiatives, which is driven by adding optimal value to the company. Furthermore such a company needs to be innovative and creative and must make entrepreneurial and company value added thinking part of their daily operations.

Adding value to a company and achieving profitability and efficiency entails various elements. Among these are marketing, which increases projects and income and operations management, which delivers a service or product to a client according to what was marketed and communicated. Value can be increased through sound marketing while at the same time costs can be limited through sound operations management (Maliti, 2010:3).

According to Jacobs, Chase and Aquilano (2009:4) at the most fundamental level, operations and supply management means getting work done quickly, efficiently, without error and at low cost. Jacobs, *et al.* (2009:4) elaborates on this theme by defining operations as the processes used to transform the resources that a firm employ, into products and services that clients and customers desire.

Identifying competitive advantages is an important element in managing and driving a profitable, successful company. Such a competitive advantage distinguishes the company from their competition and gives them an opportunity to build a value based brand around such an advantage. Thus operations management plays an important role in identifying and creating competitive advantages.

Lombard (2012) stated during an interview that project managers and company directors want to know how a project's quality (efficient and effective) and health (financial) are affected operationally. They also want to know how resources can be allocated as efficiently as possible to ensure the successful projects through pro-active project management.

Project managers and company directors in the consulting engineering industry, however do not widely agree on their interpretation and understanding of the activities in a consulting engineering company's value chain that do add value to the client as well as the company. It is important to understand operations management inside a service oriented company, it is also necessary to understand how the interpretation of the value added concept affects the successful implementation of engineering projects in South Africa.



## 2. PROBLEM STATEMENT

***Do Diversified perceptions of the value added (VA) concept on operations management by operational personnel affect (relational) operations management and project performance in the consulting engineering industry?***

One of the most important objectives of a project manager is to provide the most value for the client and company with the resources at their disposal. They must plan strategically and make well thought out decisions with this “value added” concept in mind. Managers will do this by using every resource and asset at their disposal in such an effective and efficient way that the maximum amount of value is extracted out of the operational process.

- a) On a higher level, this may entail mergers, acquisitions and selling of highly valued assets at the right economic time.
- b) On a lower level it may entail a strategic action such as managing employee time, keeping costs to a minimum and ensuring efficient project management.

According to Jacobs, *et al.* (2009:7) operations management can be defined as *the design, operation and improvement of the systems that creates and delivers the company's primary services*. Monks (quoted by Amil Kumar & Suresh, 2009:9) defines operations management as *the process whereby resources, flowing within a defined system are combined and transformed by a controlled manner to add value in accordance with policies communicated by management*.

These definitions can also be interpreted as depicting the constant improvement of a system that creates and delivers value to the client as well as the company. Operations management is a key element in identifying and creating competitive advantages. Therefore it also is a key element in determining the total value that is added to a company.

Consulting engineering companies work project-oriented. In terms of this point of departure a project comes to life through a service oriented operational process, in the same way that a product is realised through an operational process that is focused on manufacturing. Lombard (2012) explains that an engineering project in its simplest form can consist of:

- a) **Desktop Study Element:** Identifying the client's need; investigating the need and finding a solution for that need; documenting the solution to that need. For example, designing an electrical distribution network for a new residential development.

- b) **Project Management Elements:** Physically implementing the construction of the engineering solution to the clients need. For example, by adjudicating the appointment of the tender and application procedures and by secure project management.

Lombard (2012) further explains: it is important that both of these project elements adhere to all quality and engineering specifications as set out by the engineering industry, and both need to answer the client's and regulatory bodies' requirements. Then a positive impact is made on the industry, the client, company as well as all governing aspects such as the economic, social and political spheres of the country.

It is sensible to take into account the important role that consulting engineering companies play (nationally and abroad), as well as how essential it is to implement and to complete engineering projects. In light of this it is important that engineering projects are executed with the necessary skills and experience. The operational processes also need to be in place to deliver these projects in time and under the budget.

The way managers perceive projects and their own input in maximizing the value that can be added to their company influence the strategies that are implemented and indorsed by top management (Lombard, 2012). Abbott (2012) during an interview agreed with this remark stating that any misinterpretation amongst project managers and company directors of the concept of added value could have negative consequences for the company. Abbott (2012) explains that a project manager may understand the value concept in such a way that he or she would rather spend time on marketing or technical activities than improving and reinventing the operation management of the company. Such a situation can lead to an inefficient and ineffective management of operations, which in turn may translate into unsuccessful implementation of projects, poor project performance and health.

In light of the above it is thus clear that it is necessary to understand the interplay (the effect of such interplay) between various elements in a company's operations management. This implies a relationship between operations management performance, project performance and operational personnel's perceptions on how much value is added to the company through different company departments and operational department activities. By determining this interplay it can provide insight into how operations management and project performance in consulting engineering companies in South Africa can be improved.

The aim of this study is to assess these study elements and to determine if such a relationship exists by gathering data on one consulting engineering company.

## 3. RESEARCH OBJECTIVES

### 3.1 Primary objectives

The primary objective of this research study is formulated as follows:

- a) Assessing operations management performance (OMP), project performance (PP) and operational personnel's interpretation of the value added (VA) concept with regard to operational management (OM) and determining whether a relationship exists between these three elements in a consulting engineering company in South Africa selected by the researcher.

### 3.2 Secondary objectives

- a) Conducting a literature review in order to gain insight into the dynamics of the consulting engineering industry.
- b) Determining through a literature review the underlining value chain activities that make out the general consulting engineering company's value chain, with the focus on operations management.
- c) Pointing out through a literature review the different underlining elements/variables that make out operations management in the consulting engineering industry.
- d) Pointing out through a literature review the different underlining elements/variables that make out project performance and health in the consulting engineering industry.
- e) Creating a general company value chain depicting the different department activities out of which a consulting engineering company consists.
- f) Creating a general operations management value chain that depicts the different operations management elements needed for a consulting engineering company.
- g) Using the general company and operations management value chain to create a measuring instrument capable of gauging the performance of operations management as well as the operational personnel's perceptions on the amount of value added to the company through different company departments and operational department activities.
- h) Identifying a consulting engineering company in South Africa that is willing to participate in this research study and then collecting data on the different study elements by distributing this measurement instrument throughout the company.

## 4. SCOPE OF THE STUDY

### 4.1 Field of this study

The field of this study with special reference to the service industry falls mainly into the following academics fields:

- a) Operational and supply management
- b) Organisational management
- c) Financial management

### 4.2 Organisations and geographical demarcation

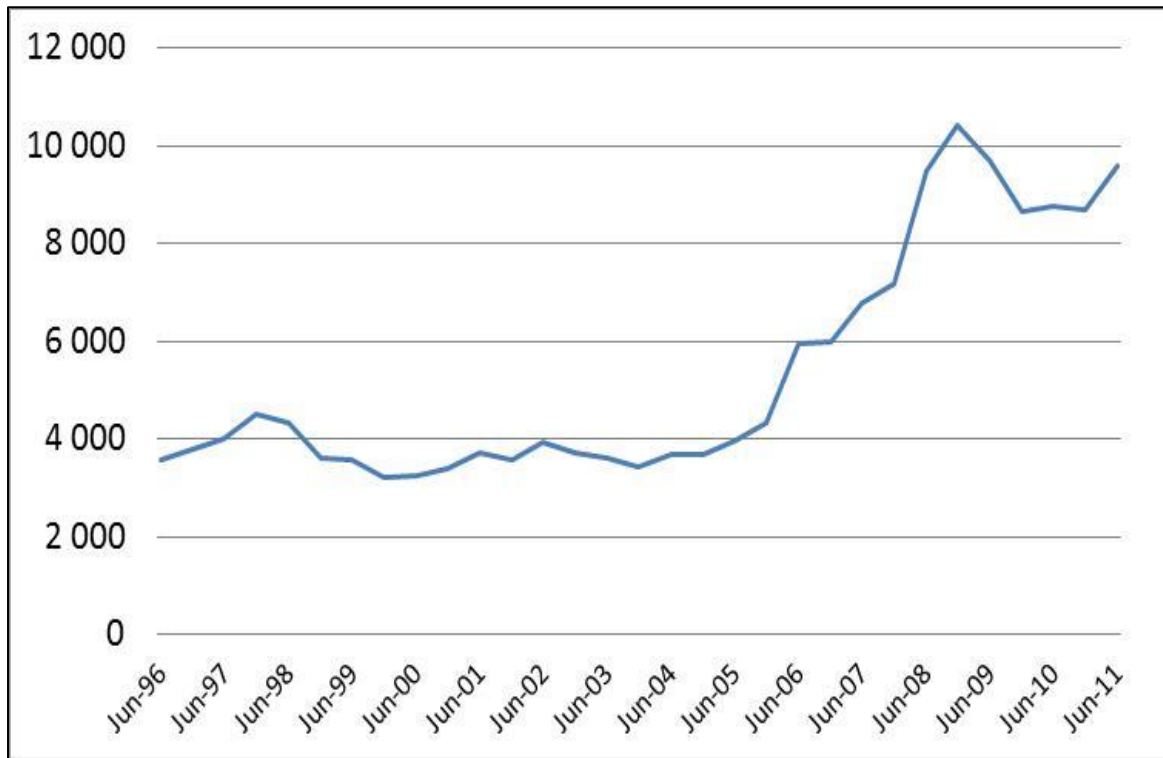
This study includes a single consulting engineering company in South Africa with the focus falling on the operational personnel that operates inside this company and the engineering projects that have been completed over the past years. The company that is selected specialises in electrical, electronic and mechanical engineering services with various branches over South Africa (Klerksdorp, Centurion, Robertson, Tzaneen and Richards Bay).

### 4.3 Industry

The industry under investigation is the consulting engineer industry in South Africa with special reference to electrical engineering. Figure 1 shows the Fee income (Rm) of the industry and figure 2 shows the Fee income percentage earned by sub-disciplines. Important organisations governing the consulting engineering industry and engineers are as follows:

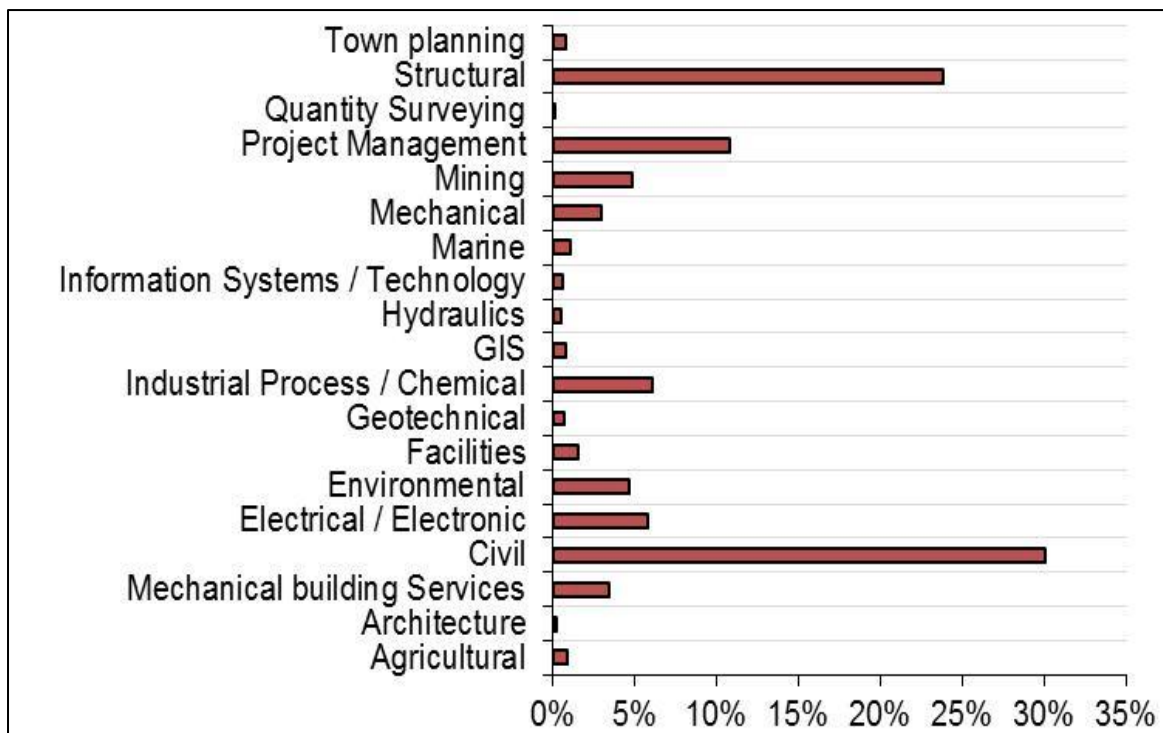
- a) The Engineering Council of South Africa (ECSA) is a statutory body established in terms of the Engineering Profession Act. The aim is to promote a high level of education and training of practitioners in the engineering profession in order to facilitate full recognition of professionalism in the engineering profession. (ECSA: 2012)
- b) Consulting Engineers South Africa (CESA) is recognised by the ECSA as a voluntary association in terms of section 25(3) and 35(1) of the Engineering Profession Act. CESA represents, for its members, a body which promotes their joint interests and because of its standing provides quality assurance for clients. (CESA: 2012)

Figure 1: Feed income (Rm) of the Consulting Engineering Industry



Source: Adopted from CESA (2011).

Figure 2: Fee income percentage (%) earned by sub-disciplines



Source: Adopted from CESA (2011).

## 5. RESEARCH METHODOLOGY

The research study aims at achieving the research objectives by breaking the study into two phases.

The first phase consists of a literature review that identifies and discusses the main research constructs and the underlying variables/elements that make out these constructs.

The second phase consists of an empirical study in which data from operational personnel and projects inside the selected consulting engineering company was collected with the use of a self-developed questionnaire. This questionnaire was distributed to various operational personnel throughout the consulting engineering company selected by the researcher.

These two phases are discussed in the following sections.

### 5.1 Literature review

The literature review contains relevant journal articles, websites articles, dissertations and text books used to obtain knowledge and to build an understanding of the relevant concepts of this study.

The literature review was conducted to gain insight into the different concepts and study elements that form part of this research study and to identify and discuss the different underlying elements that make out these study elements. The concepts that outline this literature review are defined as follows:

- a) General consulting engineering industry
- b) Service oriented company
- c) Value added concept
- d) Operations and project management
- e) Project performance and health

At the end of the chapter with the literature review the information uncovered during the review was used to construct a generalised company and operations management value chain for a consulting engineering company. These two value chains represent the different operational elements out of which a consulting engineering company would consist. The two value chains were used to guide the construction of a measuring instrument used in the empirical study.

## 5.2 Empirical study

A consulting engineering company specialising in electrical, electronic and mechanical engineering disciplines where identified. The company was approached with the idea of evaluating operational personnel's perceptions of value added operationally and to determine whether relationship can be pointed out that exists between these perceptions and operations and project performance.

The company approved of this study and decided to make available operational personnel, financial database as well as information on completed projects. Two methods were used during the empirical study to gather and collect data on all the identified study elements.

A measuring instrument was developed with the guidance of an operational and company value chain. This instrument was distributed in the company to collect information from operational personnel. Data was collected through these questionnaires on personnel's perceptions about the concept of added value in relation to operations management and operations management performance. The financial database of the selected consulting engineering company also was used to collect data on project performance.

The data that was collected empirically was employed to construct a data-set. From this data-set statistical analysis was done to assess the following elements: operations management, project performance and the operational personnel's perceptions towards the amount of value added to the company.

This section describes the following aspects: the study population and sample, the measuring instruments used, how the data was collected, building of the data-set and the statistical analysis of the data-set.

### 5.2.1 Main empirical study elements

The main empirical study elements that make out this study are defined as follows:

- a) Project performance and health
- b) Operations management performance
- c) Operational personnel's perception towards value added to the company through activities of departments and operations management
- d) Project characteristics
- e) Demographics of project managers

### 5.2.2 Study population and sample

The study population consists of the general consulting engineering companies in South Africa, the projects they implement and the operational personnel involved in the implementation of these projects.

The operational personnel referred to above include engineers, technicians and administrative personnel who act as project managers, project administrators and project engineers. They were involved with physical designs, site visits and procedures during the implementation of the project. A convenience sample method was used by choosing a single consulting engineering company in which the author of this research study works.

An amount of 34 operational personnel were identified inside the selected consulting engineering company. These personnel are spread out throughout the different company branches (Klerksdorp, Centurion, Tzaneen Robertson and Richards Bay). All 34 operational personnel were approached and provided with a questionnaire, they were asked to complete the questionnaire and to identify three projects each (a potential of 102 engineering projects) and to answer operational questions about these projects. A total amount of 23 questionnaires (67.65% of the research sample) were returned, of which 56 engineering projects (54.90% of the research sample) were identified by the respondents.

Generalisations about this consulting engineering company selected by the researcher can be made to improve operations management structures, because the study sample gives a realistic representation of the company itself.

Due to the fact that one consulting engineering company was selected for this research study, generalisations about the total population (consulting engineering companies in South Africa) cannot be made because this study sample does not represent all of the consulting engineering companies in South Africa. Although the above is true the results of this study can be viewed as a pilot study to encourage a more in depth study on all consulting engineering companies in South Africa.

In addition this study focuses on professional engineering projects and the professional operational people, such as project managers and directors involved with such projects. Only these functional demographic positions were targeted in this study. The decision was based on the fact that these positions are directly involved in the implementation of the different projects and that the management of such projects determine the outcome of a project.

### 5.2.3 Measuring instruments

From the literature review value chains were developed to assess company and operations management. These value chains summarise the different elements of this research study.

By using these two value chains a measuring instrument was developed consisting of three sections. The different sections of the measuring instrument are explained as follows:

a) **Section A:** value added.

The first section of this instrument represents a generalised company value chain for a consulting engineering industry. This value chain depicts the different departments that form the company and add value to it as well as a brief description of the activities that form part of the different departments. Seeing that this research study focuses on operations management, the operations management department is broken up into six sub-elements that add value to the operations department as a whole.

The purpose of this section was that the respondents study his or her company's value chain and to indicate how much value each activity in this chain adds to the company. This part of the instrument focused on operational personnel and their perceptions towards the concept of added value. The results of this exercise were seen as the operational personnel's perception of the amount of value added to the company by each value chain activity.

b) **Section B:** operations management and project performance.

This section of the measuring instrument focussed on three different elements: operations management performance, project performance and project demographic information. The aim was to measure these three elements for different projects of which the respondent acted as project manager.

Six sub-elements were used to measure the performance of operations management and in addition information on project performance and project demographic was collected. The aim of this section was for the respondents to select three projects in which they were involved with and to answer the different questions on operations management and project performance for each project.

c) **Section C:** operational personnel's demographics.

The final section of the measuring instrument dealt with demographical information about the different operational personnel who were involved in the projects as outlined in section B.

Refer to Appendix C for a representation of the measuring instrument used in this research study.

#### **5.2.4 Confidentiality**

The company and all participants were assured of confidentiality. The researcher gave the assurance that the company's project information and the individual results of company managers and directors will not be disclosed.

#### **5.2.5 Gathering of data**

Operational personnel inside the range of the study sample were identified after an appointment with the HR department. With the assistance of the payroll system as well all of the operational personnel inside the selected consulting engineering company could be identified.

The measurement instrument was sent electronically through email in Excel format to the different project managers who made out the study sample. Each email briefly outlined the objective of this study. The measuring instrument was accompanied by a covering letter assuring confidentiality, briefly explaining the study and the different elements, giving instructions on how to complete the instrument and contact information provided if assistance was required or an appointment had to be made.

During the course of distributing this instrument, various phone calls, Skype conferences and appointments was made helping the respondents to answer the different sections of the questionnaire correctly.

After all the measuring instruments were returned a second exercise was implemented by using the various projects that was indicated by operational personnel on the measuring instrument. The projects that were indicated were identified on the company's financial system. The company that was selected for the research study uses a financial system that records all projects and the corresponding financial and operational information. After the specific projects were identified the financial and operational data was retrieved.

#### **5.2.6 Building of the data-set**

Information for each of the main empirical study elements was collected from the measuring instrument and the company's financial database. This data was used to build a research study data-set for each project and project manager.

This data-set was employed to analyse the data statistically that was gathered. More detail regarding the structure of this data set is discussed and outlined in chapter 3.

### 5.2.7 Statistical analysis of data-set

Statistical consultation services of the North-West University (Potchefstroom Campus) were used to analyse the constructed data set.

Descriptive statistics were used to calculate mean (measure of central tendency) and standard deviation (indicate distributions or scattering of data) values for the different variables and the construct that make out this study. Where constructs were formulated out of different variables, Cronbach alpha coefficients were calculated to determine the internal consistency or average correlation between these variables and constructs to assess the reliability of such a construct. For the purpose of this study a Cronbach alpha coefficient of 0.7 were regarded as acceptable level of reliability

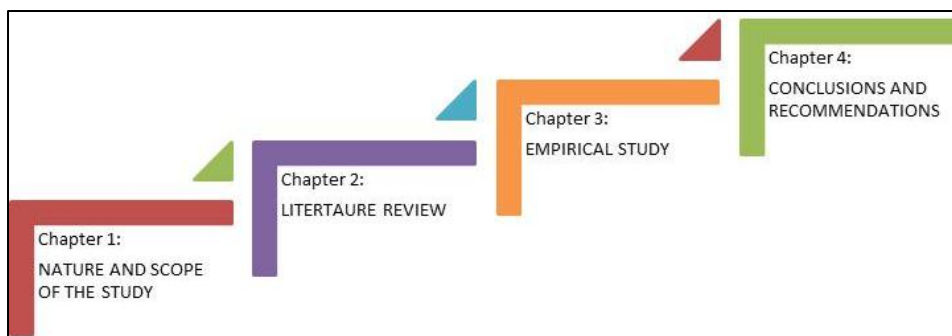
Independent t-tests were performed to determine the statistical significant (p-values) relationship between project and operational personnel's demographic and main study element variables. It was determined that the statistical significance could not be used in relationship analysis between study variables and demographic variables, because the sample size is too small per demographic group. Although it was determined that p-values will not be accurate enough, the effect size values (d-values) were used to measure if the differences between any of the project and operational personnel's demographic and main study element variables are of any practical significance.

The existence of a possible relationship between the main study elements were determined by performing a correlation analysis.

## 6. LAYOUT OF THE STUDY

The layout of this research study is structured into the following chapters:

**Figure 3: Layout of the study**



a) **Chapter 1** – Nature and scope of the study:

Chapter 1 introduces the reader to the research study concept. The chapter also discusses and defines the problem statement, research questions and research objectives.

Thereafter the chapter continuous to outline the research methodology used in the literature study and empirical study. This is done by discussing the design of the measuring instruments to gauge the alignment of the value added perception of the service offering by different managers, the performance of operations management and project performance and health. This chapter further describes the data gathering process and the statistical methods used to analyse the gathered data.

b) **Chapter 2** – Literature review:

Chapter 2 consist of a literature review on the following elements in the consulting engineering industry: service oriented company, concept of added value, operations and project management and project performance. All the different underlying concepts of the above are discussed and explained.

At the end of the chapter the content of the literature review is used to design a company value chain and operations management value chain for a general consulting engineering company.

c) **Chapter 3** – Empirical study

Chapter 3 outlines the empirical framework used in this study and discusses linear regression models design and the respective dependent and independent variables. This chapter in addition presents the results gathered and analysed according to the research methodology and empirical framework. These results are discussed and elaborated on.

d) **Chapter 4** – Conclusions and recommendations:

The final chapter consists of conclusions and recommendations from the findings obtained in the study. The achievement of the research objectives of the study is assessed and recommendations on future research are made.

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# CHAPTER 2:

# LITERATURE REVIEW

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## 1. INTRODUCTION

The aim of the literature review is to give insight into the dynamics of the consulting engineering industry, the underlining value chain activities that make out the general consulting engineering company's value chain with the focus on operations management, the different underlining elements/variables that makes out project performance and health and operations management in the consulting engineering industry.

This research study is based on consulting engineering companies which are according to CESA (2012) service oriented. To fully understand and build an operational framework around the processes involved in a service oriented company, one should first understand the nature and characteristics of a consulting engineering company and how a service oriented company differs from a manufacturing company.

The first part of the literature review aims at doing this by giving the reader an overview of the consulting engineering industry and business. This is done by briefly discussing the different elements and characteristics of the industry, by defining a professional service operation (PSO), the professional service operations management (PSOM) and by discussing how service offerings differ from product offerings.

Looking at the value added concept, Kickul, Griffiths, Jayaram and Wagner (2010:78) suggests that both operations management and entrepreneurship can lead to new value creation across and within industry and lead to firm level boundaries. Starovic, Cooper and Davis (2004:3) suggest that most companies would describe themselves as being in the business of maximizing value for their shareholders; however, how that value is defined, measured and pursued is somewhat more debatable.

Understanding how project managers in a consulting engineering company perceive the value added concept, the second part of this literature review aims to give the reader a better understanding of the concept of added value from a business point of view. This is done by defining the value added concept and briefly exploring and discussing one value

oriented business strategy called value based management (VBM), and one value oriented analysing instrument called Porter's Value Chain.

Steinberg (1990:104) explains that historically operations management focused exclusively on the manufacturing industry; however the scope of operations management has broadened and these concepts and techniques are now also being applied and used in the service oriented industry. Previous research has long indicated that service-oriented activities require the same sort of disciplines and strategies that make modern manufacturing so efficient (Brennan, 2006:98).

Kickul, *et al.* (2010:78) suggests that operations management and supply chain management can facilitate the creation of a sustainable competitive advantage that can lead to new business and company growth development.

The third part of this literature review identifies and discusses different elements that form part of operations management and the fourth part briefly discusses project performance and health.

This literature review is structured around consulting engineering, the service oriented company, the concept of added value , operations management and project performance. Each of these disciplines has the potential to form an extensive study, but the purpose of this literature review is to review literature surrounding these disciplines briefly and to formulate a framework under which operations management in a consulting engineering company can to a certain extent be understood.

At the end of this chapter the information in the literature study is used to formulate a company and operations management value chain for a general consulting engineering company. These value chains will be used in the research study as measuring instruments as described by the research methodology of this study.

## **2. CONSULTING ENGINEERING**

### **2.1 Introduction**

Consulting engineering companies are service oriented companies which offer a mix of services and products to their clients and customers (ECSA, 2012a:3). Yang & Chou (2010:1183) defines the responsibility of consulting engineering companies as that of

designing and planning the construction, operation and maintenance of infrastructures and facilities to meet clients' needs.

Engineering is a profession and activity that provides important services to individuals, enterprises and the government and is essential to meeting the needs of people, to economic development and to the provision of services to society (ECSA, 2012a:3).

This research study focuses on a consulting engineering company. To get a better understanding of how such a company operates, it is important to understand the characteristics and nature of the industry in which it operates.

The aim of this literature review section is to give the reader an overview of the consulting engineering industry and business. This is done by discussing the different elements and characteristics of the industry briefly. The elements that are discussed in this section take a look at engineering as a profession, risks and regulations of engineering work, engineering disciplines, registration categories, economic sectors, client types, resource dimensions, engineering soft skills and the key success factors of consulting engineering.

## **2.2 Engineering as a profession**

Engineering as a profession involves the purposeful application of mathematical and natural science and a body of engineering knowledge, technology and techniques (ECSA, 2012a:3). ECSA (2012a:3) states that engineering aims to produce solutions to specific problems. It is further stated that the effects of these solutions are often uncertain and that critical engineering decisions rely on practical experience.

Yang (2010:1183) argues that the professional role of engineering has evolved from the role of the traditional technical expert to that of the entrepreneurial business engineer.

ECSA (2012a:3) elaborates on the importance of engineering because of the social, economic and environmental risks involved. ECSA (2012a:3) therefore states that engineering must be carried out competently, responsibly and ethically in the following way:

- a) Available resources must be used efficiently.
- b) It must be economically sustainable.
- c) It must ensure health and safety.
- d) It must be environmentally sound and sustainable.
- e) Generally it must manage risks throughout the entire lifecycle of a project product or system.

## 2.3 Risks of engineering work

Engineering is important due to the benefits economically, socially and environmentally, but engineering must be carried out competently, because of the risks involved. These risks arise because of the means used to produce engineering solution and products that generally exploit or attempt to control natural forces or complex processes. ECSA (2012a:3) states that the exploitation of the following can have a negative impact socially, economically or environmentally:

- a) Exploitation of natural resources and harnessing of energy for useful purposes.
- b) Use of materials and substances with useful chemical or physical properties and machinery and equipment.
- c) Transfer storage and processing of information.
- d) Construction, maintenance, refurbishment and demolition of buildings and engineering structures.
- e) Organization and control of system processes.

## 2.4 Regulation of engineering work

The practice of engineering work is regulated both on a general and specific level: general provisions are contained in the Engineering Profession Act, 2000 (EPA) (No. 46 of 2000) and specific provisions exist in a number of other Acts (ECSA, 2012a:6).

According to ECSA (2012a:6), EPA establishes the professional and candidate categories and defines the requirements for registration; an applicant for registration must demonstrate competency against the standards for the category determined by the ECSA Council. These standards are defined in published competency standards documents that represent the required entry level performance for registration (ECSA, 2012a:6).

Consulting Engineers South Africa (CESA) is a governing association which gives engineering consulting companies the opportunity to register as a CESA member. CESA represents for its members, a body that promotes their joint interests and, because of its standing, provides quality assurance for clients (CESA, 2012).

CESA (2012) states that they are committed to enhancing the professional and business interests of its members, improving the quality of life for all South Africans by the promotion of engineering excellence and serving clients with professionalism, integrity and independence of judgement.

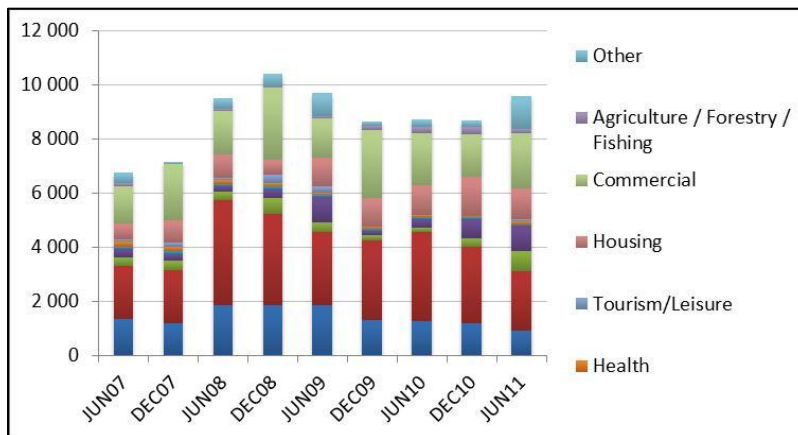
## 2.5 Engineering disciplines and registration categories

ECSA (2012a:3) defines the different engineering registration categories as a professional engineer, professional engineering technologist, professional engineering technician and Profession Certificated Engineer. ECSA (2012a:5) further defines the different engineering disciplines as aeronautical, agricultural, chemical, civil, electrical, industrial, mechanical, metallurgical and materials and mining.

## 2.6 Economic sectors & client types

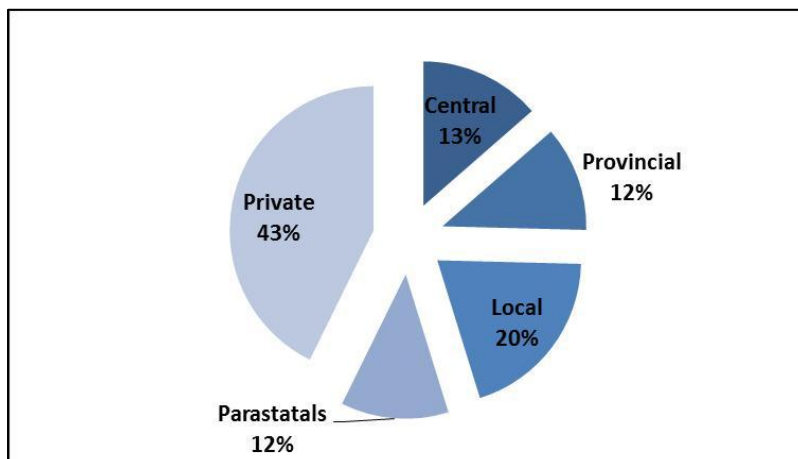
CESA (2011) indicates the different fee earnings per economic sector and percentage fee earnings per client type in the Bi-Annual Economic and Capacity Survey Report as depicted in the following figures.

**Figure 4: Fee income percentage (Rm) earned by economic sectors**



Source: Adopted from CESA (2011).

**Figure 5: Fee income percentage (%) earned by client type**



Source: Adopted from CESA (2011).

## 2.7 Resource dimensions

Consulting Engineering companies have essentially two major resource dimensions, personnel and equipment (Roger & Krasner, 1990:37). Personnel or employees with various technical skills and experience are the heart of the company. Equipment such as engineering software packages and computers are the indispensable tools of the engineer, helping the engineer to increase engineering performance, productivity and accurateness. Each personnel or equipment resource can be attained through hiring, purchase or contractual arrangements for use without ownership (Roger, *et al.*, 1990:37).

## 2.8 Engineering soft skills

Hecker (1997:62) argues in her writing (*Successful Consulting Engineering*) that an engineer must have a combination of technical and non-technical skills. Hecker (1997:62) states that an engineer will be presented with non-technical job tasks early in their careers, job tasks that their educational institution did not focus on.

These non-technical skills called soft skills are of great importance to an engineer in the consulting engineering industry. The most important soft skill to master is to communicate effectively (Hecker, 1997:62).

Hecker (1997:62) further states that engineering students must understand that once they graduate they embark on a lifetime journey of self-improvement in developing soft skills.

According to Brennan (2006:99) tooling is the process of deciding which skills employees require when it comes to operations management. Taking this terminology one step further, tooling is also about educating and teaching employees certain skills. Brennan (2009, 99) explains that tooling can create increased generalised skill sets amongst employees. This increase in generalised skills will increase the flexibility and responsiveness of the task force thus increasing operational performance.

Taking the above into consideration it can be concluded it is important for soft engineering, skills as Hecker explained, to form part of the tooling elements, as Brennan elucidated further. These concepts are discussed in more detail in the operations management section.

Hecker (1997:63) describes the general soft skills that any engineer in a consulting engineering company would have to master in the following table.

**Table 1: Engineering soft skills**

RESPONSIBILITY	SOFT SKILLS/EXPERTISE REQUIRED
Negotiate Contracts	<ol style="list-style-type: none"> <li>1. Listen actively.</li> <li>2. Speak to be understood.</li> <li>3. Separate the people from the problem.</li> <li>4. Identify interests.</li> <li>5. Invent options for mutual gain.</li> </ol>
Write Proposals	<ol style="list-style-type: none"> <li>1. Determine project issues and develop a unique approach.</li> <li>2. Write correctly and persuasively.</li> <li>3. Portray technical issues in a down-to-earth, friendly manner on paper.</li> <li>4. Convince others that you are someone with whom they would want to work.</li> </ol>
Author studies, reports, papers, letters	<ol style="list-style-type: none"> <li>1. Determine in advance what the client expects and how the written document will be used.</li> <li>2. Write grammatically correct, clear and, concise communication documents that meet clients' needs and expectations.</li> <li>3. Relay technical issues and topics in a straightforward, understandable manner.</li> </ol>
Supervise Employees	<ol style="list-style-type: none"> <li>1. Provide constructive feedback.</li> <li>2. Encourage excellence and continual improvement.</li> <li>3. Provide vision and direction.</li> <li>4. Inspire and motivate.</li> </ol>
Client Relations and Communications	<ol style="list-style-type: none"> <li>1. Listen actively.</li> <li>2. Resolve conflict.</li> <li>3. Help clients determine what they need.</li> <li>4. Share technical information with a nontechnical audience.</li> <li>5. Make a friend.</li> </ol>
Lead Work Teams	<ol style="list-style-type: none"> <li>1. Facilitate meetings.</li> <li>2. Manage group processes.</li> <li>3. Encourage participation.</li> <li>4. Reach consensus and lead by example.</li> </ol>
Make Presentations	<ol style="list-style-type: none"> <li>1. Understand audience needs.</li> <li>2. Use effective verbal and nonverbal communication in front of groups.</li> <li>3. Appear poised, knowledgeable, enthusiastic and confident in front of others.</li> <li>4. Organise and present materials in a concise, interesting manner.</li> </ol>

Source: Adapted from Hecker (1997:63).

## 2.9 Key factors to successful consulting engineering

When looking at a successful consulting engineering company, Hecker (1997:63) identifies the following areas that are vital for success:

**a) Project management:**

Project management is one of consulting engineers' core principles and clients will appoint consulting engineers who have proved that they can manage their project and also do it proactively (Hecker, 1997:63).

**b) Client relations:**

If consulting engineering companies wish to be appointed by their existing clients to do new work, they need to provide a high level of service. This requires skills in communications, management and teamwork (Hecker, 1997:63). Building a relationship with a client requires active listening, the ability to show concern and empathy and a positive attitude (Hecker, 1997:63).

**c) Marketing:**

The Primary source of income for consulting engineers is their time and knowledge. Clients tend to assume that engineers are technically competent and therefore clients will rather appoint an engineering company whose employees have proven themselves to communicate and manage projects effectively (Hecker, 1997:64).

**d) People Management:**

It is important for an engineer to harness a teams' power effectively, effective managers need to foster collaboration and motivation, to provide feedback, promote beneficial change and be inspirational (Hecker, 1997:64).

**e) Human Resources:**

The ability to attract, develop, retain, and deploy staff is the single biggest determinant of a professional service firm's competitive success. Human resource issues, such as recruiting, training, and development form an essential part of a professional services firm's competitive strategy (Maister, 1993:93).

Yang (2010:1183) argues that a well-run consulting company must attain a management advantage when facing the global economy, international competition and high quality requirements. Yang (2010:1183) then says that the only way to achieve this management advantage and to ensure profitability would require the consulting company to:

- a) Anticipate the needs of future markets.
- b) Find a systematic way to assign its staff to incoming projects.

The systematic way of assigning staff to incoming projects can be linked to loading, which is an element of operations management. Brennan (2006:99) defines the loading concept as the process of deciding how the work queues should be combined when it comes to operations management.

Taking Yang's argument into consideration it can be stated that operations management elements can also be classified as key success factors of a successful consulting engineering company.

These concepts are discussed in more detail in the section covering operations management.

## **3. SERVICE ORIENTED COMPANY**

### **3.1 Introduction**

The previous section discussed the characteristics and nature of the industry in which consulting engineering companies are operating. The purpose of such a discussion was to start forming an operational framework around the concept of consulting engineering and to understand how these types of companies operate.

Taking this literature review one step further, understanding the nature and characteristics of a service company (consulting engineering companies are service oriented companies that offers a mix of services and products to their clients and customers ) is necessary to understand and build an operational framework around the processes involved in a service oriented company and thus a consulting engineering company.

The aim of this literature review section is to give the reader an overview of service oriented companies by defining a professional service operation (PSO) and the professional service operations management (PSOM), as well as describing how service offerings differ from product offerings and service design.

### 3.2 Professional service organization

Lewis and Brown (2011:2) argues that customer interaction, customization, flexible processes, high cost labour and low cost capital characteristics forms part of the main components of a service oriented company. Maister (1993:3) agrees by defining the nature of a professional service organisation as having a high degree of customization in their work and that face-to-face interaction with their clients is a strong component for these companies.

According to Maister (1993:3) professional service organisations should manage these customised activities. He states further that very special skills are required of top performers.

Michael and Andrew (2012:2) assert that the interaction of these components (customisation and client contact) contribute to more process variations operationally in service offering than in product offerings. Maister (1993:3) argues that this calls for a company to attract and retain highly skilled individuals. Maister (1993:3) therefore states that the professional service is involved in two market places: in the services market place and in the market place for skilled operational personnel. These companies should balance the demands of the client marketplace and the people marketplace.

Consulting engineering companies are exposed to these process variations operationally, because of customised activities and a high level of client contact inside the services process.

Taking all of the above into consideration, for a professional services firm to gain a competitive advantage the principal of operational leveraging becomes important (Maister, 1993:165). This principle implies that a services firm trains, develops and empowers its junior and middle management employees to do projects and perform tasks that have the complexity levels of senior management employees. The difference in turn over costs of these lower level employees and the fees charged for the work done as if by senior individuals gives such firms a competitive advantage (Maister, 1993:165).

Service oriented companies such as consulting engineering companies ought to manage the various types of work done by different types of ECSA registered operational personnel (engineers, technologists and technicians ) as defined by ECSA.

Maister (1993:198) confirms this by stating that professional services firms must devise management approaches that ensure that lower value work is not being done by higher-priced people, except where absolutely necessary.

### 3.3 The professional employee

A consulting engineering company attracts and retains highly skilled individuals, as discussed in the section on professional service organisation. In such a professional services company, both productivity and quality are correlated with the degree to which the professional worker is engaged and committed to the task at hand.

Maister (1993:3) argues that a service oriented company should be involved in the people market place in order to acquire highly skilled personnel. However, it is even more important to retain these highly qualified operational personnel in a service oriented company.

High motivation leads to high productivity and quality, which leads to marketplace success. In turn, this results in economic success for the firm, allowing the firm to be generous with its rewards, including high compensation, good promotion opportunities, and challenging work. This atmosphere of ample reward breeds good morale, which results in high motivation –and the cycle begins anew (Maister, 1993:169).

Maister (1993:171) is of the opinion that it is the role of the supervisor in a professional services firm to help create the conditions under which the forces of commitment, creativity, and involvement can be unleashed. The supervisor must help the professional find the meaning in the work to be done.

In the management of professionals the supervisor should be very clear on the *what* (provide clear goals), spend only the bare minimum of time on the *how* (involve them in decision-making, provide autonomy) and spend a lot of time on the *why* (provide meaning) (Maister, 1993:173).

### 3.4 Professional service operation

Professional service organisations (PSO) portray specific operational characteristics in which the service process is designed and managed. These specific characteristics make up a consulting engineering company and these characteristics are thus discussed briefly in this section.

Sampson and Froehle (as quoted by Lewis and Brown, 2012:2) argue that the presence of high customer contact and inputs is a necessary and sufficient condition to define a production process as a service process, and that these customer interactions are the most important factor in operations management strategies. It is widely accepted that the PSO type of operations has the most customer interaction, because the client or customer with

the consultant or producer define the service package (Lewis, *et al.*, 2012:2). Because of the high customer contact, service customisation is a necessity; not one customer's need will fully present that of another customer (Lewis, *et al.*, 2012:2).

High levels of customer interaction require fluid and flexible processes to accommodate the customisation of service oriented operations (Lewis, *et al.*, 2012:2). Lewis, *et al.* (2012:2) are of the opinion that service process variation and relatively slow throughput time is directly correlated to the complexity of the service offering design.

PSOs have a high labour cost system which is normalised by a low cost capital system, labour is expensive because professional employees are needed and these professional employees are externally regulated and controlled regarding their education and practise. These professionals must also adhere to explicit and external codes of ethics and implicit norms that guide appropriate professional behaviour (Lewis, *et al.*, 2012:2). Michael, *et al.* (2012:2), elaborates on the pros and cons of PSOs by referring to the high costs of labour and also the low costs of capital. These characteristics allow PSOs to adopt different organisational structures such as a partnership.

The characteristics of PSOs represents a different context of deploying operations management tools and techniques, for example PSOs typically will focus less on process standardisation and automation and more on a form of leveraged work management, where a different combination of lower cost or qualified labour is used (Lewis, *et al.*, 2012:2).

### 3.5 Professional service operations management

Operations management for professional service oriented companies is unique. Therefore such a professional service operations management (PSOM) strategy should focus operationally on the management of the PSO characteristics (customer, service offering customisation, service processes and the professional engineer).

Lewis, *et al.* (2012:3) argues that the PSOM strategy should focus on the management of the PSO characteristics operationally and suggests the following:

- a) **Managing customers and customization:** Clients may find it difficult to evaluate the quality of professional service. Factors such as organisational reputation, employee appearance, employee behaviour, flexibility to adapt to individual customer's varying needs and supporting facilities can be managed to increase service quality of a company.

- b) **Managing processes:** Factors such as limited repetitive learning opportunities, lack of task standardisation, professional judgements and uncertain and highly variable completion times can be managed to increase the quality of the PSOs that are processed.
- c) **Managing professionals and professional organisations:** Managing professionals are about subtle influences: guiding, nudging and persuading. Factors such as partnership structure and incentive programs can be managed accordingly.

### 3.6 Difference Between Product and Service Offerings

The literature review has thus far determined that a difference in operations exist between product (manufacturing oriented operations) and service offering (service oriented operations). Although the difference between these two categories has been outlined, this section will elaborate on the difference.

Jacobs, *et al.* (2009:10) defines five differences between a service and a product; these differences are given as follows:

- a) Compared to a product, service is an intangible process where the service itself cannot be weighted or measured.
- b) Compared to a product which is manufactured in a facility with no client interactions, service requires some degree of interaction with the customer or client.
- c) Services are heterogeneous: they will vary from day to day as a function of the attitudes and characteristics of the different stakeholders involved in the transformation process.
- d) Compared to products that can be stored, service as a process is perishable and dependent on time.
- e) Specifications of a service are defined and evaluated as a package of features that affect the five senses. These features are defined by Jacobs, *et al.* (2009:6) as follows:
  - i. Supporting facilities (location, decoration, layout, architectural appropriateness, supporting equipment)
  - ii. Facilitating goods (variety, consistency, quantity)
  - iii. Explicit services (training of personnel, consistency of service performance, availability and access to the service)

- iv. Implicit services (attitudes of the servers, atmosphere, waiting time, status, privacy, security and convenience)

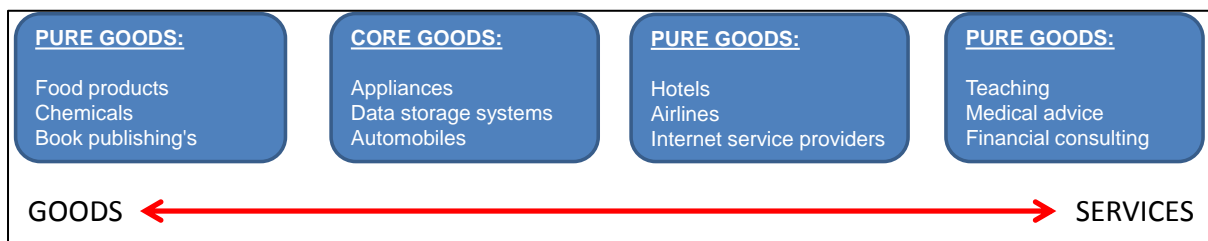
Armistead (1989:248) defines a service offering as:

- a) a mixture of physical item(-s) or piece(-s) of work;
- b) the interaction of the service organisation with the customer or client through a personal face-to-face encounter.

Furthermore Armistead (1989:248) shows that normally a service oriented organisation offers not only one service but a service bundle that consists of a number of services, and that each specific service offered involves a number of stages and interaction with different stakeholders. The core characteristics and nature of a service offering have a potential and inherent variability that increases the likelihood of error high and often make it visible to the stakeholders who are present in at least one of the stages of the production value chain (Armistead, 1989:248).

Companies usually offer a combination of a goods and service that can fall into one of four categories as defined by the goods-services continuum.

**Figure 6: Goods and services continuum**



Source: Adopted from Jacobs, *et al.* (2009:11).

Taking all of the above into account, it can be concluded that difference between the service offering and product offering exist, these will affect the operational process design for a company that is service or manufactured oriented, and thus the operations management thereof. Consulting engineering companies must take these differences into consideration when looking at operations management.

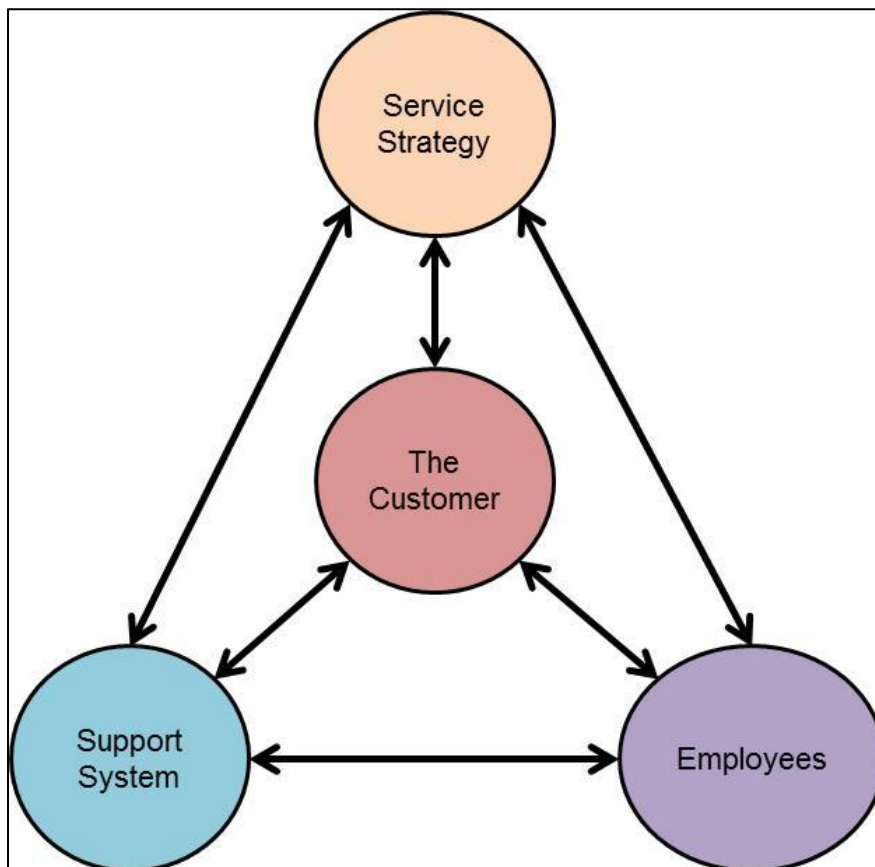
### 3.7 Service design

The service design is the framework used to form and deliver a service or product to the customer, this is important to understand when looking at consulting engineering companies.

The service design for a consulting engineering company can be explained by the service triangle as defined by Jacobs, *et al.* (2009:256). This service triangle is at the core of a service oriented company. Such a service triangle should be taken into consideration when looking at the operations management of a consulting engineering company.

Jacobs, *et al.* (2009:256) demonstrates operationally in the following figure how such a service triangle should look like.

**Figure 7: Service triangle**



Source: Adopted from Jacobs, *et al.* (2009:256).

The role of operations in this triangle is important. Operations are responsible for the services systems (procedures, equipment and facilities) and for managing the work of the service workforce.

Jacobs, *et al.* (2009:257) defines the service design characteristics operationally as follows:

- a) Customer contact: Where the customers are involved, the physical service offering process is present.
- b) Creation of the service offering: work process involved in providing the service.

- c) Extent of contact: Percentage of time that the customer is part of the system.

These service design characteristics can be used to distinguish different service oriented companies.

Jacobs, *et al.* (2009:267) defines the following characteristics of a well-designed service system:

- a) Each element of the service system is consistent with the operating focus of the company.
- b) The system is user friendly.
- c) It is robust.
- d) It is structured so that consistent performance by its people and systems is easily maintained.
- e) It provides effective links between the back office and the front office so that nothing falls between the cracks.

Several factors distinguish service design from manufactured product development. Jacobs, *et al.* (2009:259) briefly explains such differences as follows:

- a) In manufacturing the process and the product must be developed simultaneously; in services the process is the product.
- b) Although equipment and software that supports a service can be protected by legal protection, a service operation does not have this legal protection usually available for goods.
- c) The service package, rather than a definable goods product, constitutes the major output of the development process.
- d) Many aspects of the service package are often defined by the training individuals receive before they become part of the service organization.

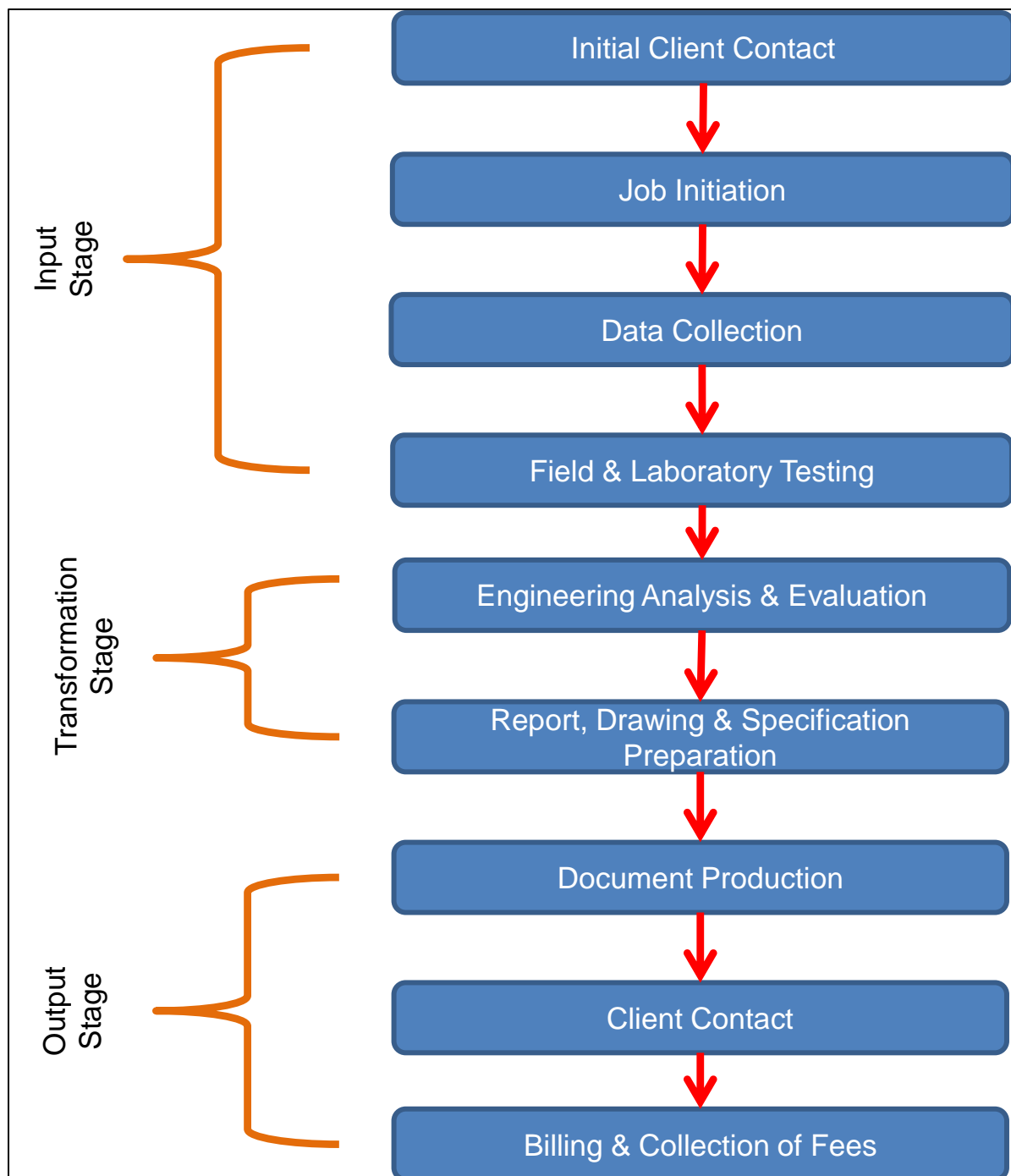
Consulting engineering companies should make the service triangle the centre of their service design. They should also include the focus elements of this service triangle in the operational process design used to create the different services and products. These services and products are sold to clients through the offering process design of which both these process design forms part of the same process design for a service oriented company.

The operational process design used in a company's service design is fundamental to the service design. This operational process will differ from consulting engineering company to

consulting engineering company depending on the exact service the particular company delivers to its clients.

Steinberg (1990:104) illustrates a simplified flow chart depicting a general service design for an engineering consulting company.

**Figure 8: Service design for a typical engineering company**



Source: Adapted from Steinberg (1990:104).

## 4. VALUE ADDED CONCEPT

### 4.1 Introduction

One aspect of this research study focuses on how project managers understand the value added concept inside a consulting engineering company. Taking this concept one step further, this research study aims to identify how much value, as perceived by project managers, is added through operations management activities to the company. Understanding this, a link may be established between value added perception of operations management activities and the performance of operations management.

Most companies would describe themselves as being in the business of maximising value for their shareholders, but how that value is defined, measured and pursued is debatable (Starovic, *et al.*, 2004:3).

Starovic, *et al.*, (2004:3) explains that it is not hard to find examples of decisions that do not take long-term value into account. In many cases, decisions that destroy value are not driven by greed or dishonesty, but by the result of pursuing legitimate business objectives such as growth or increasing market share. Starovic, *et al.*, (2004:3) identifies the problem: managers often lack understanding of the difference between decisions that lead to higher profits and those decisions that create value.

Consulting engineering firms are usually managed by professional engineers who are directly involved in the marketing and operations aspect of the company, as is the case in any small to medium-sized service delivery firm in South Africa. The perceptions of these engineers regarding maximisation of value for their company or the value added concept are translated into the day to day operations of the company which realises a certain amount of profit.

Engineers are value oriented, which is good; they will always decide which activities are value added and will never involve themselves in activities that do not add value to their project. The problem is that engineers use their understanding of value added activities with regard to engineering work, and superimpose these methods on day- to-day operations of their consulting companies. In short, engineers use value added principles from an engineer's perspective to manage their companies, which should be managed from a business perspective of added value (Lombard, 2012).

Starovic, *et al.* (2004:3) elaborates on this problem by saying that actions by managers will be governed by any number of received business wisdoms about growth, innovation, customer satisfaction, market share, etcetera. These are the common and frequently conflicting choices available. Most managers will struggle to prioritise them or understand the casual relationships between these objectives and a sustained growth in profits (Starovic, *et al.*, 2004:3).

The business world has become more value oriented and businesses are focussing on value added activities to differentiate themselves and to create competitive advantages, this has led to new value oriented strategies, value added analysing instruments and value added measuring instruments.

Steinberg (1990:1.6) argues that value analysis can be used as an approach to analyse the costs and efficiencies of a technical project, as well as evaluating administrative procedures such as paper flow, management of records, forms and office equipment.

According to Kickul, *et al.* (2010:78), both operations management and entrepreneurship can lead to new value creation across and within industry and firm level boundaries.

This literature review section aims to give the reader a better understanding of the concept of added value from a business point of view. This is done by defining the value added concept and briefly exploring and discussing Porter's Value Chain, as well as one value oriented business strategy, which is called value based management (VBM).

## 4.2 Defining value

According to CBEOD (2012) the meaning of the word "value" is the amount of money that something is worth, CAEOD (2012) defines "value" as importance, worth or benefit and OEOD (2012) defines it as the regard that something is held to deserve, the importance, worth or usefulness of something else.

Value can be added economically or product wise. CBEOD (2012) defines the general term "value added" as the increase in the value of a resource, product or service as the result of a particular process or as the result of something useful that someone has given to a company, especially something that helps the company make more money. OEOD (2012) defines the same term "value added" as the amount by which the value of an article is increased at each stage of its production, excluding the initial costs and having features added to a basic line or model for which the buyer is prepared to pay. BOD (2012) looks at

the process by defining “value added” as any steps in the production process that improve the product for the customer and results in a higher net worth. Or it can be seen as the difference between the cost of materials purchased by a firm and the price at which it sells the goods that use those materials.

From an economical point of view, CBEOD (2012) defines “economic value” as the value of an asset calculated according to its ability to produce income in the future. CBEOD (2012) defines “economic value added” as the amount by which the profit made by a company exceeds the capital it has invested to make that profit. Economic value added is considered to be a way of measuring how successful a company is.

Summarising the above, the value of a product or a service is something that is important and beneficial to someone the value can be measured in terms of the amount of money the product or service can generate relative to its costs. Adding value to a service or product means that a production process is in place to improve or deliver the service or product at a cost less than it is sold for. The measurement of the value of a product or service can be measured as follows:

Value Added (**V**) = Selling Price (**S**) – Operations and Manufacturing Costs (**C**)

The added economic value is a measure of a company’s financial performance based on the residual wealth, which is calculated by deducting cost of capital from its operating profit.

Economic value added (**EVA**) = Net operating profit after taxes (**NOPAT**) – (Capital \* Cost of Capital)

Understanding the value added concept is one thing but understanding and evaluating the value added concept inside a company is something else. A value chain of a company tries to explain the value added concept inside a company by analysing how one activity adds value to the other and in the end to the client and company itself. The following section discusses this value chain in more depth.

## 4.3 Value chain

### 4.3.1 Introduction

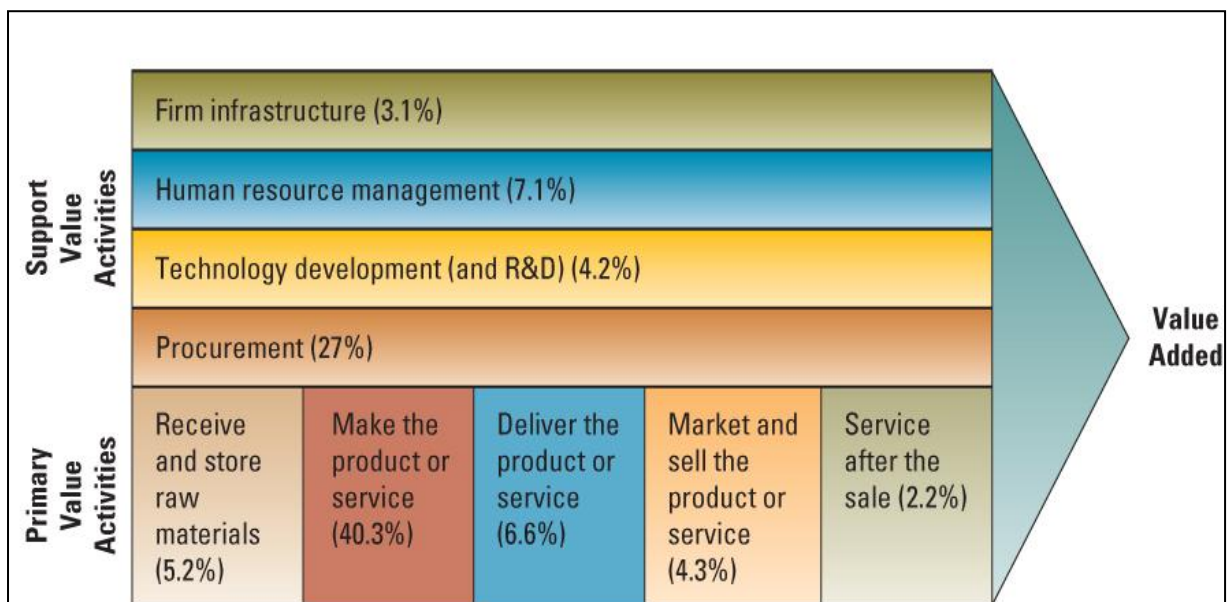
For a company to achieve an end result, for example a product or service, certain steps and certain working activities must be executed in a certain order. Each step adds value to the next step and to the overall end-result. This process is called a value chain of a company.

The way in which value chain activities are performed determines the costs and profit of a company.

Porter (1985:33) explains that competitive advantage stems from the many discrete activities a firm performs in designing, producing, marketing, delivering and supporting its products. All of these activities can contribute to a firm's relative cost position and create a basis for differentiation. Porter (1985:33) states that in order to analyse the sources of competitive advantage, all the activities that a firm performs and how interaction takes place need to be examined in a systematic way. BOD (2012) defines a "value chain" as an interlinked value-adding activity that converts inputs into outputs, which in turn add to the bottom line and helps create a competitive advantage.

Baltzan & Phillips (2010:21) views an organization as a series of processes, each of which adds value to a product or service for each customer/client, and thus is called the value chain. A company's value chain consists of primary value activities and support value activities, which both add value to the end product or service. Primary value activities are the procedures followed to create the product or deliver a service, whereas the support value activities are activities that consist of the operating, administrative and supporting structures of the company, which are needed to drive a business successfully. The following figure is an example of such a value chain.

**Figure 9: Example of value chain activities**



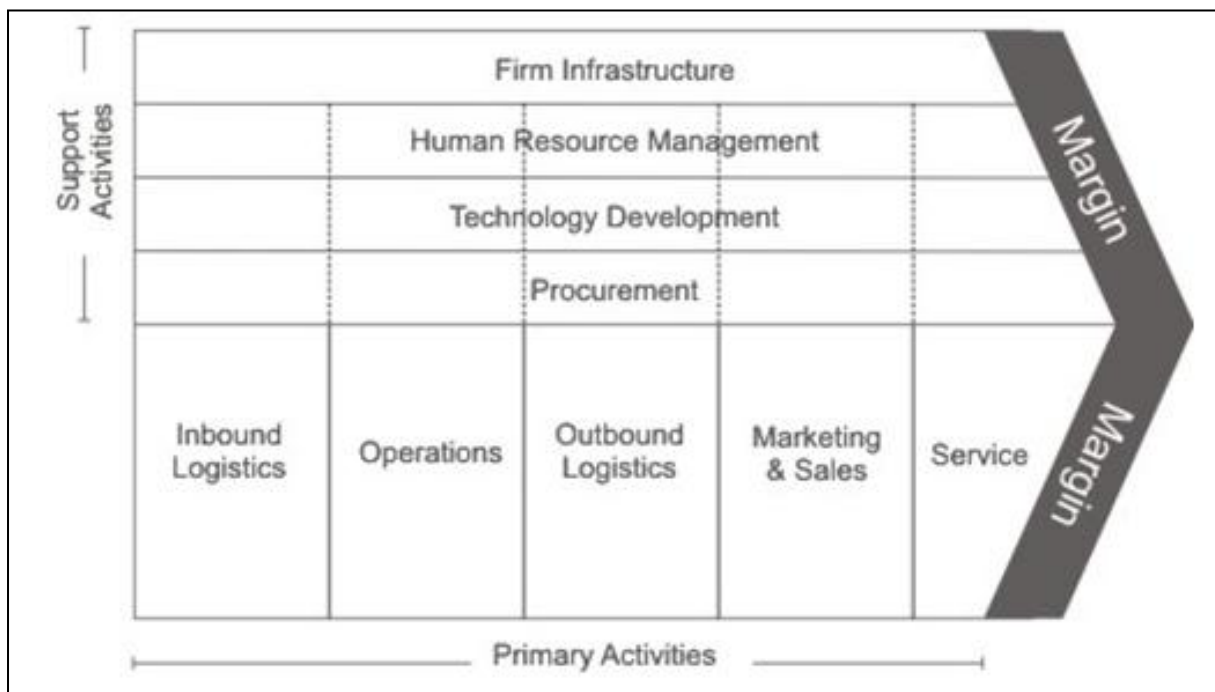
Source: Adopted Baltzan, et al. (2010:21).

Value chains can be constructed to show different levels of detail. Preferably each value chain should show what inputs are required for a specific activity, the transformation involved and the outputs given by that particular transformation, and how that activity adds value to the next activity.

### 4.3.2 Porter's value chain

Michael Porter introduced the concept of the value chain in his influential book "Competitive Advantage". Porter proposed a general-purpose value chain that companies can use to examine all of their activities and see how they are connected (Porter, 1998:33). This generic value chain is shown in the figure below. It is an instrument which in a systematic way examines all the activities a firm performs and how these activities interact (Porter, 1998:33). Porter (1998:33) explains that a firm gains competitive advantage by performing these strategically important activities more cheaply or better than its competitors.

Figure 10: Porter's generic value chain



Source: Adopted from Anon (2012).

Porter (1998:39) identified five primary activities and four support activities which make out the value chain of a company. These activities are described as follows:

**Primary activities:**

- a) Inbound logistics: activities associated with receiving, storing and disseminating inputs to the product, such as material handling, warehousing, inventory control, vehicle scheduling and return to suppliers (Porter, 1998:39).
- b) Operations: activities associated with transforming inputs into the final product form, such as machining, packaging, assembly, equipment maintenance, testing, printing and facility operations (Porter, 1998:40).
- c) Outbound logistics: activities associated with collecting, storing and physically distributing the product to buyers (Porter, 1998:40).
- d) Marketing & sales: activities associated with providing a means by which buyers can purchase the product and inducing them to do so, such as through advertising, promotion, sales force, quoting, channel selection, channel relations and pricing (Porter, 1998:40).
- e) Service: activities associated with providing service to enhance or maintain the value of the product, such as through installation, repair, training, parts supply and product adjustment (Porter, 1998:40).

**Support Activities:**

- a) Procurement: activities associated with the function of purchasing the raw materials and other inputs used in creating value (Porter, 1998:41).
- b) Technology development: Activities associated with research and development, process automation and other forms of technology development used to support the value chain activities (Porter, 1998:41).
- c) Human resource management: activities associated with recruiting, developing and compensating employees (Porter, 1998:41).
- d) Firm infrastructure activities: activities associated with finance, legal matters, quality and management (Porter, 1998:41).

Using this value chain instrument introduced by Michael Porter, the performance and value added potential of all the activities in a company and how they interact with each other can now be examined systematically. This type of analysis is important to operational and general managers inside a company and they will use this value chain concept to examine all sorts of activities for various reason. Why this is important to manager are discussed in the following section.



### 4.3.3 Why is a value chain analysis important?

Value chain analysis should be used when you want to find out where you, your team or your company can create value. Value chain analysis helps identify the ways in which one creates value for customers and helps one think through how to maximise this value. Value chain analysis is the process or exercise through which one or one's team identifies the value chain, its activities, inputs, outputs, transformation processes, identifies weak areas and proposes new initiatives (Anon, 2012).

Companies must create value; they must change business inputs into business outputs in such a manner that they have a greater value than the original cost of creating those outputs. Furthermore, this value added process may help to distinguish the company from others, creating a competitive advantage. According to Anon (2012) "it's a matter of fundamental importance to companies, because it addresses the economic logic of why the organization exists in the first place."

The value that is created and captured by a company is equal to the profit margin. The profit margin increases with the increase in value created by the company, thus leading to the competitive advantage (Anon, 2012).

Any company specialises in some sort of product or service. Every company has different departments, which in turn has numerous inter-related activities that must be executed successfully for the company to render their products or services to their client's. In other words, the end product or service is dependent upon the successful execution of each department's activities. If a client is satisfied, brand loyalty is established, giving the company a competitive advantage.

If a company aims to be successful, a business strategy that is applicable to their specific products or services must be created and implemented. Baltzan, *et al.* (2010:21) states that for any company to be successful their business strategy must be understood and accepted by the whole company before it can be implemented successfully.

Numerous factors influence the successful implementation of a company's business strategy, of which the main factor is the company's business processes which creates a value chain (Baltzan, *et al.*, 2010:21). Baltzan, *et al.* (2010:21) further defines a business process as "a standardized set of activities that accomplishes a specific task, such as processing a customer's order".

Identifying a value chain of a company can help to evaluate and improve the effectiveness of a company's processes, thus enabling that company to provide unique value to its clients, creating a competitive advantage. According to Baltzan, *et al.* (2010:22), for a company to achieve a competitive advantage, such a company must perform one or more activities that create value. This should be in such a way that it creates more overall value than the competitors.

Analysing a company's value chain is a highly effective tool. Using this tool could provide information for evaluating and improving activities that add value to products or services. A company must continually adapt to its competitive environment in order to stay competitive. This means doing continual value chain analyses, which will lead to the adoption of new business strategies (Anon, 2012).

Once a value chain has been identified and constructed it can be analysed by investigating each activity in the chain. This is done in order to fine tune each activity where necessary for, so that the most value could be added (Anon, 2012). The analysis of the value chain of a company may lead to the reconfiguration of individual activities or the re-engineering of the whole chain. This may result in cost and differentiation advantages for the company. An analysis of the value chain of a company may lead to a decision to add or remove activities, add or remove inputs to those activities, change the output to those activities or to manage the activities better. This will be done in order to add more value more quickly with fewer costs to the client.

Constructing such a value chain for a consulting engineering company, defining the operational elements inside this value chain, and using this value chain to measure the value that is added to the company through the operational elements can give insight into where the focus in a consulting engineering company should be. Furthermore, such an instrument can be used to analyse the perceptions of project managers on how much value is added by each activity in the value chain – thus determining how in line the perceptions of company operational personnel are.

#### **4.3.4 How to create a value chain?**

Porter's generic value chain can be used as a starting point to create a value chain, where each element in this model is used to identify activities in a company, Anon (2012) explains the following steps:

- a) Identify sub-activities for each primary activity: there are three different types of sub-activities that are named, direct, indirect and quality activities.
- b) Identify sub-activities for each support activity: determine the sub-activities that create value within each primary activity.
- c) Identify the connections: point out the connections between all the different activities that have been identified.
- d) Look for opportunities to increase value: taking all of the connections and sub-activities into consideration, identify steps that can be taken to enhance the value offered to the client.

After the value chain has been created, the most important stage is reached: evaluation, recommendation, planning and implementation. Each activity's role in value chain as a whole must be analysed critically, for example: should it be there? Does this activity deliver the amount of value to the next activity or client as it is supposed to? After critical analyses, recommendations can be made and implemented in order to make the value chain more effective, and to add more value to the client or to any remaining value chains inside the company.

## 4.4 Value Based Management (VBM)

### 4.4.1 Introduction

The notion that there is a minimum return acceptable on investment is a simple, yet frequently forgotten notion. Starovic, *et al.* (2004:5) explains that not only debt capital is costly (because of the interest rate applied by the lender), but equity capital too (because of the opportunity cost). Starovic, *et al.* (2004:5) states that value based management (VBM) strategies exhibits the basic premise that profit needs to be measured in a way that takes into account the cost of the capital employed to generate it.

VBM is a management strategy that identifies the value driven processes in a company and is an attempt to return to the basics of value creation and to focus on what matters to the owners of the companies. Furthermore, VBM focuses on those processes that maximise the value for the shareholder or the company. In this way it gives insight into the alignment of value based activities inside a company as perceived by managers and employees.

Starovic, *et al.* (2004) explains that VBM can be defined in two ways:

- a) On the one hand, VBM can be defined as generating value for shareholders, who is at the heart of the economy.

- b) On the other hand, VBM can be defined in terms of a more specific concept that narrows VBM into a management approach or even a philosophy, characterised mainly by the metrics used to measure performance.

Anon (1998) focusses on the philosophical aspect when he characterises VBM as a business philosophy and management system by which to compete effectively in the global marketplace. This system focuses on the inherent value, dignity and empowerment of each person, particularly each employee, customer and supplier. Anon (1998) elaborates by explaining that VBM offers a logical framework for designing a company's structures and processes in order to instil an ownership culture that enables the organisation to carry on its mission most effectively.

Anon (1998) explains that VBM calls for a new philosophy of leadership and company culture, one that empowers others to realise their hidden potential, not one who rules by fear or refuses to be accountable to others. Anon (1998) distinguishes three VBM components as follows:

- a) Foundation of universal moral values between each employee, customer and supplier: company core values and code of ethics are agreed upon through consensus by every person in the company, and are subject to periodic review and improvement.
- b) Delivering maximum value and higher quality at lower prices to the customer: The value (V) delivered to the customer increases as quality (Q) of the goods or service increases and/or its price (P) decreases. This definition of value can be explained by the following formula:

$$V = Q / P$$

- c) Rewards based on the value people contribute to the company: this is a fundamental aspect of ownership and models such as these may consist of monthly bonuses linked to each worker's profit centre within the company, annual performance bonuses based on formulas tying each worker's contribution to overall company profit and a structured profit based programme of shared ownership.

Taking the above into consideration it can be concluded that VBM focuses on creating shareholder value. Creating shareholder value is discussed in more detail in the following section.



#### 4.4.2 Creating shareholder value

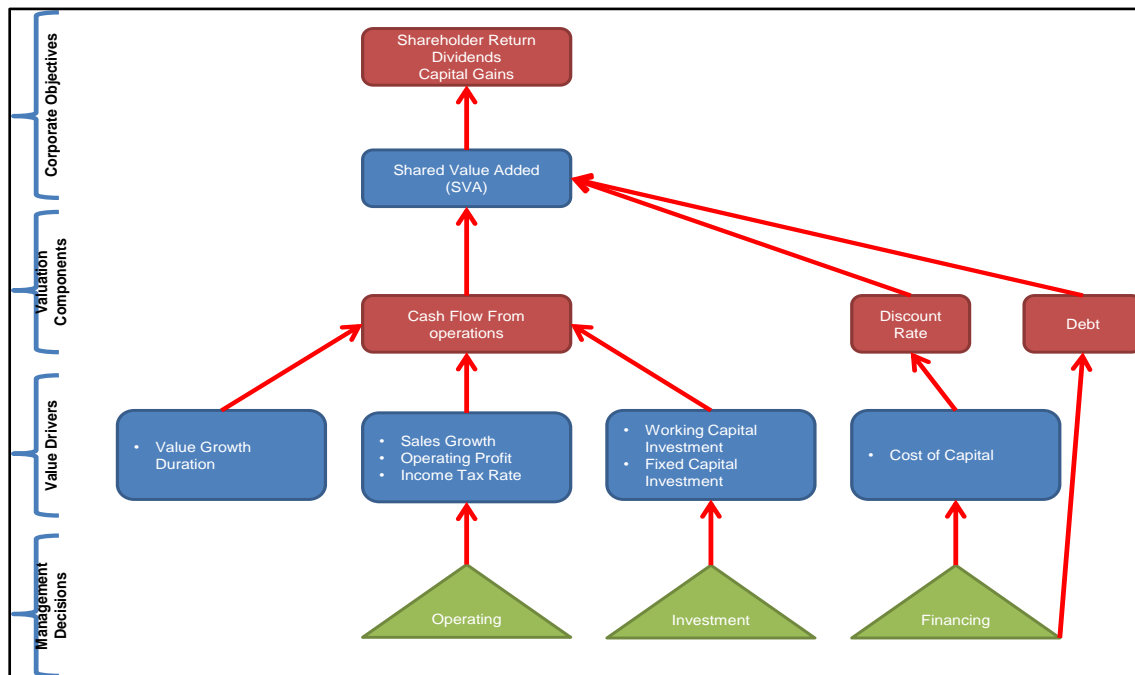
Creating shareholder value is about creating a competitive advantage in the marketplace; managing to create value begins with strategy and ends with financial results (Duyck, 1998:102). The first step in such a strategy is to identify what drives shareholder value. This information can then be used to build a strategy around specific identified value driven activities to initiate value-creating growth inside a company. Rappaport (2006:76) argues that value-creating growth provides a strategic challenge for most companies.

Rappaport (2006:3) sets out ten basic governance principles that should form part of any company value driven strategy, but points out that no company will achieve all of these principles at the same time. These principles are described as follows:

- a) Do not manage earnings or provide guidance on earnings and make strategic decisions that maximise expected value, even at the expense of lowering near term earnings.
- b) Make acquisitions that maximise expected value, even at the expense of lowering near term earnings and carry only assets that maximise value.
- c) Return cash to shareholders when there are no credible value-creating opportunities to invest in the business.
- d) Reward CEO's and other senior executives for delivering superior long-term returns.
- e) Reward operating unit executives for adding superior multiyear value.
- f) Reward the middle managers and frontline employees for delivering superior performance on the key value drivers, which they influence directly
- g) Require senior executives to bear the risk of ownership just as shareholders do and provide investors with information that is relevant to value.

Rappaport (1998:56) created a shareholder value network. Refer to the following figure which what elements are involved in creating value for a company and its shareholders.

Figure 11: Shareholder value network



Source: Adapted from Fourie (2010:25).

#### 4.4.3 Measuring Shareholder Value

Throughout the late 1980s and 1990s there were a growing number of concerns raised about traditional accounting measures. These concerns led to the development of a number of “value metrics”, the most significant of which are shareholder value analysis (SVA), economic profit (EP), economic value added (EVA), cash flows return on investment (CFROI) and total business returns (TBR).

#### 4.4.4 Managing for Shareholder Value

At the heart of managing for value lies an agency problem common to many large and particularly listed companies. This problem is created by the separation of ownership and management (Starovic, *et al.*, 2004:16). Starovic, *et al.* (2004:17) suggested that what really matters in companies today is not the financial capital provided by the shareholders but the intellectual capital of employees. In other words, the knowledge and the creativity of people working for the company are the real assets.

Starovic, *et al.* (2004:19), identified five elements that companies shared when they implemented VBM strategies:

- a) Nearly all companies made an explicit commitment to shareholder value.

- b) Through training, companies created an environment receptive to the changes that the programmes would engender.
- c) Companies reinforced the training with broad-based incentive systems that were closely tied to the VBM performance measures, and which gave employees throughout the company a sense of ownership in both the company and the programme.
- d) Companies were willing to make major organisational changes that would allow their workers to make decisions that could create value.
- e) The changes companies introduced to their system and processes were broad and inclusive, rather than focused narrowly on financial reports.

As discussed in this section, managing shareholder value is about the intellectual capital of employees. Taking this into consideration, as well as the important part the professional employee plays in a service oriented company such as a consulting engineering company, it can be concluded that the professional employee is at the centre of a successful service oriented company. Managing the company with management strategies based on creating value place the focus on the professional employees and the part they play, thus increasing shareholder value.

## 5. OPERATIONS MANAGEMENT

### 5.1 Introduction

Another element of this research study focused on operations management inside a consulting engineering company. Taking this concept one step further, this research study aims to identify the underlying variables/elements that make out operations management in a service oriented company. By understanding these variables, a link may be established between value added perception toward operations management activities and the performance of operations management.

Historically, operations management focused exclusively on the manufacturing industry, however the scope of operations management has broadened and these concepts and techniques are now being applied and used in the service oriented industry (Steinberg, 1990:104). Previous research has long since indicated that service oriented activities require the same sort of disciplines and strategies that render modern manufacturing so efficient (Brennan, 2006:98).

A paper with the purpose to define the unique role of an operations manager (OM) in an engineering consulting firm, states that the title “operations manager” is well known in the manufacturing industry and that this term is finding its way into the service oriented organisations (Steinberg, 1990:104). Steinberg (1990:104) encourages new operational strategies in consulting firms, saying that to gain a competitive advantage, engineering firms must tighten management control over their operating efficiencies.

Operations management and supply chain management can facilitate the creation of a sustainable competitive advantage that can lead to new business and company growth development (Kickul, *et al.*, 2010:78).

Steinberg (1990:104) explains that by defining the goals and objectives well and by giving priority to the reduction of time and cost, a model can be created for tightening management control over company operating efficiencies. Regarding the creation of an operations manager (OM) position inside a company, Steinberg (2009:105) encourages mid-sized engineering consulting firms to create and define the unique functions of such a position.

Brennan (2006:98) explains that the differences in the activities performed by professionals in a service oriented environment prevent the use of standardised processes. Many academics and practitioners are therefore cautious to apply operations management and manufacturing practices as management techniques inside a service oriented company when managing a team of professionals. Armistead (1989:247) elaborates on this problem by discussing the presence of customers within the service production process. The intangible and unique nature of many aspects of service quality and the multi stage mixed nature of services. All of these factors make it difficult to incorporate procedures employed in manufacturing in a service oriented environment.

Brennan (2006:98) provides an answer to this problem: since service oriented companies must manage customised activities, management of information and of operation processes cannot be made routine. Developing an understanding of the management of professionals is an exciting, challenging and interesting endeavour. Due to the lack of research in this area, this field presents an ideal opportunity for a service oriented case study (Brennan, 2006:98).

Examining some elements and measurements of operations management, Steinberg (1990:107) explains that, whenever possible, changes, alterations and other revisions in the standard operational process must be minimised. He adds that an engineering consultancy company must be concerned with the quality, consistency and individuality of their services.

Brennan, as stated above, argues that it is difficult to standardise operational processes in a service oriented company. In contrast to this, Steinberg (1990:107) argues that to achieve maximum efficiency, the issues of quality, consistency and individuality must be balanced with the advantage of standardisation.

Both Brennan (2006:102) and Steinberg (1990:105) argue that productivity represents the revenue of a company, which is a measurement used in gauging the efficiency of operation management. Brennan (2006:98) proposes the use of operations management principles associated with flexible manufacturing techniques to address the specific problems of resource allocation in service oriented companies. Armistead (1989:247) proposes that it is necessary to understand the dimensions of customer service of a company in order to manage the quality of service delivered by that company's operational department.

This literature review section aims to give the reader a better understanding of operations management from a service oriented perspective. This is done by briefly discussing the following aspects: operations management strategy, metrics and performance measurements, productivity, capacity management, learning, product and service design, resource management, operations manager, customer service, entrepreneurship and project management.

## 5.2 Defining operations management strategy

The first element of operations management in this chapter is the overall strategy of such a discipline. It is important to know the overall strategy, focal points and objectives of a department before elements further down can be designed. Creating and forming an operations management strategy is all about the transformation process, as defined in the value chain literature review section.

The objective of an operational management strategy is to create a transformation process inside the company that is **efficient** and **effective** on such a level that the product or service delivered is of maximum **value** to the client and to the company (Jacobs, *et al.*, 2009:6).

Mintzberg (as quoted by De Lima, Da Costa & De Faria, 2009:404) argues that only through a consistent pattern of actions, a strategy can be identified making it possible that performance measurements can mediate the interaction between performance results and their consistency. Performance measurement systems should be designed, implemented and managed as part of a strategic management system (Diaz Garrido, *et al.*, as quoted by De Lima, *et al.*, 2009:404). This strategic management system should be employed as a

means to provide surveillance, motivation, monitoring performance, stimulating learning, sending signals, anticipating events, as well as introducing constraints and manage scenarios to the operations system (Yeung, *et al.*, as quoted by De Lima *et al.*, 2009:404).

Jacobs, *et al.* (2009:6) defines two key performance elements in operations management:

- a) Efficiency: providing a service with the least amount of input resources, saving time, money and effort, thus doing the *thing* right.
- b) Effectiveness: providing a service of high quality, doing the right things to create the most value for a company, thus doing the *right* things.

The outputs of efficiency and effectiveness are values in the form of a service or product, and efficiency and effectiveness work against each other in creating this value (Jacobs, *et al.*, 2009:6). As defined in the literature review section on value, value equals quality divided by price. Quality is increased by increasing effectiveness, and price is decreased by increasing efficiency. The purpose of a good operations management strategy is to create a balance between efficiency and effectiveness (Jacobs, *et al.*, 2009:6).

Taking the above into consideration, we can define the operations performance equation as follows:

$$Value = \frac{Quality}{Price} = \frac{Effectiveness}{Efficiency}$$

De Lima, *et al.* (2009:405) presents an operations strategic management framework indicating the main elements and their relationship with each other that forms the strategic framework life cycle.

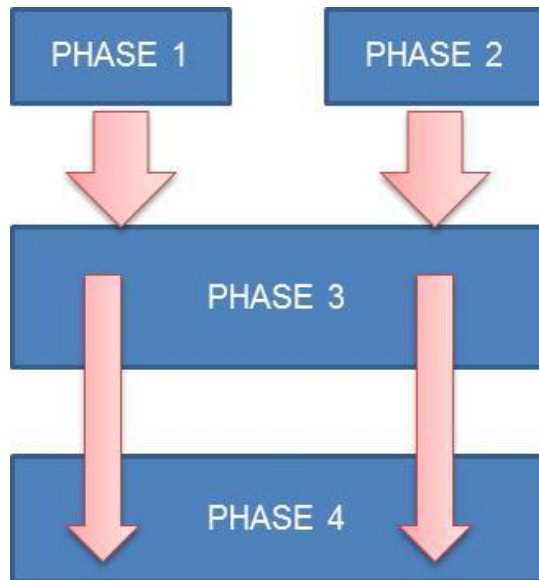
**Figure 12: Operations strategic management framework**



Source: Adopted from De Lima *et al.* (2009:405).

The process to formulate operations strategy, as indicated in the figure above, is organised into four main phases. These phases are sequenced in specific steps, as indicated in the figure below.

**Figure 13: Process for operations strategy formulation**



**Source: Adopted from De Lima et al. (2009:409).**

These phases are defined by De Lima, *et al.* (2009:409) as follows:

- a) Phase 1: Service groups are organised, and names, market standards are declared as reference for the identified service groups. Service groups are analysed through competitive criteria, using market reference in order to identify the main problems.
- b) Phase 2: Opportunities and threats are identified.
- c) Phase 3: GAPS are identified in phases 1 and 2 and are used to guide new actions in the formulations process.
- d) Phase 4: Performance indicators are reviewed to follow development of new actions, actions are detailed and performance measures are redesigned.

### 5.3 Metrics and performance measurement

The overall strategic framework for operations management was discussed briefly. Metrics and performance measurements are critical to an overall strategy, as these elements enable a manager to guide the overall process. This section will discuss general metrics and performance measurements, and will then focus on one performance of operations management measurement, named productivity.

Metrics and performance measurements are the tools used to translate a company's mission or strategy into reality. This entails defining and describing goals and performance measures (Melnyk, Stewart & Swink, 2004:209).

According to Melnyk, *et al.* (2004:210) metrics and performance measurements present a challenge to operations management, seeing that operations managers and academics usually differ in their understanding of operations metrics, due to different priorities.

Melnyk, *et al.* (2004:210) is of the opinion that little attention has been devoted in the past to metrics within the field of operations management; however the current business environment, which is making static metrics systems obsolete, is leading to more research on metrics in the operational field. De Lima, *et al.* (2009:403) agrees with Melnyk, *et al.* about this new change in focus on operational metrics. They concur that new operations systems design requirements have compelled companies to engage in a broad process of in-depth change, which is known as an operations system redesign. This operational redesign focusses on performance measurement, sub-systems, processes and measures used to assess company performances (De Lima, *et al.*, 2009:403).

Melnyk, *et al.* (2004:211), defines a metric as describing how value is delivered to its stakeholders (client, company and employee), the characteristics of a metric are as follows:

- a) The metric should be verifiable.
- b) The metric can be measured.
- c) The metric is comparable.

According to Neely (as quoted by De Lima, *et al.*, 2009:404), performance measurements entail the process of quantifying the efficiency and effectiveness of an action. In this sense a performance measurement system is the set of metrics used to quantify both the efficiency and effectiveness of actions

Metrics according to Melnyk, *et al.* (2004:211), enable operational personnel to:

- a) Evaluate and control.
- b) Communicate performance.
- c) Identify gaps that need improvement.

Melnyk, *et al.* (2004:212) states that metrics can be defined to fall into different metric categories used for different purposes, according to the tense of the metric (outcome or

predictive) and the focus (financial or operational) of the metric as seen in the following figure.

Figure 14: Metric typology

		<b>METRICS TENSE</b>	
		<b>OUTCOME</b>	<b>PREDICTIVE</b>
<b>METRICS FOCUS</b>	<b>FINANCIAL</b>	Return on Assets	Overtime Dollars (predictive for budget overruns)
	<b>OPERATIONAL</b>	Elapsed Lead Time	Number of Process Steps and Setups (predictive for lead times)

Source: Adopted from Melnyk et al. (2004:212).

The fact that metrics can be defined and used in different levels are important, metrics can usually come in three different levels as defined by Melnyk, *et al.* (2004:212):

- a) Individual metrics
- b) The metrics set
- c) The overall performance measurement system.

These three metric levels are interlinked. Melnyk, *et al.* (2004:213) states that the individual metric forms the base and is aggregated to form a metric set that guides and directs an individual's activities in support of strategic objectives. Co-ordinating these metric sets is part of the performance measurement system.

Productivity, utilisation, learning can all be defined as metrics for measuring operations management performance. These metrics are discussed in more detail in the following sections.

## 5.4 Productivity

Productivity is an important operations management element and can be used as a metric to be measured on a regular basis.

Jacobs, *et al.* (2009:28) defines productivity as a common measure that is used to determine how well a country, industry or business uses its resources. Jacobs, *et al.* (2009:28) argues that the measurement of productivity is important for operational related performance.

Jacobs, *et al.* (2009:28) defines productivity in its broadest sense as follows:

$$\textit{Productivity} = \frac{\textit{Outputs}}{\textit{Inputs}}$$

A comparison on productivity can be made in two or three ways; Jacobs, *et al.* (2009:28) explains these as follows:

- a) A company can compare itself with similar operations in the industry.
- b) A company can compare specific operations or process over a period of time.

Brennan (2006:102) and Steinberg (1990:105) argue from a service oriented perspective that productivity represents the revenue of a company. Higher productivity levels in a service oriented business means higher billable hours. Such higher hours are directly associated with higher revenues, and higher revenues are, in turn, associated with higher profits. This is because most company expenses are either fixed, such as salaries, or directly chargeable to clients, such as travel expenses.

Steinberg (1990:105) elaborates on this point by describing how high productivity levels leads to better production or operations. He defines productivity in its broadest sense from an engineering perspective as follows:

$$\textit{Productivity} = \frac{\textit{Complete Report}}{\textit{Raw Engineering Information}}$$

Brennan (2006:102) defines productivity in its broadest sense from a service oriented and financial perspective as follows:

$$\textit{Productivity} = \frac{\textit{Billable Hours}}{\textit{Specific Time Period (40 hours per week)}}$$

The productivity level of an employee at a company, according to Brennan (2006:102), is influenced by three key levers:

- a) Education level
- b) Number of years at the company
- c) Billing rate.



Brennan (2006:103) argues that these productivity levers can be improved by focusing on Professional Engineering (PE) certification, which will lead to greater productivity levels. It is motivation and technical abilities that enable a person to achieve PE certification, which thus lead to greater productivity.

Although Steinberg agrees with Brennan regarding the productivity levers, Steinberg (1990:105) argues that productivity can be influenced by overhead costs. Such costs can be decreased by increasing billable hours or by reducing indirect costs.

## 5.5 Capacity management

Capacity management is defined as another operations management element that can be used as a metric to be measured on a regular basis.

Capacity defined by Jacobs, *et al.* (2009:123) is the amount of output that a system is capable of achieving over a specific period of time. Jacobs, *et al.* (2009:123) defines operationally four characteristics of capacity planning as follows:

- a) It is a relationship between resource inputs and product outputs.
- b) It has real time capacity, which depends on what is to be produced in real time.
- c) It emphasises the time dimensions of capacity.
- d) It has different meanings to individuals at different levels within the operations management hierarchy.

Capacity level has a critical impact on a company's response rate, its cost structure, its inventory policies and its management and staff requirements (Jacobs, *et al.*, 2009:123). The main objective of strategic capacity planning is to provide an approach for determining the overall capacity level of capital intensive resources. These include facilities, equipment and overall labour force size that best supports the company's overall long range competitive strategy (Jacobs, *et al.*, 2009:123). Jacobs, *et al.* (2009:124) argues the capacity utilisation rate is important operationally and can be measured as follows:

$$\text{Capacity Utilization Rate} = \frac{\text{Capacity Used}}{\text{Best Operating Level}}$$

Jacobs, *et al.* (2009:133) describes three differences between service and manufacturing processes with regard to the planning of capacity:

- a) Time: service offerings cannot be stored for later use; the capacity must be available when it is needed.
- b) Location: service capacity must be located near the customer, depending on the type of service offered.
- c) Volatility of demand: this is much higher for service processes than for manufacturing processes.

## 5.6 Learning, Education & Experience

The first two sections of the literature review indicated that learning, education and experience of professional employees are critical to the success of any consulting engineering company.

According to Jacobs, *et al.* (2009:125), as operations produce more of a product or service, experience is gained in the best production methods, which reduces the cost of productions in a predictable manner. Companies use economies of scale to increase the effectiveness of the learning curve.

Jacobs, *et al.* defines a learning curve as a line displaying the relationship between unit production time and the cumulative number of units produced. These learning curves also play an important role in planning corporate strategy, and they can be applied to individual or organisational learning.

The rate of learning and the initial starting level of experience are the two elements that affect the individual's learning curve (Jacobs, *et al.*, 2009:150). Jacobs, *et al.* (2009:150) identifies eight general guidelines for the improvement of individual performance:

- a) Proper selection of workers
- b) Proper training
- c) Motivation
- d) Work specialisation
- e) Do one or a very few jobs at a time
- f) Use tools or equipment that assists or support performance
- g) Provide quick and easy access for help
- h) Allow workers to help redesign their tasks.

Organisational learning is critical for a competitive advantage. This type of learning is acquired through the following means:

- a) Individual learning
- b) Technology
- c) Structure
- d) Documents that it retains
- e) Standard operating procedures

Hecker (1997:62) argues that an engineer must have a combination of technical and non-technical skills. The reasons for this requirement are as follows:

- a) **Technical skills:** Although engineering educational institutions focus more on the technical skills of engineering, no institution can train and educate every student in all of the existing engineering principles and disciplines. Rather, they will teach students the fundamental skills of the profession. This will give the aspiring engineers a good basis from which they will be able to develop themselves, depending on which discipline and organisation they decide to become involved (Hecker, 1997:64).

From a consulting engineering company perspective, engineers must be technically trained in a certain discipline and on a certain level so that the skill set or sets can be translated into the services they offer. In other words, the technical educational level must be aligned with the service design of the company. For example, when one examines the electrical discipline in engineering, a company can only sell a service that designs sub-stations if the engineers who are employed have the capability to design such a sub-station, or if the company has the capability to outsource this service one way or the other.

- b) **Non-technical skills:** These skill sets are defined by Hecker (1997:63) as soft skills and states that these skills are important to any engineer as he or she needs to participate fully in the key success factors of consulting engineering (project management, client relations, marketing and people management). Hecker (1997:63) adds that generally clients assume that engineers do have the technical skills and knowledge. Therefore, when clients try to identify an engineer with whom they are going to work, the engineer's non-technical skills become the deciding factor.

Hecker (1997:62) argues that engineers will be presented with non-technical job tasks early in their careers. These include job tasks that their educational institution did not

focus on, such as the ability to communicate effectively, which is the most important soft skill to master (Hecker, 1997:62).

Hecker (1997:64) encourages engineers and engineering companies to keep on learning at graduation, but to build on the foundations laid by the educational institutions. Hecker (1997:4) states that, since consulting companies expect their employees to be outstanding service providers, the companies themselves must be the catalyst for this continual learning.

Roger & Krasner (1990:38) argues that operations management regarding performance and productivity can be increased with additional consulting experience.

Summarising the above, creating an educational culture inside a company is important because of the following advantages:

- a) It aligns the company service offerings with the company capabilities.
- b) It increases productivity and performance operationally.
- c) It emphasises and increases the soft skill sets required for successful consulting engineering.

Hecker (1990:62) describes seven methods that can be used inside a company to encourage and sustain a learning atmosphere:

- a) **Make improvement requirements:** The organisation needs to integrate and reinforce the learning of skills into all the aspects of employment. Companies should recognise and reward improvement of these skills in both the programmes focusing on performance appraisal and on compensation.
- b) **Insist that senior staff model the behaviour:** Trying to pattern one's actions and behaviours on the effective styles and methods of others is a useful learning tool.
- c) **Expand teamwork beyond engineering projects:** This builds communication and teamwork skills and provide the added benefits of allowing more involvement and input into operations.
- d) **Provide a library of available reading material:** Companies should make some small investments each year in books that are related to self-improvement, covering topics such as communications or management.
- e) **Teach employees to be good service providers:** Determine what the clients perceive as good service, and plan to meet these expectations.

- f) **Provide training:** Employees should receive training in specific important competencies, such as presentation skills and conflict resolution.
- g) **Encourage involvement:** Get staff involved in the engineering profession, as well as in the community. This is a great way to build confidence and communications skills.

Looking from a metrics and performance viewpoint, Melnyk, Stewart & Swink (2004:210) argues that the importance of metrics has long been recognised and that every company, every activity and employee requires metrics. Melnyk, *et al.* (2004:210) is of the opinion that metrics play an important part in tooling employees. This is because that which operations measure is what is important and indicates how they intend to deliver value to their customers.

CE (2009:21) gives some insight into how learning or training can be measured in an organisation. CE (2009:21) defines the performance of training as the number of training days provided as equivalent to a full time employee per year. The formulation of this definition is given as follows:

$$\text{Performance (days)} = \frac{\text{Total number of training days provided}}{\text{Average number of employees, partners and directors}}$$

## 5.7 Product and service design

As shown in the first sections of the literature review, service offerings differ from product offerings. This is because of the customer involvement, which introduces variability into the process in terms of the time it takes to serve the client/customer and the knowledge and experience the employee requires who serves the customer/client.

Vargo and Lusch (as quoted by Kimbell, 2011) define a service in terms of dynamic processes through which value is co-created within a value constellation or service system. According to (Kimbell, 2011) engineers design functions in response to constraints. In other words, the service design of an engineering company can be defined as the dynamic process through which value is added in response to a constraint, which can be the need of a client.

(Kimbell, 2011) is of the opinion that service design and development are not well understood. Therefore manufacturing service operations may apply to service operations, however it is also possible that services might present new challenges.

Shostack (as quoted by Kimbell, 2011) argues that services can be designed intentionally; stating that documenting and monitoring the service delivery process was the key methodology behind designing a successful service offering. Shostack (as quoted by Kimbell, 2011) proposes the creation of a visual representation of the service design that specifies what happens in front of a customer and behind the line of visibility.

Kimbell (2011) focuses on the following aspects: the design of the service delivery system, continuous designing processes to improve quality, the service encounter, blueprints, evidence, clues, as well as the management of customer experiences. According to the research of Kimbell (2011) these aspects represent importance advances in understanding how organisations design services.

Frei (quoted by Jacobs, *et al.*, 2009:108) identifies the following three general factors that must be taken into account when altering a service offering or designing a new service offering:

- a) Service experience impact
- b) Operational impact
- c) Financial impact

The operational impact can be analysed by specifying the complexity and divergence of the proposed service process relative to the basic service process (Jacobs, *et al.*, 2009:109).

Kimbell (2011) conceptualises the different approaches for service design in the following figure.

**Figure 15: Approaches to conceptualizing service design**

		Ways of thinking about service	
		Distinctions between goods and services are maintained	Service is the basic unit of economic exchange
Ways of thinking about design	Design as problem-solving	Engineering	Service engineering
	Design as enquiry	Non-engineering design disciplines	Designing for service

Source: Adopted from Kimbell (2011).

It can be seen that the quadrants propose distinct ways of understanding service design. These quadrants are divided between how services are understood and the nature of design, each representing two types of literature research (Kimbell, 2011). This framework makes a clear difference in how people think about design and services, by shaping how service design can be understood (Kimbell, 2011).

## 5.8 Resource management

Resource management is the allocation of resources to projects and the management thereof. These activities are fundamental to operations management and the consulting engineering industry.

Engineering organisations fundamentally have two major resource categories according to Roger, (1990:37):

- a) Personnel, for example engineers or technicians.
- b) Equipment, for example engineering software or computers.

How these resources are sourced, allocated to projects, as well as managed by project managers and directors, are important strategies that form part of the service offering design and affects operations management. The following section discusses the optimal mix of sourced resources, as well as the allocation of resources seen from a manufacturing and mathematical perspective.

### 5.8.1 Optimal mix of sourced resources

Each personnel or equipment resource can be attained through hiring, purchasing or contractual arrangements for use without ownership (Roger, 1990:37). Roger (1990:38) elaborates on this by saying that deciding on the optimal mix of internal and external resources is of great importance to the engineering company. The following factors should be taken into consideration when deciding what mix of resources to use:

- a) The firm's long-term technological and competitive needs.
- b) The level of financial resources available.
- c) The project volume that is projected.
- d) The degree of project control desired.

Roger (1990:39) proposes the mixed integer linear programming model (MILP) to analyse and develop the optimal mix of sourced resources. The model provides the capability to:

- a) Combine engineering personnel and equipment that are fully internal to the firm with the technological capability that is fully external to the firm, or choose some intermediate alternative.
- b) Develop a multi-period aggregate staffing plan for multi-level engineering staff.
- c) Develop a multi-period machine requirements and capacity plan for multi-level engineering equipment.
- d) Allow the internal and external personnel and equipment to have different performance levels.
- e) Allow engineering management to specify independently the degree of control they wish to exert over engineering personnel and the use of equipment.
- f) Achieve the technological capability, capacity and control requirements all at minimum costs.

### 5.8.2 Resource allocation from a manufacturing perspective

Brennan (2006:98) proposes that operations management principles associated with flexible manufacturing techniques be used to address the specific problems of resource allocation in service oriented companies. Brennan (2006:98) developed a series of propositions, which was examined in the context of a case study on engineers and technicians in a consulting company.

A flexible manufacturing system (FMS) uses machines that are characterised as flexible, versatile and multipurpose. Such machines can perform many types of operational activities by being capable to change tools automatically and handle material (Brennan, 2006:98). The operation management techniques behind FMS aim to exploit the flexibility of this system by loading and controlling the system according to different pre-defined structures and schemes. The aim is to achieve the efficiency and utilization levels of mass production systems while retaining the flexibility of the system (Brennan, 2006:98).

To quote Brennan (2006:106): “the dynamic complexity of a service oriented companies’ workload allocation can be represented by machines (**professionals**) with different tooling (**experience and expertise**) requirements and products (**projects**) with different routing (**staffing**) requirements over a common set of tasks.”

The three concepts, loading, tooling and pooling are necessary to understand the concept of flexible manufacturing fully, and how this concept articulates problems that service oriented companies may experience. Brennan (2006:99) described these concepts from within a

production oriented framework and how these represent the problem of resource allocation that a service oriented framework may experience as follows:

**a) Production oriented framework:**

- Loading: The process of deciding how work queues should be combined. Two factors are of importance, (1) the assigned workloads should be balanced to avoid bottlenecks and (2) the movement of the number of required parts can be minimised when operations are performed on the same machine (Brennan, 2006:99).
- Tooling: This is the process of deciding which tools to assign to which machines. One factor is of importance, (1) to increase flexibility, more operations should be assigned to more than one machine (Brennan, 2006:99).
- Pooling: This is the process of varying workloads among multi server queues of varying size (Brennan, 2006:99).

**b) Service oriented framework:**

- Loading: This is the process of deciding how staff should be assigned to projects. Factors influencing loading in a service oriented framework are (1) assigned workloads should be balanced and (2) minimised movements of the required parts (Brennan, 2006:99).
- Tooling: This is the process of deciding which skilled employees should be involved. Factors influencing loading in a service oriented framework are (1) increase in generalised skills, which increases the flexibility and responsiveness of the task force (Brennan, 2006:99).
- Pooling: This is the process of designing alternative routes (variability) into the production system. Such routes are recommended to (1) form larger project groups, because it is well known that the production of more than one part type or project, each with alternative routes, increases system variability (Brennan, 2006:99).

Furthermore Brennan (2006:99) states that the production oriented framework associated with the concept of flexible manufacturing can be used in a service oriented framework. Within such a framework machines follow different requirements for tooling and products, as well as for routing. Over a set of common tasks this can represent the dynamic complexity of the service organisation.

In light of the above, Brennan (2009:106) pointed out four propositions that can be used to better the management of operations within a service organisation:

- a) **Proposition 1: generalised skill set:** Service oriented organisations should consider a general set of skills and knowledge base as minimum requirements for professionals on the staff, because this flexibility in the production system is increased by overlapping sets of generalised capabilities, which in turn increases productivity (Brennan, 2006:99).
- b) **Proposition 2: balancing the workload:** Bottlenecks that occur due to the high utilisation of specific resources can be eliminated by balancing the workload in an organisation. Usually work allocation models are founded on three factors: Who is accredited with opening the project? Who is assigned to lead the project? Who is assigned to staff the project? Models such as these may include assigning the project to the person who opened it, or to the team or person who is technically the most capable to handle the specific project (Brennan, 2006:99).
- c) **Proposition 3: project leadership:** Distribute the work among more project leaders that have smaller project teams, because the work may increase throughput by minimising the handoffs among the professionals (Brennan, 2006:99). Such models to allocate project leadership are based on opportunity, staff availability, individual preference and staff experience.
- d) **Proposition 4: operational models:** Operational models can be used to help a company assess the impact that different resource allocation schemes may have on the organisation (Brennan, 2006:99).

Brennan (2006:104) did a case study on the problems manifested by a consulting engineering company regarding its allocation of resources. These problems affected productivity and the management of that productivity. The company's top performers retained much of the project work themselves and protected their own productivity rates. These employees can be classified as production bottlenecks. Most employees, who opened a project, self-assigned them as project leaders. Brennan (2006:104) detected regular inconsistencies in the project billings with little time allocated to project planning and problem definition. The result is that many projects may undergo handoffs, without any billing for project communication or coordination.

### 5.8.3 Resource allocation from a mathematical perspective

Yang (2010:1183) examines the resource allocation problem in consulting engineering companies from a more mathematical point of view. Yang (2010:1183) defines the optimal goals for resource allocation as follows:

- a) Maximise overall profit.
- b) Minimise the spreading of workload. Balance the workloads of engineers. Unbalanced workloads between engineers and teams often raise conflicts between teams that have to contend with a heavy load and those that move a lighter load (Yang, 2010:1185).
- c) Minimise the overtime that is allowed. Avoid excessive overtime hours. This creates stress and fatigue and ultimately causes poor-quality products and service offerings (Yang, 2010:1185).
- d) Maximise the average utilisation percentage. Accept as many projects as possible, giving preference to those with higher priority; this will eliminate demoralizing idleness (Yang, 2010:1185).

The first objective is financially driven; the last three objectives are not, but they emphasise enhancing the morale in the company. Yang (2010:1183) developed a multi objective staff-to-job assignment model (MUST) to assist consulting engineering companies in the management of their manpower. The model calculates the best combinations of different engineering teams assigned to different projects over a planned time horizon.

Yang (2010:1187) defines the following input values required by the MUST model:

- a) Estimated man hours for the different teams to perform the different projects.
- b) Revenue per project.
- c) Priority level of project.
- d) Hourly cost of the different teams.
- e) Availability of the different teams.
- f) Regular working time for the different teams.

According to Yang (2010:1886), the MUST model covers multiple objectives and involves a nonlinear, non-smooth and probabilistic search space. Therefore it cannot be solved either by classical mathematical programming techniques or by gradient based optimisation methods, but is rather solved with the help of a particle swarm optimisation algorithm.

## 5.9 Operations Manager (OM)

Operations manager or director is required to implement the overall operations management strategy and to measure all operational metrics and correct any process as deemed necessary. Steinberg (1990:1.4) indicates that it is good for mid-sized engineering consulting firms to create and define the unique functions the position of such an operations manager entail (OM).

It is important to have an operational manager (OM) who oversees the operational management aspect of a service oriented company. However, it is not always that simple to encourage top management to create and fill such a position. In a consulting engineering company engineers are encouraged to devote some time to perform operational management tasks inside the company (Lombard, 2012).

Steinberg (1990:105) explains that if a technical person is forced into such an OM position it is unlikely that this person will dedicate adequate time to operational issues. Steinberg (1990:105) encourages companies to appoint an OM and to allow that individual to devote his/her efforts to understanding, evaluating and improving the operational efficiency inside the organisation.

The responsibilities, expertise and authority of such an operations manager, according to Steinberg (1990:105), can be described as follows:

- a) Coordinating the production function – the involvement begins at the input stage and continuous through the transformation stage to the output stage.
- b) The OM should have the responsibility and authority to address issues that arise during any one of these stages and can affect the efficiencies and costs of production.
- c) The OM should have good communication skills and people skills.
- d) The OM should report directly to the general office manager and should be involved in the day-to-day operations at the office.
- e) The OM must be interested in and motivated to pursue a management transition.
- f) The OM must focus and key in on two business aspects, namely, production and productivity, which to a large degree are interrelated and intertwined.
- g) The OM must have general knowledge of the technical and administrative aspects of the company, as well as the responsibilities and the authority to handle issues that exceed traditional departmental lines.

- h) The OM should be able to use Value Analysis as an approach to analyse the efficiencies of a technical project and to evaluate administrative procedures, costs and efficiencies.

## 5.10 Operations management and customer service

Armistead (1989:248) argues that the nature of the customer service process affects the quality of the service itself. This customer service process forms part of operations management activities and must be managed. According to Hecker (1997:63), clients generally define quality service in terms of good communications, building a positive relationship, collaboration and proactive project management.

In a journal paper, *Customer service and operations management in service businesses*, Armistead (1989:248) defines and divides customer service dimensions into firm and soft dimensions as follows:

- a) "Firm" Dimensions:

**Table 2: Firm dimensions of customer service**

<b>FRAMEWORK OF TIME</b>	(1) Availability of service, (2) Responsiveness of service, (3) Queue time, (4) Process time, (5) Dependability.
<b>FAULT FREENESS</b>	(1) Physical items of the service bundle, (2) Correctness of information advice.
<b>FLEXIBILITY</b>	(1) To customise the service, (3) To cope with mistakes, (3) To introduce new services (to complete a service package).

Source: Adapted from Armistead (1989:249).

- b) "Soft" Dimensions

**Table 3: Soft dimensions of customer service**

<b>STYLE</b>	(1) Appropriateness of attitudes, (2) Accessibility to people and location, (3) Perceived value and (4) Ambience.
<b>STEERING</b>	(1) Perceived importance, (2) Feelings of being in control, (3) Clarity of service (where to go, what to do), (4) Consistency and (5) Duration the service seems to take.
<b>SAFETY</b>	(1) Trust, (2) Confidence, (3) Honesty of advice / information and (4) Security.

Source: Adapted from Armistead (1989:249).

Armistead (1989:525) uses the Soft and Firm dimensions of customer service to position service organization inside a customer service matrix as follows:

**Table 4: Customer service matrix**

		SOFT Dimensions	
		LOW	HIGH
FIRM Dimensions	HIGH	Complacent Technocrats & Bureaucrats	Stars
	LOW	Lip Servers	Complacent Professional Servers

Source: Adopted from Armistead (1989:252).

These different categories are defined as follows:

- a) Complacent technocrats and bureaucrats: service organisations with a high degree of physical items in their service bundle. Here attention is given to the aspects the firm's quality control, while disregarding the aspects of service contact with regard to the service package.
- b) Stars: organisations that pay attention to and commit them equally to the 'firm' and 'soft' aspects of customer service, irrespective of the relative proportions of physical items and intangible service aspects in the service package.
- c) Lip Servers: organisations that tend to pay lip service to the operational aspects of customer service, but in reality fail to deliver in either the 'firm' or the 'soft' dimensions of the service.
- d) Complacent professional servers: organisations that pay attention to the 'soft' dimensions of service but tend to ignore the 'firm' dimensions, perhaps because these dimensions are perceived as less important.

## 5.11 Operations management and entrepreneurship

Entrepreneurship is one of the elements of operations management. In this sense entrepreneurship is needed to balance efficiency and innovation in the service offering process. Entrepreneurship is furthermore used to balance the operational structure of a company between being formalised and flexible.

Kickul, *et al.* (2010:78) suggests that operations management and entrepreneurship rely on the ability to innovate and operationalise in a dynamic environment. It is argued that co-operation between operations management and entrepreneurship should lead to fewer failures and faster successes.

Operations management and entrepreneurship is about value creation. Such a value creation process is identified by Kickul, *et al.* (2010:83) as follows:

- a) The innovative entrepreneur has the vision of a new product, service or method of production or delivery.
- b) Operations management provides the best practices for the entrepreneur to reach his/her goals within the working environment while recognising the opportunities and constraints that exist.

Entrepreneurship and operations management can be linked as follows:

- a) The operational capabilities and the context in which these capabilities are employed contribute to low operating costs and product quality, which is important to any companies' performance (Kickul, *et al.*, 2010:79).
- b) Formalised routines and processes act as a signal for institutionalised effectiveness, which translates into greater support from institutional stakeholders. On the other hand an organisation with a flexible structure adapts more effectively to changing environments. Adler (as quoted by Kickul, *et al.*, 2010:79) proposed the idea of the productivity dilemma, focusing on the tension between efficiency and innovation in operations management. According to Patel (as quoted by Kickul, *et al.*, 2010:79) manufacturing flexibility and formalisation can co-exist and enhance operational performance.
- c) Song (as quoted by Kickul, *et al.*, 2010:80) states that entrepreneurial companies can build their resources and experience operationally to position themselves in the market place and thus create a competitive advantage.
- d) In a paper Goodale (as quoted by Kickul, *et al.*, 2010:81) concludes that presentation of operations control does not oppose the interests of corporate entrepreneurship, rather it is essential to those interests. Kickul, *et al.* (2010:81) further explains that the influence of operations control variables should not be generalised as positive or negative influences for entrepreneurial innovation.

Thus it can be concluded that the entrepreneurial elements in operations management are quite important. Also, with the entrepreneurial climate of the consulting engineering industry the importance of the entrepreneurial climate can even be highlighted more. Entrepreneurship and entrapreneurship are discussed briefly in the following sections.

### **5.11.1 Entrepreneurship**

Entrepreneurship is a way of thinking, acting and reasoning that is focused on seizing opportunities and obsessed leadership balanced and holistic in approach (Timmons and Spinelli, 2007:79). This approach involves the process of creation, renewal, enhancement and realisation of value for all the stakeholders. The centre point of this process is to create or recognise an opportunity, the willingness to seize the opportunity and to undertake the calculated risks associated with this particular opportunity (Timmons, *et al.* 2007:79).

Entrepreneurship is defined by Fernald, Solomon and Tarabishy (2005:2) as having three components:

- a) It promotes innovation and change, which leads to new resource combinations and new ways of doing business. This is achieved by combining resources such as people, money, technologies, procedures, distribution channels, material or any other resources.
- b) It seizes profit opportunities without regard to the resources that are currently controlled.
- c) It expands existing resources through enhanced learning, bootstrapping or synergies.

The entrepreneurial process, according to (Timmons and Spinelli, 2007:82), is opportunity driven; it is driven by a leading entrepreneur and a team, uses resources creatively and cautiously, is dependent on healthy and balanced organisations, operates holistic and integrated and is sustainable.

### **5.11.2 Entrepreneurial process**

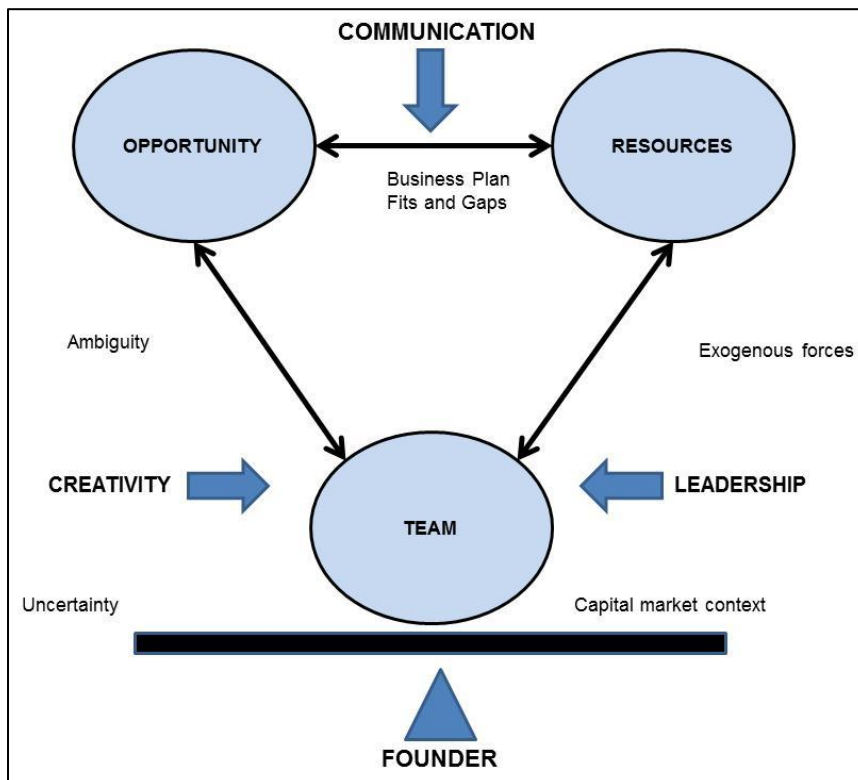
The entrepreneurial process is defined and described by the Timmons model. This model includes the following three components, which are balanced by the lead entrepreneur or founder (Timmons & Spinelli, 2007:89):

- a) The opportunity: this component lies at the heart of the entrepreneurial process. The knowledge to determine the difference between what may seem like a good idea and a genuine opportunity is a key success factor in entrepreneurship.

- b) The resources: this component needs to be used creatively and cautiously with the ability to 'do more with less'.
- c) The team: this component forms an essential part of the elevated potential firm, and also presents the biggest challenge for the lead entrepreneur to develop and maintain.

The founder is also called the lead entrepreneur, and balances these three components to achieve the predetermined goals of sustainability and growth (Timmons and Spinelli, 2007: 89).

Figure 16: Timmons model



Source: Adopted from Timmons and Spinelli (2007: 89).

### 5.11.3 Corporate entrepreneurship

Corporate entrepreneurship can be defined as entrepreneurship that entails the process of creating new business within an established organisation with the focus to improve organisational profitability, enhance the company's competitive position and create better overall value (Carrier, 1996:6). Guth and Ginsburg (1990:50) argue that the two primary aims of entrepreneurship are strategic renewal and the creation of new venture opportunities. Entrepreneurial processes does not only involve the creation of new business ventures, but other innovative activities as well, such as the development of new services,

technologies, products, administrative techniques, strategies and competitive positions (Antoncic & Robert, 2003:9).

Carrier (1996:6) argues that entrapreneurship is usually identical with innovation that is initiated and implemented by employees. In entrapreneurship the following two factors are of great importance:

- a) Individuals who implement innovations within the organisations that employs them.
- b) The condition required that leads to the entrepreneurial process. This is the organisational mode, which can be characterised by the factors of autonomy and freedom, which allows employees to act innovative.

According to Hisrich, Peters & Sheperd (2005:43), employees require a type of freedom to express themselves and follow their own leads in an organisation. Therefore a managerial strategy is required that focuses on stimulating entrepreneurial behaviour among employees. Such a strategy is of great importance in the competitiveness in the market environment.

Jordaan (2008:44) identifies seven dimensions of entrapreneurship:

- a) Innovation: new ideas, creativity and experimentation.
- b) Pro-activeness: acting in expectation of future problems, changes or needs.
- c) New business venturing: new business or business units within the organisation.
- d) Risk Taking: venturing into uncertain areas and committing assets.
- e) Organisational self-renewal: reformulation of strategic plans, organisational change.
- f) Autonomy: self-direction and independent action.
- g) Competitive aggressiveness: strong challenging competition to achieve entry or improve position and up the value of the organisation.

## **5.12 Project Management (PM)**

Project management in the consulting engineering industry is fundamental to any project's success and also forms part of the service offering process of any consulting engineering company.

Munns & Bjeirmi (1996:81) defines project management as the process of controlling the achievement of project objectives. Munns, *et al.* (1996:81) further states that project management utilises the existing organisational structures and resources to manage the project by applying a set of tools and techniques.

To understand project management, the project itself has to be defined. Munns, *et al.* (1996:81) defines a project as the achievement of a specific objective. This process involves a series of activities and tasks which consumes resources and has to be completed within a time period.

Naaranoja, Haapalainen & Lonka, (2007:665) in a paper, *Strategic management tools in projects case construction project*, concluded that it is important for an organisation to focus on all three hierarchy levels of project management that exist within any organisation. These project management levels are defined as follows:

- a) Project business strategy: refers to the selection and management of projects (Naaranoja, *et al.*, 2007:659).
- b) Project strategy: refers to a high level plan for achieving given project objectives (Naaranoja, *et al.*, 2007:659).
- c) Project management strategy: refers to a strategy for the management of a project, such as teaming strategy (Naaranoja, *et al.*, 2007:659).

Project management consist of a combination of functions. According to Munns, *et al.* (1996:82), these functions include the following:

- a) Defining the requirements of work and **establishing the extent of work.**
- b) Allocating the resources required and **planning the execution of the work.**
- c) Monitoring the progress of the work and **adjusting deviations from the plan.**

The success of project management depends on having the project completed under budget, satisfying the project schedule, meeting adequate quality standards and reaching project goals (Munns, *et al.*, 1996:82).

Muuns, *et al.* (1996:82) defines the factors which may cause project management to fail:

- a) Inadequate basis for the project and the wrong person as project manager.
- b) Top management is unsupportive and tasks defined inadequately.
- c) Lack of project management techniques and management techniques miss-used.
- d) Project closedown is not planned and there is a lack of commitment to the project.

In a paper, *Project management turnover*, by Parker & Skitmore (2004), the effect of management turnover on project management success was investigated. It was found that project management turnover directly affects the project team. It disrupts the project performance and potentially can harm the profitability of the organisation.

Parker, *et al.* (2004:212) suggests three actions that should be beneficial in avoiding management turnover effects on project management:

- a) Promote effective activities to develop project management. Such activities should increase and enhance current skills, for example, in formal training, effective performance appraisal and review, cross training, special assignment and coaching on the job.
- b) When developing project managers, employ a rotation process to ensure that project managers gain experience in all life cycle phases.
- c) Employ a succession planning a great deal.

Muuns, *et al.*, (1996:82) defines the success factors of project management as follows:

- a) Planning with commitment to complete projects.
- b) Careful appointment of a skilled project manager.
- c) Spending time to define the project adequately.
- d) Correctly planning the activities in the project.
- e) Ensuring correct and adequate information flows.
- f) Changing activities to accommodate frequent changes on operational dynamics.
- g) Accommodating employee's personal goals with performance and reward.
- h) Making a fresh start when mistakes in implementation have been identified.

In a paper, *Standardized project management may increase development projects success*, by Milosevic & Patanakul (2004:191), they concluded that companies tend to standardise project management only to a certain level, while maintaining a certain level of flexibility.

## 6. PROJECT PERFORMANCE

The last element of this research study is focused on project performance and maintaining health inside a consulting engineering company. Taking this concept one step further, this research the aim of this study is to identify the underlying variables/elements that is necessary for project performance and maintaining health in a service oriented company. Through this insight a link can be established between operations management activities and the performance in engineering projects.

A company's effectiveness partly depends on the success of its projects. Consequently many researchers have investigated those factors affecting project success, including

product definition, quality of execution and project management techniques (Milosevic & Patanakul, 2004:181).

Time, quality and productivity define the performance of projects. Jacobs, *et al.* (209:110) describes these variables in the following table.

**Table 5: Performance measures for development projects**

<b>PERFORMANCE DIMENSION</b>	<b>MEASURES</b>	<b>IMPACT ON COMPETITIVENESS</b>
<b>Time to Market</b>	Frequency of new product introductions. Time from initial concept to market introduction. Actual versus planned time.	Responsiveness to customers. Quality of design. Frequency of projects.
<b>Productivity</b>	Engineering hours per project. Cost of materials and tooling per project. Actual versus planned.	Number of projects. Frequency of projects.
<b>Quality</b>	Conformance – Reliability in use. Design – Performance and customer satisfaction. Yield – Factory and field	Reputation – Customer loyalty Relative attractiveness to customers market share Profitability-cost of on-going service.

Source: Adapted from Jacobs (2009:110).

Munns, *et al.* (1996:81) argues that the success of project management has often been associated with the final outcome of the project. Therefore, over time it has been shown that project management and the outcome of a particular project are not necessarily related.

Munns, *et al.* (1996:81) states that the objectives of project management, such as the control of time, cost and progress should not be confused with measuring project success. There should also be distinguished between the success of a project and the success of a project management activity.

Morris and Hugh (as quoted by Munns, *et al.*, 1996:82) defined the success of a project as dependent on a realistic goal, competition, client satisfaction, a definite goal, profitability,

third parties, market availability, the implementation process and the perceived value of the project.

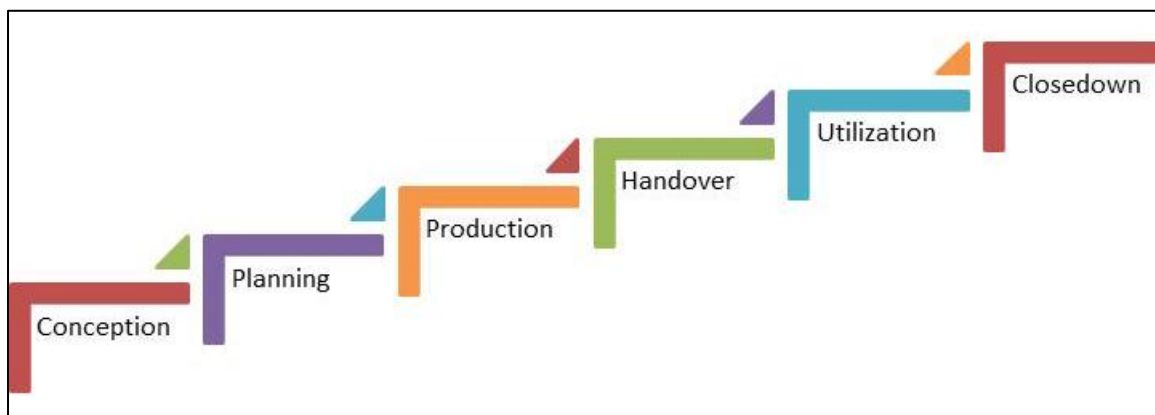
By looking at the success factors of a project and project management, Munns, *et al.* (1996:82) is of the opinion that successes between these two actions are not correlated. The project may still be a success despite the failings of project management, if it meets the higher and long-term objectives. Munns *et al.* (1996:83) discuss literature stating that project management is essential in project success. They also cite literature stating that project management ends when the project has been implemented and does not take the long-term aspect into consideration.

In a paper, *Standardized project management may increase development projects success*, by Milosevic & Patanakul (2004), the following key success factors of a project was highlighted from the literature:

- a) Standardised project management processes
- b) Standardised project management tools and skills
- c) Communication
- d) Interpersonal relationship
- e) Project organization
- f) Project culture

The stages in a project's life cycle are defined by Munns, *et al.* (1996:84) as in the following table.

**Figure 17: Stages in a projects life cycle**



**Source: Adopted from Munns, *et al.* (1996:84).**

To measure project performance successfully, Munns, *et al.* (1996:85) suggests assessing performance in terms of the following three parameters:

- a) **The implementation:** consisting of the first four stages, this parameter is concerned with the project management aspect.
- b) **Perceived values:** this parameter is concerned with the utilisation stage when the users will interact with the project.
- c) **Client satisfaction:** this parameter is concerned with the closedown stage when the client can examine and assess the project to ascertain whether the original goals have been met.

In terms of the above, project performance and health can be measured by taking the following simple characteristics into consideration:

- a) Was the project completed inside the time set for the project program?
- b) Was the project completed under the project budget?
- c) What is the perceived quality of the project for the company and for the clients themselves?

## 7. CE COMPANIES VALUE CHAINS

The literature review was conducted to gain insight into the following aspects of operations management: the dynamics of the consulting engineering industry as well as the different underlining value chain activities of the general consulting engineering companies. The research also focused on underlining elements/variables that make up operations management in the consulting engineering industry, and underlining elements/variables that makes up project performance and health in the consulting engineering industry.

As outlined by this research study methodology, two value chains were constructed that portray the characteristics of operations management in a general consulting engineering company. This was done by applying information gleaned from the literature study.

The value chains mentioned are defined as follows:

- a) A general company value chain with the focus on operations management for a consulting engineering company. (Refer to Appendix A.)
- b) General operations management value chain depicting the different elements of operations management involved in the management for a consulting engineering company. (Refer to Appendix B.)

## 8. SUMMARY

The focus of this literature review was on the concept of added value, operations management performance and project performance. This focus was achieved by discussing the different underlying elements that make up these concepts. When this concept is understood within a consulting engineering environment, a link can be established between perception of operations management activities that add value and the performance of operations management within the consulting engineering industry.

The literature review began by providing a brief overview of the consulting engineering industry. This was done by approaching engineering as a profession, examining the risks and reviewing the regulation of engineering work. It was further pointed out that operations management forms part of the key success factors for a successful consulting engineering company. The review also found that tooling and loading play an important part in operations management for consulting engineering companies.

A consulting engineering company exhibits the characteristics of a service oriented company and. In light of this fact, the aspects and differences between a service oriented and manufactured oriented company was discussed. This was done in order to understand the operational framework underlying the processes involved in a service oriented company.

The literature review continued by discussing in a second section the professional service organisation, and focused on the professional employee that forms part of a service oriented company. It was pointed out that the input of such a professional employee is critical to the success of any professional service organisation. The review also concluded that consulting engineering companies constantly should be on the lookout for new professional employees and put measures in place to retain existing professional employees.

By examining the professional service company it was found that the following characteristics are typical of consulting engineering companies: high labour costs, high level of customer interaction and flexible operational processes. It became clear that these characteristics represent a different context in which operations management tools and techniques should be employed.

Differences in operations management between product and service offering were pointed out and elaborated on. The conclusion was that consulting engineering companies should take these differences into consideration when considering operations management. This second section of the literature review was closed by discussing the service design. It was

found that the service triangle (service strategy, the customer, employees and support system) should be made the centre of any consulting engineering company's service design, and that the operational process design is fundamental to any service design.

The third part of this literature review focused on the concept of added value and of the value chain introduced by Michael Porter. Identifying a company's value chain and applying this to analyse operations management, provides a highly effective tool. It was found that a value chain for a consulting engineering company can be construed to include company department activities, as well as operational management elements. Such a value chain can be used to analyse the perceptions of project managers on how much value is added by each activity in the value chain. Thereby they can determine whether the perceptions of operational personnel's perceptions are in line with the corporate strategy of the company.

While investigating value based management, which is a value added management technique. It was found that the professional employee plays an important part in a service oriented company, such as a consulting engineering company. Therefore it can be asserted that professional employees and their understanding of the company strategy and operations are central to the success of a service oriented company. It is thus important that these professional employees understand the concept of added value correctly and that their perceptions are in line with the corporate strategy.

The fourth part of this literature study dealt with operations management, which forms the main focus of this research study. The following aspects of operations management was discussed briefly: management strategy, metrics and performance measurements, productivity, capacity management, learning, product and service design, resource management, the functions of the operations manager, customer service, entrepreneurship and project management. Taking all of the elements mentioned above into consideration, the underlying elements of operations management inside a consulting engineering company could be pointed out as: strategic department management, service offering process, tooling, loading, project planning and management, as well as the operational hierarchy and culture.

To close this chapter, an overview was given of the literature review and research methodology as a whole. As outlined by this research study methodology, two value chains were constructed that portray the characteristics of operations management in a general consulting engineering company. This was done by applying information gleaned from the literature study. (Refer to the Appendices for the measuring instrument and the generalised value chains.)

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# CHAPTER 3:

## EMPIRICAL STUDY

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### 1. INTRODUCTION

The primary objective of this research study was to assess operations management performance, project performance, operational personnel's interpretation of the value added (VA) concept with regard to operational management (OM). Thereafter the study was to determine whether a relationship exists between these three study elements in a consulting engineering company in South Africa selected by the researcher.

The empirical study was conducted by developing a questionnaire that could measure different aspects of these three main study elements. This questionnaire was distributed throughout a selected consulting engineering company in South Africa. As described in chapter 1, the focus was on operational personnel inside this consulting engineering company. This includes the following: engineers, technicians and administrative personnel who act as project managers, project administrators and project engineers involved with physical designs. Site visits was also done and procedures followed during the implementation of the project.

A number of 34 operational personnel were identified inside the selected consulting engineering company. They were approached, handed out a questionnaire, and asked to complete the questionnaire. They also had to identify three projects each (a potential of 102 engineering projects) and to answer operational questions about these projects. After all questionnaires were returned, a second exercise was done by gathering financial and operational data from the company's financial database. This was done for each project that was identified inside each questionnaire by the operational personnel who were approached. After all the data were collected and captured, a data set was built consisting out of the main three study elements and the various sub-elements that were measured and on which the data were gathered.

This chapter begins by defining the main empirical study elements in the first section. Thereafter it provides insight into these main study elements (constructs) and the different sub-elements (variables) by defining and describing each element's characteristic as it is

understood. The chapter then continues by briefly outlining how the different study elements were used to construct the empirical data set.

The chapter continues by discussing the response to the survey and portrays the respondents and demographics of the projects investigated in this study.

The chapter ends by focusing on the statistical analysis of survey results. The aim of these statistical analyses were to assess the main three study elements, and the relationship between these study elements, as well as the different demographics regarding respondents and projects, Then the study was to determine whether a relationship do exist between these main three study elements.

Statistical consultation services of the North-West University (Potchefstroom Campus) were used to analyse the constructed data set. The software applications employed were SPSS. Descriptive statistics were used to calculate mean (measure of central tendency) and standard deviation (indicate distributions or scattering of data) values for the different variables and constructs that make up this study. Where constructs were formulated from different variables, Cronbach Alpha coefficients were calculated to determine the internal consistency or average correlation between these variables and constructs. This was done to assess the reliability of such a construct. For the purpose of this study a Cronbach alpha coefficient of 0.7 were regarded as an acceptable level of reliability

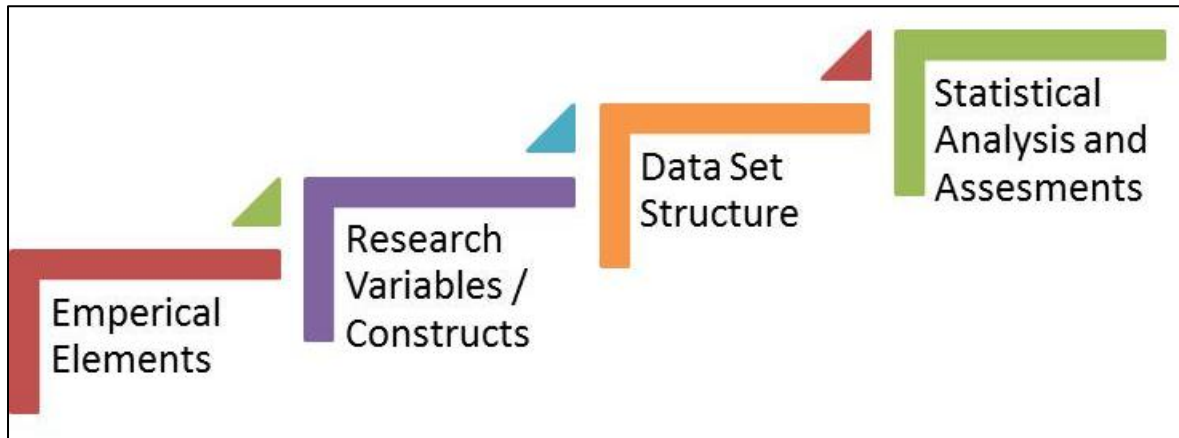
Independent t-tests were performed to determine the statistical significant (p-values) relationship between the demographics of the project and operational personnel and the main study element variables. It was determined that the statistical significance could not be used in a relationship analysis between study variables and demographic variables. The reason is that the sample size is too small to depict each demographic group. Although it was determined that p-values will not be accurate enough, the effect size values (d-values) were employed to measure whether the differences between any of the project and operational personnel demographic and main study element variables are of any practical significance. The practical significance values are indicated in the analysis tables. For the purpose of this study d-values  $\leq 0.5$  means no practical significant difference, d-values between 0.5 and 0.8 means medium practical significant difference and d-values  $\geq 0.8$  means large practical significant difference.

## 2. EMPIRICAL FRAMEWORK

The empirical framework is used to outline how this research study was compiled regarding the different elements and the analyses used during the study.

The empirical framework as discussed in this section is outlined in the following figure:

Figure 18: Empirical framework



### 2.1 Main empirical study elements

The primary research elements on which this study focuses, are the empirical elements.

Taking into consideration the research questions and objectives of this research study, the following main empirical elements where identified:

- a) Project performance and health
- b) Operations management performance
- c) Project managers' perception of value added to the company through company department activities
- d) Project managers' perception of value added to the company through operations management activities
- e) Project characteristics
- f) Project manager demographics.

Each of these empirical elements consists of different variables/constructs that measure or explain the particular empirical element. These different variables and their characteristics are outlined in the following section.

## 2.2 Research variables / constructs

### 2.2.1 Project performance

The following table depicts the variables for project performance & health. Data on these variables were collected in the interviews by using the “operations management performance measuring instrument” (refer to Appendix C), and by gathering data from the company’s financial database as described by the research methodology.

**Table 6: Project performance variables**

Item	Variable Name	Variable	Variable Type	Variable Description
1	Overall Project Performance	X1	Numerical, Discrete	Overall project performance indicator. (Calculated as average of sub elements).
2	Project Quality Performance	X11	Numerical, Discrete	What is the quality of the service during the project and the quality of the end product? (Excellent = 10 Average = 5 Bad = 0)
3	Project Program Performance	X12	Numerical, Discrete	Was the project completed according to project program, in other words in project completion period? (% over time up to 50%)
3	Project Financial Performance	X13	Numerical, Discrete	Was the project completed according to financial plan, to deliver a financial profit? (% project profit)

### 2.2.2 Operations management performance variables

The following table depicts the variables for operations management performance. Data on these variables were collected in the interviews by using the “operations management performance measuring instrument” (Refer to Appendix C) as described by the research methodology.

**Table 7: Operation management performance variables**

Item	Variable Name	Variable	Variable Type	Variable Description
1	Operations Management Performance (OMP)	X2	Numerical, Discrete	Overall operations management performance indicator. (Calculated as average of sub elements).
2	Strategic Department Management (SDM)	X21	Numerical, Discrete	Sub-Construct measured by strategic ownership and analysis elements.
3	Service offering Process (SOP)	X22	Numerical, Discrete	Sub-Construct measured by operational process and offering process design elements.
4	Tooling (T)	X23	Numerical,	Sub-Construct measured by training and

			Discrete	educating elements.
5	Loading (L)	X24	Numerical, Discrete	Sub-Construct measured by project owner allocation and resource allocation management elements.
6	Project Planning & Management (PPM)	X25	Numerical, Discrete	Sub-Constructs measured by general and complex project management elements.
7	Operational Hierarchy & Culture (OHC)	X26	Numerical, Discrete	Sub-Construct measured by general and entrepreneurial management elements.

### 2.2.3 Operational personnel's perception towards VA to the company through DA

The following table depicts the variables for project managers perception towards value added to the company through company department activities. Data on these variables were collected in the interviews and electronic correspondence by using the "value chain indicating value added per activity measuring instrument" (Refer to Appendix D) as described by the research methodology.

**Table 8: Operational personnel's perception towards VA to the company through DA**

Item	Variable Name	Variable	Variable Type	Variable Description
1	VA to Company by Operations Management Department	X31	Numerical, Discrete	PM perception towards % VA to the company through Operations Management Department (OMD)
2	VA to Company by Corporate Services Department	X32	Numerical, Discrete	PM perception towards % VA to the company through Corporate Services Department (CS)
3	VA to Company by Financial Department	X33	Numerical, Discrete	PM perception towards % VA to the company through Financial (DF)
4	VA to Company by Marketing & Communications Department	X34	Numerical, Discrete	PM perception towards % VA to the company through Marketing & Communications Department (MCD)
5	VA to Company by Client Department	X35	Numerical, Discrete	PM perception towards how much % VA to the company through Client Department (CD)
6	VA to Company by Corporate Strategic Plan	X36	Numerical, Discrete	PM perception towards % VA to the company through Corporate Strategic Plan (CSP)

### 2.2.4 PM perception towards VA to the company through OM

The following table depicts the variables for project managers perception towards value added to the company through operations management department activities. Data on these variables were collected in the interviews and electronic correspondence by using the "value

chain indicating value added per activity measuring instrument” (Refer to Appendix D) as described by the research methodology.

**Table 9: Operational personnel’s perception towards VA to the company through OA**

Item	Variable Name	Variable	Variable Type	Variable Description
1	VA to Company by Strategic Department Management (SDM)	X41	Numerical, Discrete	PM perception towards % VA to the Company through (SDM)
2	VA to Company by Service Offering Process (SOP)	X42	Numerical, Discrete	PM perception towards % VA to the Company through (SOP)
3	VA to Company by Tooling (T)	X43	Numerical, Discrete	PM perception towards % VA to the Company through (T)
4	VA to Company by Loading (L)	X44	Numerical, Discrete	PM perception towards % VA to the Company through (L)
5	VA to Company by Project Planning and Management (PPM)	X45	Numerical, Discrete	PM perception towards % VA to the Company through (PPM)
6	VA to Company by Operational Hierarchy & Culture (OHC)	X46	Numerical, Discrete	PM perception towards % VA to the Company through (OHC)

### 2.2.5 Project characteristic variables

The following table depicts the variables for project characteristics. Data on these variables were collected in the interviews by using the “operations management performance measuring instrument” (refer to Appendix C), and by gathering data from the company’s financial database as described by the research methodology.

**Table 10: Project characteristic variables**

Item	Variable Name	Variable	Variable Type	Variable Description
1	Project Type	X51	Categorical	Expertise Project, Experience Project, Efficiency Project
2	Client Type	X52	Categorical	Government Central, Government Provincial, Government Local, Private, Parastatal
3	Leverage	X53	Numerical, Discrete	Junior / Senior Operational Personnel Hours spend on project
4	Duration of Project	X54	Numerical, Discrete	Months
5	Engineering Discipline	X55	Categorical	Electrical, Electronic, Mechanical, Software Development, Utilities, Other

## 2.2.6 Project manager demographic variables

The following table depicts the variables for project characteristics, data on these variables were collected in the interviews by using the “operations management performance measuring instrument” (refer to appendix C) and by gathering data from the company’s financial database as described by the research methodology.

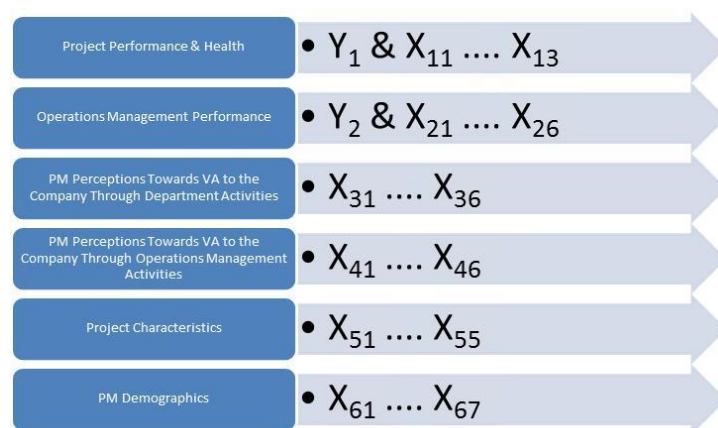
**Table 11: Operational personnel’s demographics variables**

Item	Variable Name	Variable	Variable Type	Variable Description
1	Age Group	X61	Categorical	Age group of Project Manager (18-29, 30-39, 40-49, 50-59, 60+)
2	Gender	X62	Categorical	Gender of Project Manager (Male, Female)
3	Race	X63	Categorical	Race of Project Manager (Black, White, Coloured, Indian, Other)
4	Highest Engineering Academic Qualification	X64	Categorical	None, National Certificate, National Diploma, National Degree, Post Graduate Qualifications, Other
5	Highest Business Academic Qualification	X65	Categorical	None, National Certificate, National Diploma, National Degree, Post Graduate Qualifications, Other
6	Managerial Level	X66	Categorical	Company Director, Project Manager
7	Engineering Discipline	X67	Categorical	Electrical, Electronic, Mechanical, Software Development, Utilities, Other

## 2.3 Research study data-set

The different empirical elements were used to construct the data set, the following figure represents such a structure.

**Figure 19: Research study data-set**



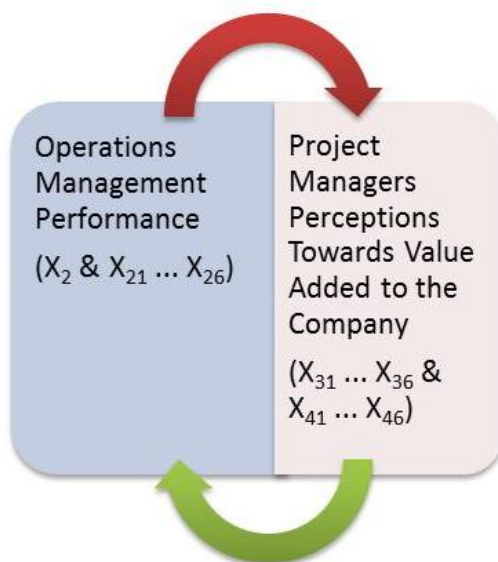
## 2.4 Assessment of empirical elements and relationships

The following empirical elements are assessed to give insight into the research study:

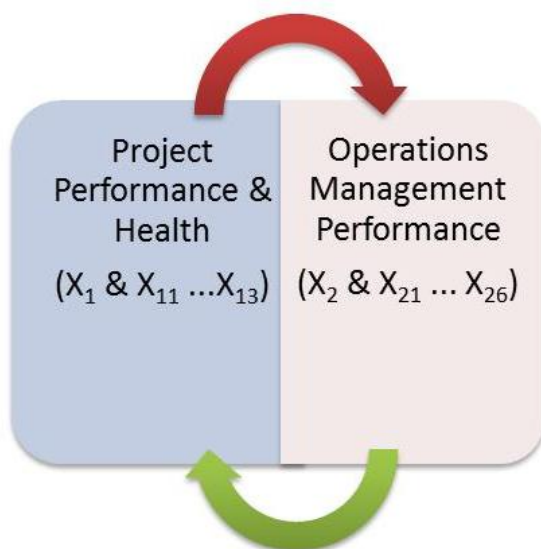
- Project performance (PP)
- Operations management performance (OMP)
- Perceptions towards value added (VA) to the company by operational personnel.

Assessing the relationships as depicted in the following figures gives insight into the main research study questions.

**Figure 20: Assessment of relationship between operational personnel's perceptions Towards VA to the company and OMP**



**Figure 21: Assessment of relationship between OMP and PP**



### 3. RESPONSE TO SURVEY

Questionnaires (constructed from section A, B and C) were distributed to 34 operational personnel throughout the selected consulting engineering company on 28 October 2012. Each respondent was required by the questionnaire to select three projects in which they were involved as project manager (potential of 102 projects) and to complete general and project specific questions regarding these projects.

By the end of the cut-off date, 14 September 2012, a total number of 26 questionnaires were returned with a response rate of 76.47%. A total number of 65 projects were selected with a response rate of 63.73% – compared to the potential of 102 projects if each respondent selected three projects.

Three of the 26 questionnaires that were returned had to be discarded, because of incomplete data and unsuccessful follow-up sessions. Nine of the 65 projects selected had to be discarded, because of incomplete questionnaires and financial and operational data contained in the company database on these projects that was either missing or insufficient.

The following table portrays the frequency and percentage responses to the survey regarding operational personnel.

**Table 12: Responses to survey: Operational personnel information**

Item	Responses to Survey (Section A & C of questionnaire)	Frequency	Percentage
1	Number of questionnaires (Section A & C) distributed	34	100.00%
2	Number of questionnaires (Section A & C) returned	26	76.47%
3	Number of questionnaires (Section A & C) discarded	3	8.82%
4	Number of questionnaires (Section A & C) analysed	23	67.65%

The following table portrays the frequency and percentage responses to the survey regarding operational project.

**Table 13: Responses to survey: Project information**

Item	Project Information Captured (Section B of questionnaire)	Frequency	Percentage
1	Number of potential project information (Section B) captured	102	100.00%
2	Number of project information (Section B) returned	65	63.73%
3	Number of project information (Section B) discarded	9	8.82%
4	Number of project information (Section B) analysed	56	54.90%

## 4. DEMOGRAPHIC INFORMATION OF STUDY

### 4.1 Project manager demographic information

Section C of the questionnaire used in the survey captured the demographical information of the respondents where they had to indicate there, age group, gender, race, highest engineering qualification, highest business qualification, management level and focused engineering discipline. The following sections portray the frequency and percentage distribution of each demographical category of the respondents.

#### 4.1.1 Age group of respondents

The majority of the respondents are below 39 years of age where 13.04% are between the age of 18 and 29 and where 47.83% of respondents are between the age of 30 and 39. The minority of the respondents are older than 40 years of age where 13.04% are between the age of 40 and 49 and where 21.74% of respondents are between the age of 50 and 59.

Table 14: Age group of respondents

Item	Age Group of Respondents	Frequency	Percentage
1	18 - 29	3	13.04%
2	30 - 39	11	47.83%
3	40 - 49	3	13.04%
4	50 - 59	5	21.74%
5	60+	1	4.35%
6	<b>Total</b>	<b>23</b>	<b>100.00%</b>

#### 4.1.2 Gender of respondents

The majority of the respondents are male (82.61%) while the minority are female (17.39%).

Table 15: Gender of respondents

Item	Gender of Respondents	Frequency	Percentage
1	Female	4	17.39%
2	Male	19	82.61%
3	<b>Total</b>	<b>23</b>	<b>100.00%</b>

#### 4.1.3 Racial group classification of respondents

The majority of the respondents are white (91.30%), two are black (8.7%) and no other races participated in this study.

**Table 16: Racial group classification of respondents**

Item	Race Group Classification of Respondents	Frequency	Percentage
1	Black	2	8.70%
2	White	21	91.30%
3	Coloured	0	0.00%
4	Indian	0	0.00%
5	Other	0	0.00%
6	<b>Total</b>	<b>23</b>	<b>100.00%</b>

#### 4.1.4 Highest engineering qualification achieved by respondents

The purpose of the question was to determine the respondent's highest engineering qualification, seeing that their educational background could play an important role regarding their operational ability and their perceptions towards the value added concept.

Most of the respondents (43.48%) obtained a national degree, where 17.39% of respondents have no engineering qualification, 4.35% of respondents obtained a national certificate, 17.39% of respondents obtained a national diploma, and 13.04% of respondents obtained a post graduate degree.

**Table 17: Highest engineering qualification achieved by respondents**

Item	Highest Academic Engineering Qualification achieved by Respondents	Frequency	Percentage
1	None	4	17.39%
2	National Certificate	1	4.35%
3	National Diploma	4	17.39%
4	National Degree	10	43.48%
5	Post Graduate Degree	3	13.04%
6	Other	1	4.35%
7	<b>Total</b>	<b>23</b>	<b>100.00%</b>

#### 4.1.5 Highest business qualification achieved by respondents

The purpose of the question was to determine the respondent's highest business qualification, seeing that their educational background could play an important role regarding their operational ability and their perceptions towards the value added concept.

Most of the respondents (52.17%) have no business qualification, where 13.04% of respondents obtained a national certificate, 17.39% of respondents obtained a national diploma, 8.7% of respondents obtained a national degree and 8.7% of respondents obtained a post-graduate degree.

**Table 18: Highest business qualification achieved by respondents**

Item	Highest Academic Business Qualification achieved by Respondents	Frequency	Percentage
1	None	12	52.17%
2	National Certificate	3	13.04%
3	National Diploma	4	17.39%
4	National Degree	2	8.70%
5	Post Graduate Degree	2	8.70%
6	Other	0	0.00%
7	<b>Total</b>	<b>23</b>	<b>100.00%</b>

#### 4.1.6 Management level of respondents

The purpose of including the management level in the demographic data was to determine whether operational personnel from different levels of management could play an important role regarding their perceptions of the value added concept.

The majority of respondents (47.83%) are classified as project managers, while 17.39% of respondents are classified as company directors, 13.04% of respondents are classified as project administrators and 21.74% of respondents are classified as technical personnel.

**Table 19: Management level of respondents**

Item	Management Level of Respondents	Frequency	Percentage
1	Company Director	4	17.39%
2	Project Administrator	3	13.04%
3	Project Manager	11	47.83%
4	Technical	5	21.74%
5	<b>Total</b>	<b>23</b>	<b>100.00%</b>

#### 4.1.7 Focused engineering disciplines of respondents

This demographic variable was included to determine on which engineering discipline the operational personnel focused who took part in the survey. The majority of operational personnel (91.30%) who took part in this survey focused on electrical engineering while only one operational person focused on mechanical engineering and one on utilities.

**Table 20: Focused engineering disciplines of respondents**

Item	Focused Engineering Discipline of Respondents	Frequency	Percentage
1	Electrical	21	91.30%
2	Electronic	0	0.00%
3	Mechanical	1	4.35%
4	Utilities	1	4.35%
5	Software Development	0	0.00%
6	Other	0	0.00%
7	<b>Total</b>	<b>23</b>	<b>100.00%</b>

## 4.2 Project demographic information

Section B of the questionnaire used in the survey captured the demographical information of the projects selected by the respondents. It was expected from the respondents to answer these questions if they had the information available to them. A second exercise was done by gathering and collecting the required financial and operational information from the company's database.

Respondents had to indicate the following: project demographic variables, project type, client type, leverage classification, project duration classification and project engineering discipline classification. The following sections portray the frequency and percentage distribution of each demographical category of the respondents.

### 4.2.1 Project type classification of surveyed projects

The majority of projects (58.83%) in this survey are classified as experience projects (operational personnel has the skills and expertise to execute such a project, but this type of project do hold challenges that may require a more senior operational person), while 25% of projects are classified as efficiency project (extensive knowledge on these type of project, meaning that such projects almost become repetitive work) and 16.07% of projects are classified as expertise projects (projects that require specialists).

**Table 21: Project type classification of surveyed projects**

Item	Project Type Classification	Frequency	Percentage
1	Efficiency	14	25.00%
2	Experience	33	58.93%
3	Expertise	9	16.07%
4	<b>Total</b>	<b>56</b>	<b>100.00%</b>

### 4.2.2 Client type classification of surveyed projects

The client classifications of the different project are almost evenly spread where 10.71% of project clients are government central, 23.21% of project clients are government local, 25% of project clients are government provincial, 21.43% of project clients are parastatals and 19.64% of project clients are private.

**Table 22: Client type classification of surveyed projects**

Item	Client Types Classification	Frequency	Percentage
1	Government Central	6	10.71%
2	Government Local	13	23.21%
3	Government Provincial	14	25.00%
4	Parastatals	12	21.43%
5	Private	11	19.64%
6	<b>Total</b>	<b>56</b>	<b>100.00%</b>



### 4.2.3 Project leverage classification of surveyed projects

Operational Leverage in a service oriented company is the junior to senior ratio of operational personnel that works on a project. The higher the leverage ratio the better, because more junior hours are being spend than senior hours.

Examining the results of the survey, 23.21% of projects had a leverage ratio between 0 and 2, 33.93% of projects had a leverage ratio between 2 and 3, 17.86% of projects had a leverage ratio between 4 and 6, 19.64% of projects had a leverage ratio between 6 and 8 and 5.36% of projects had a leverage ratio 8 and higher.

**Table 23: Project leverage classification of surveyed projects**

Item	Leverage Classification of Projects	Frequency	Percentage
1	0-2	13	23.21%
2	2-4	19	33.93%
3	4-6	10	17.86%
4	6-8	11	19.64%
5	8+	3	5.36%
<b>6</b>	<b>Total</b>	<b>56</b>	<b>100.00%</b>

### 4.2.4 Duration classification of surveyed projects

The majority of projects duration (42.86%) is between 6 and 12 months, while 14.29% of project durations are between 0 and 6 months, 28.57% of project durations are between 12 and 18 months and 14.28% of project durations are 18 months or higher.

**Table 24: Duration classification of surveyed projects**

Item	Duration Classification of Projects	Frequency	Percentage
1	0-6	8	14.29%
2	6-12	24	42.86%
3	12-18	16	28.57%
4	18-24	4	7.14%
5	24+	4	7.14%
<b>6</b>	<b>Total</b>	<b>56</b>	<b>100.00%</b>

### 4.2.5 Engineering Disciplines Classification of Surveyed Projects

The majority of projects (80.36%) are classified within the electrical engineering discipline, while the rest of the projects fall into the mechanical, electronic and utility disciplines.

**Table 25 – Engineering discipline classification of surveyed projects**

Item	Engineering Disciplines of Projects	Frequency	Percentage
1	Electrical	45	80.36%
2	Mechanical	5	8.93%
3	Electronic	0	0%
4	Utilities	4	7.14%
5	Other	2	3.57%
6	<b>Total</b>	<b>56</b>	<b>100.00%</b>

## 5. EMPIRICAL STUDY RESULTS & DISCUSSION

### 5.1 Analysis of Project Performance (PP)

#### 5.1.1 Assessment of Project Performance (PP)

Throughout the literature review it was determined that an overall indication of project performance lies with the following three variables;

- a) Project Quality: How good is the quality of the project?
- b) Project Program: Was the project completed inside the planned time?
- c) Project Financial: Was the project completed inside the planned budget?

Taking the above into consideration, we can state that when a project is completed in time under budget and the deliverables of the project are of good quality the overall project performance is good.

Section B of the questionnaire used in the survey captured the financial and operational information of the projects selected by the respondents. It was expected from the respondents to answer these questions if they had the information available to them. A second exercise was done by gathering and collecting the required financial and operational information from the company's ERP database.

All project performance data is based on a 0 to 10 scale, where 0 is defined as the worst scenario and 10 as the best scenario. A higher number represents a better performance and a lower number represents a weaker performance compared to other variables (0 = very poor, 2.5 = poor, 5 = medium, 7.5 = good and 10 = very good).

The following table portrays the results of the descriptive statistical analysis of the different variables that form the basis or project performance.

**Table 26: Project performance survey results**

Item	Variable Description	Variable	n	Mean [ $\bar{x}$ ]	Std. Deviation [s]
1	Project Quality Performance	X11	56	7.571	1.906
2	Project Program Performance	X12	56	8.551	2.452
3	Project Financial Performance	X13	56	4.391	2.193
4	Overall Project Performance	X1	56	6.837	1.429

**Project Program Performance** variable ( $\bar{x} = 8.551$ ) has the highest score indicating that project are managed strictly according to project programs, **Project Financial Performance** variable ( $\bar{x} = 4.391$ ) has the lowest score indicating that the projects are not managed according to a project budget and **Project Quality Performance** variable ( $\bar{x} = 7.751$ ) with a relatively high score indicating that project are managed strictly according to project quality specifications.

Examining the average of these variables project quality and program performance is above the average score while project financial performance is below the average score.

The construct **Overall Project Performance** ( $\bar{x} = 6.837$ ) is the average of the 3 underlying variables portrayed in the table above. Two of the 3 project performance variables, **Project Quality Performance** ( $\bar{x} = 7.571$ ) and **Project Program Performance** ( $\bar{x} = 8.551$ ) are above the average mean **Overall Project Performance** ( $\bar{x} = 6.837$ ). Furthermore 1 out of the 3 project performance variables, **Project Financial Performance** ( $\bar{x} = 4.391$ ) are below the average mean **Overall Project Performance** ( $\bar{x} = 6.837$ ).

The standard deviation of the 6 constructs as well as the average standard deviation is above 1, meaning that the surveyed data does not resemble normal distribution, seeing that most of the values lie within an interval of plus and minus three standard deviations above or below the mean.

These results indicate the existence of an average to strong project performance inside the surveyed consulting engineering company, but also indicate room for improvement with the focus placed on the **Project Financial Performance** ( $\bar{x} = 4.391$ ) variable.

Examining the underlying variables that make up the construct project performance, the following explanation could be formulated:

**a) Project Quality Performance ( $\bar{x} = 7.571$ ;  $s = 1.906$ ) :**

Operational personnel are of the opinion that the quality of the selected projects they have executed over time are of medium to good quality.

**b) Project Program Performance ( $\bar{x} = 8.551$ ;  $s = 2.452$ ) :**

From the opinion of operational personnel and from the operational data it can be concluded that the projects selected by the respondents with regard to project program performance were executed in a good to excellent manner.

**c) Project Financial Performance ( $\bar{x} = 4.391$ ;  $s = 2.193$ ) :**

From the financial data it can be concluded that the projects selected by the respondents with regard to project financial performance were executed in a poor to medium manner.

Looking at the construct of overall project performance, the following explanation could be formulated:

**a) Overall Project Performance ( $\bar{x} = 6.837$ ;  $s = 1.429$ ) :**

Taking all three different project performance variables into consideration, it can be concluded that the overall average performance of the project selected by the respondents are executed in a medium to good manner.

### 5.1.2 Relationship assessment between project demographics and PP

Statistical and practical significance analysis were done by determining the relationship between project performance variables and project type demographic variables.

The purpose of this analysis was to determine whether there exists a significant difference between the evaluations based on the mean score of a demographic variable with regard to a specific project performance variable.

It was determined that the statistical significance could not be used in relationship analysis between study variables and demographic variables, because the sample size is too small to depict a demographic group.

The practical significance values are indicated in the analysis tables and for the purpose of this study d-values  $\leq 0.5$  means no practical significant difference, d-values between 0.5 and 0.8 means medium practical significant difference and d-values  $\geq 0.8$  means large practical significant difference.

### 5.1.2.1 Relationship assessment between project type and PP

The following table indicates the relationship between the three project performance variables and the project type demographic variable, with mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values).

Table 27: Relationship assessment between project type and PP

Item	Variable Description	Project Type					Comparison	
		Variable	Demographic Description	N	[ $\bar{x}$ ]	[s]	d	d
1	Project Quality	X11	Expertise	9	7.556	1.236		
			Experience	33	8.182	1.667	0.376	
			Efficiency	14	6.143	2.107	0.670	0.968
2	Project Program	X12	Expertise	9	10.000	0.000		
			Experience	33	8.915	1.869	0.580	
			Efficiency	14	6.760	3.405	0.952	0.633
3	Project Financial	X13	Expertise	9	4.730	2.656		
			Experience	33	4.009	2.163	0.271	
			Efficiency	14	5.071	1.881	0.128	0.491

The practical significance of these project types are as follows:

**a) Relationship assessment between experience and expertise project types:**

Project quality (d-values = 0.376) and project financial (d-values = 0.271) variables are indicating no practical significance in the mean values between an experience and expertise type project.

Project program (d-values = 0.580) variable is indicating that a medium practical significance strength exists between an experience and expertise type project, where an experience type project has a lower mean than an expertise type project.

**b) Relationship assessment between efficiency and expertise project types:**

Project financial (d-values = 0.271) variable is indicating no practical significance in the mean values between an efficiency and expertise type project.

Project quality (d-values = 0.670) variable is indicating that a medium practical significance strength exists between an efficiency and expertise type project, where an efficiency type project has a lower mean than an expertise type project.

**Project program** (d-values = 0.952) variable is indicating that a **strong practical significance** strength exists between an efficiency and expertise type project, where an **efficiency type project has a lower mean than an expertise type project**.

**c) Relationship assessment between efficiency and experience project types:**

Project financial (d-values = 0.491) variable is indicating no practical significance in the mean values between an efficiency and experience type project.

Project program (d-values = 0.633) variable is indicating that a medium practical significance strength exist between an efficiency and experience type project, where an efficiency type project has a lower mean than an experience type project.

**Project quality** (d-values = 0.968) variable is indicating that a **strong practical significance** strength exists between an efficiency and experience type project, where an **efficiency type project has a lower mean than an experience type project**.

**5.1.2.2 Relationship assessment between client type and PP**

The following table indicates the relationship between the three project performance variables and the client type demographic variable, with mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values).

**Table 28: Relationship assessment between client type and PP**

Item	Variable Description	Variable	Client Type				Comparison		
			Demographic Description	N	[ $\bar{x}$ ]	[s]	d	d	d
1	Project Quality	X11	Government Provincial	14	8.000	1.710			
			Government Local	13	6.308	2.323	0.728		
			Private	11	7.909	1.514	0.053	0.689	
			Parastatal	12	7.750	1.603	0.146	0.621	0.099
2	Project Program	X12	Government Provincial	14	7.521	2.737			
			Government Local	13	9.046	2.379	0.557		
			Private	11	8.421	2.791	0.322	0.224	
			Parastatal	12	9.500	1.243	0.723	0.191	0.386
3	Project Financial	X13	Government Provincial	14	4.199	2.400			
			Government Local	13	4.011	2.203	0.078		
			Private	11	4.673	1.875	0.197	0.300	
			Parastatal	12	5.134	2.323	0.390	0.483	0.199

The practical significance of these client types are as follows:

**a) Relationship assessment between government local and government provincial client types:**

Project financial (d-values = 0.078) variable is indicating no practical significance in the mean values between a government local and government provincial type client.

Project quality (d-values = 0.728) variable is indicating that a medium practical significance strength exists between an government local and government provincial type client, where an government local type client has a lower mean than an government provincial type client.

Project program (d-values = 0.557) variable is indicating that a medium practical significance strength exists between an government local and government provincial type client, where an government local type client has a higher mean than an government provincial type client.

**b) Relationship assessment between private and government provincial client types:**

Project quality, program and financial variables are indicating no practical significance in the mean values between a private and government provincial type client.

**c) Relationship assessment between parastatal and government provincial client types:**

Project quality and financial variables are indicating no practical significance in the mean values between a parastatal and government provincial type client.

Project program (d-values = 0.723) variable is indicating that a medium practical significance strength exists between a parastatal and government provincial type client, where a parastatal type client has a higher mean than an government provincial type client.

**d) Relationship assessment between private and government local client types:**

Project program and financial variables are indicating no practical significance in the mean values between a private and government local type client.

Project quality (d-values = 0.689) variable is indicating that a medium practical significance strength exists between a private and government local type client, where an private type client has a higher mean than an government local type client.

**e) Relationship assessment between parastatal and government local client types:**

Project program and financial variables are indicating no practical significance in the mean values between a parastatal and government local type client.

Project quality (d-values = 0.621) variable is indicating that a medium practical significance strength exists between a parastatal and government local type client, where an parastatal type client has a lower mean than an government local type client.

**f) Relationship assessment between private and parastatal client types:**

Project quality, program and financial variables are indicating no practical significance in the mean values between a private and parastatal type client.

**5.1.2.3 Relationship assessment between leverage and PP**

The following table indicates the relationship between the three project performance variables and the leverage categories demographic variable, with mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values).

**Table 29: Relationship assessment between leverage and PP**

Item	Variable Description	Variable	Leverage				Comparison	
			Demographic Description	N	[ $\bar{x}$ ]	[s]	d	d
1	Project Quality	X11	2-4	19	7.737	1.661		
			4-6	10	8.200	1.476	0.279	
			6-8+	14	7.857	1.610	0.072	0.213
2	Project Program	X12	2-4	19	8.432	2.577		
			4-6	10	9.800	0.632	0.531	
			6-8+	14	8.267	2.764	0.060	0.555
3	Project Financial	X13	2-4	19	4.262	2.081		
			4-6	10	4.201	2.225	0.027	
			6-8+	14	4.368	2.591	0.041	0.064

The practical significance of these leverage categories are as follows:

**a) Relationship assessment between 4-6 and 2-4 leverage category:**

Project quality and financial variables are indicating no practical significance in the mean values between a 4-6 and 2-4 leverage category.

Project program (d-values = 0.531) variable is indicating that a medium practical significance strength exists between a 4-6 and 2-4 leverage category, where an 4-6 leverage category has a higher mean than a 2-4 leverage category.

**b) Relationship assessment between 6-8+ and 2-4 leverage category:**

Project quality, program and financial variables are indicating no practical significance in the mean values between a 6-8+ and 2-4 leverage category.

**c) Relationship assessment between 4-6 and 6-8+ leverage category:**

Project quality and financial variables are indicating no practical significance in the mean values between a 4-6 and 6-8+ leverage category.

Project program (d-values = 0.555) variable is indicating that a medium practical significance strength exists between a 4-6 and 6-8+ leverage category, where an 6-8+ leverage category has a lower mean than a 4-6 leverage category.

### 5.1.2.4 Relationship assessment between project duration and PP

The following table indicates the relationship between the three project performance variables and the project duration categories demographic variable, with mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values).

**Table 30: Relationship assessment between project duration and PP**

Project Duration			0-12 Months			12 - 24+ Months			Comparison
Item	Variable Description	Variable	N	[ $\bar{x}$ ]	[s]	N	[ $\bar{x}$ ]	[s]	d
1	Project Quality	X11	32	7.656	1.658	24	7.458	2.226	0.089
2	Project Program	X12	32	9.116	2.131	24	7.797	2.687	0.491
3	Project Financial	X13	32	3.864	2.526	24	5.092	1.414	0.486

The practical significance of these project duration categories is as follows:

**a) Relationship assessment between 0-12 and 12-24+ project duration category:**

Project quality, program and financial variables are indicating no practical significance in the mean values between a 0-12 and 12-24+ project duration category.

## 5.2 Assessment of Operations Management Performance (OMP)

### 5.2.1 Reliability of OMP Constructs

Throughout the literature review it was determined that an overall indication of operations management performance lies with the following six constructs:

- a) Strategic Department Management
- b) Service Offering Process
- c) Tooling
- d) Loading
- e) Project Planning & Management
- f) Operational hierarchy & Culture

In the light of the above, we can state that when operations management take these constructs into consideration, the overall operations management performance will be of good quality.

These constructs were formulated by taking into account sub-elements that were measured by the questionnaire. The reliability of these constructs were analysed by calculating the average correlations of variables within the test and by determining the Cronbach Alpha coefficients. The larger the Cronbach Alpha coefficient, the higher the internal consistency, and the more reliable the construct. For the purpose of this study a Cronbach Alpha coefficient of 0.7 were regarded as acceptable level of reliability.

The following table indicates the Cronbach Alpha coefficients of the constructs measuring operations management performance.

**Table 31: Operations management performance constructs reliability**

Item	Variable Description	Variable	Cronbach's Alpha	N of Items
1	Strategic Department Management (SDM)	X21	0.887	14
2	Service offering Process (SOP)	X22	0.778	8
3	Tooling (T)	X23	0.864	9
4	Loading (L)	X24	0.517	9
5	Project Planning & Management (PPM)	X25	0.828	8
6	Operational Hierarchy & Culture (OHC)	X26	0.711	5
7	Operations Management Performance (OMP)	X2	0.888	6

The results of the reliability analysis suggests that the research instrument used in this study to access operations management performance within a consulting engineering company, has acceptable reliability, since only one construct, loading (0.517) had a lower Cronbach Alpha coefficient than 0.7.

For the purpose of this study, the construct loading will be included in this research.

### 5.2.2 Assessment of OMP

Section B of the questionnaire used in the survey divided the different operations management constructs into different sections. The respondents were asked to evaluate each statement under each section and to indicate their degree of disagreement (1) or agreement (5) with the statement's content.

All operations management performance data is based on a 0 to 5 Likert scale, where a higher number with regards to a statement is perceived to be true and lower number with regards to a statement is perceived to be untrue.

The following table portrays the results of the descriptive statistical analysis of the different constructs that form the basis of the operations management performance.

**Table 32: Operations management performance survey results**

Item	Variable Description	Variable	N	Mean [ $\bar{x}$ ]	Std. Deviation [s]
1	Strategic Department Management (SDM)	X21	56	3.601	0.716
2	Service Offering Process (SOP)	X22	56	3.364	0.717
3	Tooling (T)	X23	56	3.087	0.822
4	Loading (L)	X24	56	3.683	0.500
5	Project Planning & Management (PPM)	X25	56	3.933	0.667
6	Operational Hierarchy & Culture (OHC)	X26	56	3.832	0.663
7	Operations Management Performance (OMP)	X2	56	3.583	0.551

The construct **Tooling** ( $\bar{x} = 3.087$ ) has the lowest average score indicating a lower agreement to the statements determining the presences of this construct. Although this construct has the lowest score it is still above the score three out of five on the Likert scale. The construct **Project Planning & Management** ( $\bar{x} = 3.933$ ) has the highest average score, which indicates a higher agreement to the statements determining the presences of this construct.

The construct **Operations Management Performance** ( $\bar{x} = 3.583$ ) is the average of the six underlying constructs portrayed in the table above. Four of the six operations management constructs, **Strategic Department Management** ( $\bar{x} = 3.601$ ), **Loading** ( $\bar{x} = 3.683$ ), **Project Planning & Management** ( $\bar{x} = 3.933$ ) and **Operational Hierarchy & Culture** ( $\bar{x} = 3.832$ ) are above the average mean **Operations Management Performance** ( $\bar{x} = 3.583$ ).

The standard deviation of the six constructs, as well as the average standard deviation, is below 1, which implies that the surveyed data resembles normal distribution. This is because most the values lie within an interval of plus and minus one standard deviation above or below the mean.

These results indicate the existence of a strong operations management system and good performance inside the surveyed consulting engineering company, but also indicate room for improvement with the focus falling on the **Tooling** ( $\bar{x} = 3.087$ ) and **Service Offering Process** ( $\bar{x} = 3.364$ ) constructs.

Examining the underlying constructs that make up the construct operations management performance the following explanation could be formulated:

**a) Strategic Department Management ( $\bar{x} = 3.601$ ;  $s = 0.716$ ) :**

Most of the operational personnel are of the opinion that strategic department management of operations management department inside the specific consulting engineering company is executed in a good and acceptable manner. This implies that the management of the operations management department exhibit ownership and responsibility, key performance indicators are used to managed and makes decision inside the department on a regular basis and that the overall structure of this department is of good quality.

**b) Service Offering Process ( $\bar{x} = 3.364$ ;  $s = 0.717$ ) :**

Some of the operational personnel are of the opinion that the service offering process is well designed, balanced with company capabilities and client type that the process design guides operational personnel through the marketing, selling and project execution process and that the administrative burden is minimised. Although some of the operational personnel fully agreed with these statements other operational personnel did not fully agree.

**c) Tooling ( $\bar{x} = 3.087$ ;  $s = 0.822$ ) :**

Some of the operational personnel are of the opinion, while others did not fully agree, that focus is placed on increasing operational personnel's generalised, technical and soft skill-sets to increase productivity, flexibility and quality in the service offering process. Furthermore, that the tangible (operational systems and processes) and intangible (knowledge and experience) assets are captured and shared throughout the company and that training and education is important recognised and rewarded.

**d) Loading ( $\bar{x} = 3.683$ ;  $s = 0.500$ ) :**

Operational personnel indicated that focus was placed on the loading aspect of operations management. This means that project owners and administrators are allocated to projects, responsibility was exhibited and had the authority to manage and

make decisions as required by the project. They indicated further that resources are assigned to projects according to a certain model or method taking into consideration opportunity, staff availability, individual preferences, staff experience, tooling an operational capacity and that these resources are managed throughout the projects.

**e) Project Planning & Management ( $\bar{x} = 3.933$ ;  $s = 0.667$ ) :**

Most of the operational personnel are of the opinion that project planning and management are executed in a good manner. This is done by defining, discussing and communicating the client's needs and project deliverables clearly. They also indicated that the communication and project flow structure were defined clearly, that all aspects of the projects were completed and handed over to the client and that overall good project management principles were executed during projects.

**f) Operational Hierarchy & Culture ( $\bar{x} = 3.832$ ;  $s = 0.663$ ) :**

Most of the operational personnel are of the opinion that the operational hierarchy and culture is of good quality and that this hierarchy and culture portrays an environment of responsibility, integrity and entrepreneurship inside and outside the company borders.

**g) Operations Management Performance ( $\bar{x} = 3.583$ ;  $s = 0.551$ ) :**

Taking all six operations management performance constructs into consideration, it is the opinion of most operational personnel who executed projects within the surveyed consulting engineering company that the operations management performance is of average quality.

### **5.2.3 Relationship assessment between project demographics and OMP**

Statistical and practical significance analysis were done by determining the relationship between operations management performance variables and project type demographic variables.

The purpose of this analysis was to determine whether there exists a significant difference between the evaluations based on the mean score of a demographic variable with regard to a specific operations management performance construct.

It was determined that the statistical significance could not be used in relationship analysis between study variables and demographic variables, seeing that the sample size is too small to depict a demographic group.

The practical significance values are indicated in the analysis tables and for the purpose of this study d-values  $\leq 0.5$  means no practical significant difference, d-values between 0.5 and 0.8 means medium practical significant difference and d-values  $\geq 0.8$  means large practical significant difference.

### 5.2.3.1 Relationship assessment between project type and PP

The following table indicates the relationship between the seven operations management performance constructs and the project type demographic variable, with mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values).

**Table 33: Relationship assessment between project type and OMP**

Item	Variable Description	Variable	Project Type				Comparison	
			Demographic Description	N	[ $\bar{x}$ ]	[s]	d	d
1	SDM	X21	Expertise	9	3.524	0.593		
			Experience	33	3.805	0.687	0.410	
			Efficiency	14	3.168	0.694	0.512	0.918
2	SOP	X22	Expertise	9	3.542	0.464		
			Experience	33	3.375	0.863	0.193	
			Efficiency	14	3.223	0.408	0.687	0.176
3	T	X23	Expertise	9	2.642	0.582		
			Experience	33	3.256	0.850	0.722	
			Efficiency	14	2.976	0.806	0.415	0.329
4	L	X24	Expertise	9	3.667	0.333		
			Experience	33	3.727	0.512	0.118	
			Efficiency	14	3.587	0.572	0.139	0.245
5	PPM	X25	Expertise	9	3.944	0.745		
			Experience	33	3.962	0.676	0.024	
			Efficiency	14	3.857	0.635	0.117	0.155
6	OHC	X26	Expertise	9	4.000	0.583		
			Experience	33	3.879	0.678	0.179	
			Efficiency	14	3.614	0.663	0.582	0.390
7	OMP	X2	Expertise	9	3.553	0.475		
			Experience	33	3.667	0.587	0.195	
			Efficiency	14	3.404	0.494	0.301	0.448

The practical significance of these project types are as follows:

#### a) Relationship assessment between experience and expertise project types:

SDM (d-values = 0.410), SOP (d-values = 0.193), L (d-values = 0.118), PPM (d-values = 0.024), OHC (d-values = 0.179) and OMP (d-values = 0.195) constructs are indicating no practical significance in the mean values between an experience and expertise type project.

T (d-values = 0.722) construct is indicating that a medium practical significance strength exists between an experience and expertise type project, where an experience type project has a higher mean than an expertise type project.

**b) Relationship assessment between efficiency and expertise project types:**

L (d-values = 0.139), PPM (d-values = 0.117), and OMP (d-values = 0.301) constructs are indicating no practical significance in the mean values between an experience and expertise type project.

SDM (d-values = 0.512), SOP (d-values = 0.687) and OHC (d-values = 0.582) constructs are indicating that a medium practical significance strength exists between an efficiency and expertise type project, where an efficiency type project has a lower mean than an expertise type project.

**c) Relationship assessment between efficiency and experience project types:**

SOP (d-values = 0.176), T (d-values = 0.329), L (d-values = 0.245), PPM (d-values = 0.155), OHC (d-values = 0.390) and OMP (d-values = 0.448) constructs are indicating no practical significance in the mean values between an efficiency and experience type project.

**SDM** (d-values = 0.9518) construct is indicating that a **strong practical significance** strength exists between an efficiency and experience type project, where an **efficiency type project has a lower mean than an experience type project**.

### 5.2.3.2 Relationship assessment between client type and PP

The following table indicates the relationship between the seven operations management performance constructs and the project type demographic variable, with mean ( $\bar{x}$ ), standard deviation ( $s$ ) and effect size (d-values).

**Table 34: Relationship assessment between client type and OMP**

Client Type							Comparison		
Item	Variable Description	Variable	Demographic Description	N	[ $\bar{x}$ ]	[s]	d	d	d
1	SDM	X21	Government Provincial	14	3.796	0.764			
			Government Local	13	3.885	0.665	0.116		
			Private	11	3.279	0.699	0.677	0.866	
			Parastatal	12	3.411	0.514	0.504	0.712	0.188
2	SOP	X22	Government Provincial	14	3.723	0.749			
			Government Local	13	3.231	0.739	0.658		

			Private	11	3.364	0.665	0.480	0.180	
			Parastatal	12	3.177	0.667	0.729	0.073	0.280
3	T	X23	Government Provincial	14	3.754	0.888			
			Government Local	13	3.154	0.532	0.676		
			Private	11	2.545	0.848	1.361	0.717	
			Parastatal	12	2.704	0.438	1.183	0.846	0.187
4	L	X24	Government Provincial	14	3.929	0.611			
			Government Local	13	3.795	0.244	0.219		
			Private	11	3.283	0.483	1.057	1.061	
			Parastatal	12	3.620	0.456	0.504	0.383	0.699
5	PPM	X25	Government Provincial	14	4.036	0.581			
			Government Local	13	4.250	0.451	0.369		
			Private	11	3.466	0.607	0.938	1.291	
			Parastatal	12	3.958	0.634	0.122	0.460	0.777
6	OHC	X26	Government Provincial	14	4.114	0.814			
			Government Local	13	3.708	0.487	0.499		
			Private	11	3.600	0.704	0.632	0.153	
			Parastatal	12	3.783	0.612	0.406	0.124	0.260
7	OMP	X2	Government Provincial	14	3.892	0.612			
			Government Local	13	3.670	0.271	0.362		
			Private	11	3.256	0.614	1.036	0.675	
			Parastatal	12	3.442	0.456	0.734	0.500	0.303

The practical significance of these client types are as follows:

**a) Relationship assessment between government local and government provincial client types:**

SDM (d-values = 0.116), L (d-values = 0.219), PPM (d-values = 0.369), OHC (d-values = 0.499) and OMP (d-values = 0.362) constructs are indicating no practical significance in the mean values between a government local and government provincial type client.

SOP(d-values = 0.658) and T (d-values = 0.676) constructs are indicating that a medium practical significance strength exists between an government local and government provincial type client, where an government local type client has a lower mean than an government provincial type client.

**b) Relationship assessment between private and government provincial client types:**

SOP (d-values = 0.480) construct is indicating no practical significance in the mean values between a private and government provincial type client.

SDM (d-values = 0.677) and OHC (d-values = 0.632) constructs are indicating that a medium practical significance strength exists between a private and government provincial type client, where an private type client has a lower mean than an government provincial type client.

*T* (d-values = 1.361), *L* (d-values = 1.057), *PPM* (d-values = 0.938) and *OMP* (d-values = 1.036) constructs are indicating that a ***strong practical significance strength*** exists between a private and government provincial type client, where an ***private type client has a lower mean than an government provincial type client.***

**c) Relationship assessment between parastatal and government provincial client types:**

PPM (d-values = 0.122) and OHC (d-values = 0.406) constructs are indicating no practical significance in the mean values between a parastatal and government provincial type client.

SDM (d-values = 0.504), SOP (d-values = 0.729), *L* (d-values = 0.504) and *OMP* (d-values = 0.734) constructs are indicating that a medium practical significance strength exists between an parastatal and government provincial type client, where an parastatal type client has a lower mean than an government provincial type client.

*T* (d-values = 1.183) construct is indicating that a ***strong practical significance strength*** exists between a parastatal and government provincial type client, where an ***parastatal type client has a lower mean than an government provincial type client.***

**d) Relationship assessment between private and government local client types:**

SOP (d-values = 0.180) and OHC (d-values = 0.153) constructs are indicating no practical significance in the mean values between a private and government local type client.

*T* (d-values = 0.717) and *OMP* (d-values = 0.675) constructs are indicating that a medium practical significance strength exists between an private and government local

type client, where an private type client has a lower mean than an government local type client.

**SDM** (d-values = 0.866), **L** (d-values = 1.061) and **PPM** (d-values = 1.291) constructs are indicating that a **strong practical significance strength** exists between an private and government local type client, where an **private type client has a lower mean than an government local type client**.

- e) **Relationship assessment between parastatal and government local client types:** SOP (d-values = 0.073), L (d-values = 0.383), PPM (d-values = 0.406) and OHC (d-values = 0.124) constructs are indicating no practical significance in the mean values between a parastatal and government local type client.

SDM (d-values = 0.712) construct is indicating that a medium practical significance strength exists between a parastatal and government local type client, where an parastatal type client has a lower mean than an government local type client.

OMP (d-values = 0.500) construct is indicating that a medium practical significance strength exists between a parastatal and government local type client, where an parastatal type client has a higher mean than an government local type client.

**T** (d-values = 0.846) construct is indicating that a **strong practical significance strength** exists between a parastatal and government local type client, where an **parastatal type client has a lower mean than an government local type client**.

- f) **Relationship assessment between private and parastatal client types:** SDM (d-values = 0.188), SOP (d-values = 0.280), T (d-values = 0.187), OHC (d-values = 0.260) and OMP (d-values = 0.303) constructs are indicating no practical significance in the mean values between a private and parastatal type client.

L (d-values = 0.699), PPM (d-values = 0.777) construct are indicating that a medium practical significance strength exists between an private and parastatal type client, where an parastatal type client has a higher mean than an private type client.

### 5.2.3.3 Relationship assessment between leverage and PP

The following table indicates the relationship between the seven operations management performance constructs and the project type demographic variable, with mean ( $\bar{x}$ ), standard deviation ( $s$ ) and effect size (d-values).

**Table 35: Relationship assessment between leverage and OMP**

Item	Variable Description	Variable	Leverage				Comparison	
			Demographic Description	N	$[\bar{x}]$	[s]	d	d
1	SDM	X21	2-4	19	3.496	0.796		
			4-6	10	3.586	0.564	0.112	
			6-8+	14	3.699	0.742	0.255	0.153
2	SOP	X22	2-4	19	3.283	0.829		
			4-6	10	3.338	0.752	0.066	
			6-8+	14	3.402	0.749	0.143	0.085
3	T	X23	2-4	19	2.965	0.835		
			4-6	10	3.089	0.740	0.149	
			6-8+	14	3.151	0.952	0.195	0.065
4	L	X24	2-4	19	3.725	0.403		
			4-6	10	3.600	0.602	0.208	
			6-8+	14	3.627	0.616	0.159	0.044
5	PPM	X25	2-4	19	3.901	0.779		
			4-6	10	3.763	0.512	0.178	
			6-8+	14	3.911	0.715	0.012	0.207
6	OHC	X26	2-4	19	3.842	0.655		
			4-6	10	3.900	0.568	0.088	
			6-8+	14	3.786	0.770	0.073	0.148
7	OMP	X2	2-4	19	3.535	0.581		
			4-6	10	3.546	0.505	0.018	
			6-8+	14	3.596	0.621	0.097	0.081

The practical significance of these leverage categories are as follows:

**a) Relationship assessment between 4-6 and 2-4 leverage category:**

SDM, SOP, T, L, PPM, OHC and OMP constructs are indicating no practical significance in the mean values between a 4-6 and 2-4 leverage category.

**b) Relationship assessment between 6-8+ and 2-4 leverage category:**

SDM, SOP, T, L, PPM, OHC and OMP constructs are indicating no practical significance in the mean values between a 6-8+ and 2-4 leverage category.

**c) Relationship assessment between 4-6 and 6-8+ leverage category:**

SDM, SOP, T, L, PPM, OHC and OMP constructs are indicating no practical significance in the mean values between a 4-6 and 6-8+ leverage category.

### 5.2.3.4 Relationship assessment between project duration and PP

The following table indicates the relationship between the seven operations management performance constructs and the project type demographic variable, with mean ( $\bar{x}$ ), standard deviation ( $s$ ) and effect size ( $d$ -values).

Table 36: Relationship assessment between project duration and OMP

Project Duration			0-12 Months			12 - 24+ Months			Comparison
Item	Variable Description	Variable	N	[ $\bar{x}$ ]	[ $s$ ]	N	[ $\bar{x}$ ]	[ $s$ ]	d
1	SDM	X21	32	3.721	0.680	24	3.440	0.747	0.413
2	SOP	X22	32	3.414	0.827	24	3.297	0.548	0.142
3	T	X23	32	3.090	0.864	24	3.083	0.782	0.008
4	L	X24	32	3.722	0.487	24	3.630	0.522	0.190
5	PPM	X25	32	4.027	0.606	24	3.807	0.733	0.363
6	OHC	X26	32	3.931	0.686	24	3.700	0.619	0.337
7	OMP	X2	32	3.651	0.562	24	3.493	0.534	0.281

The practical significance of these project duration categories is as follows:

**a) Relationship assessment between 0-12 and 12-24+ project duration category:**

SDM, SOP, T, L, PPM, OHC and OMP constructs are indicating no practical significance in the mean values between a 0-12 and 12-24+ project duration category.

## 5.3 Assessment of operational personnel's perceptions towards how much value is added (VA) to the company through different company departments (CD)

### 5.3.1 Assessment of VA by CD

The third part of this literature review focused on the value added and the value chain concept introduced by Michael Porter. Identifying a company's value chain and using it for operations management analysis is a highly effective tool. Each department and activity inside a company adds a certain amount of value to the company. Throughout the literature review it became evident that the value added and the understanding of this concept by the company themselves plays an important part in operations management.

Examining value based management, which is a value added management technique, it was identified that the professional employ plays an important part in a service oriented company, such as a consulting engineering company. It can therefore be stated that the professional employee and their understating of the company strategy and workings are central to the success of a service oriented company. It is thus important that these professional employees understand the value added concept correctly and that their

perceptions towards value added to the company through different departments and operational activities are in line with corporate and operational strategies.

Section A of the questionnaire used in the survey captured operational personnel's perceptions towards the amount of value added to the company through departmental and operational activities. This was done by depicting a simple generalisation of such a value chain for a consulting engineering company. Respondents were asked to study this diagram and to indicate on this diagram how much value, according to their perception, is added by each departmental activity. It was also noted that the total value added to the company may not exceed or be less than 100%.

All project value added perceptions are based on a 0 to 100 percentage scale, where 0 is defined as 0% value added by the specific activity and 100 is defined as 100% value added by the specific activity.

The following table portrays the results of the descriptive statistical analysis of the perceptions of operational personnel inside the surveyed consulting engineering company. These perceptions are of the amount of value added to the company through different departmental activities.

**Table 37: Operational personnel's perceptions towards VA by CD results**

Item	Variable Description	Variable	N	Mean [ $\bar{x}$ ]	Std. Deviation [s]
1	VA to Company by Corporate Strategic Plan (CSP)	X31	23	8.957	5.338
2	VA to Company by Client Department (CSD)	X32	23	11.043	5.440
3	VA to Company by Marketing & Communications Department (MCD)	X33	23	8.870	5.146
4	VA to Company by Financial Department (FD)	X34	23	11.283	4.520
5	VA to Company by Corporate Services Department (CRD)	X35	23	6.826	2.708
6	VA to Company by Operations Management Department (OMD)	X36	23	53.065	12.989
7	Total Average			16.667	0

The variable **CRD** ( $\bar{x} = 6.826$ ) has the lowest average score indicating the lowest perceived value added percentage by this department. The construct **OMD** ( $\bar{x} = 53.065$ ) has the highest average score indicating the highest perceived value added percentage by this department.

Five of the 6 value added through departmental activities variables, **CSP** ( $\bar{x} = 8.957$ ), **CSD** ( $\bar{x} = 11.043$ ), **MCD** ( $\bar{x} = 8.870$ ), **FD** ( $\bar{x} = 11.283$ ) and **CRD** ( $\bar{x} = 6.826$ ) are below the average mean **of all the variables** ( $\bar{x} = 16.667$ ).

The standard deviation of the six variables is far outside 1. This means that the surveyed data does not resemble a normal distribution and that the perceptions of operational personnel on the value added concept are not in line with each other. From this can be concluded that operational personnel in the surveyed company do not feel the same about added value.

These results indicate that operational personnel perceive that most value is added through the operations management department and that for them the rest of the value is evenly spread throughout the other departments, except where the perceptions show that the those personnel deemed the corporate service departments to add the least value to the company.

Examining the value added through company department variables, the following explanation could be formulated:

**a) VA to Company by Corporate Strategic Plan ( $\bar{x} = 8.957$ ;  $s = 5.338$ ) :**

Operational personnel perceive that 8.957% of the total value added to the company (maximum value = 100%) is achieved by the strategic planning and management department (directors and management) of the company; this entails drafting the vision & mission of the company, setting the strategic objectives, designing the business portfolio, setting strategic KPI's, etcetera.

**b) VA to Company by Client Department ( $\bar{x} = 11.043$ ;  $s = 5.440$ ) :**

Operational personnel perceive that 11.043% of the total value added to the company (maximum value = 100%) is achieved by the clients department of the company, which entails building client relationships and managing client databases.

**c) VA to Company by Marketing & Communications Department ( $\bar{x} = 8.870$ ;  $s = 5.146$ ) :**

Operational personnel perceive that 8.870% of the total value added to the company (maximum value = 100%) is achieved by the marketing & communications department of the company, which entails internal and external communications, identifying market place and client needs, drafting marketing strategies, corporate identity and branding.

**d) VA to Company by Financial Department ( $\bar{x} = 11.283$ ;  $s = 4.520$ ) :**

Operational personnel perceive that 11.283% of the total value added to the company (maximum value = 100%) is achieved by the financial department of the company,

which entails general book keeping, cash flow management, Vat and tax management, managerial accounting and financial planning and management.

**e) VA to Company by Corporate Services Department (  $\bar{x}$  = 6.826; s = 2.708 ) :**

Operational personnel perceive that 6.826% of the total value added to the company (maximum value = 100%) is achieved by the corporate services department of the company, which entails human resources, risk management, IT management, Quality management, asset management, etcetera.

**f) VA to Company by Operations Management Department (  $\bar{x}$  = 53.065; s = 12.989 ) :**

Operational personnel perceive that 53.065% of the total value added to the company (maximum value = 100%) is achieved by the operations management department of the company, tooling, loading, service offering process, project planning and management and operational hierarchy and culture.

### **5.3.2 Relationship assessment between respondent demographics and VA by CD**

Statistical and practical significance analysis were done by determining the relationship between value added through company department variables and operational personnel demographic variables.

The purpose of this analysis was to determine whether there exists a significant difference between the evaluations based on the mean score of an operational personnel demographic variable with regard to a specific value added through company department variable.

It was determined that the statistical significance could not be used in relationship analyses between study variables and demographic variables, because the sample size per demographic group is too small.

The practical significance values are indicated in the analysis tables and for the purpose of this study d-values  $\leq 0.5$  means no practical significant difference, d-values between 0.5 and 0.8 means medium practical significant difference and d-values  $\geq 0.8$  means large practical significant difference.

#### **5.3.2.1 Relationship assessment between age group and VA by CD**

The following table indicates the relationship between the five value added through company department variables and one operational personnel demographic variable age group, indicating the mean (  $\bar{x}$  ), standard deviation ( s ) and effect size ( d-values ) of the relationship.

Table 38: Relationship assessment between age groups and VA by CD

Age Group			<=39			40+			Comparison
Item	Variable Description	Variable	N	[ $\bar{x}$ ]	[s]	N	[ $\bar{x}$ ]	[s]	d
1	VA to Company by CSP	X31	14	7.429	4.033	9	11.333	6.442	0.968
2	VA to Company by CSD	X32	14	11.000	6.276	9	11.111	4.167	0.018
3	VA to Company by MCD	X33	14	8.071	3.970	9	10.111	6.660	0.514
4	VA to Company by FD	X34	14	10.429	4.536	9	12.611	4.414	0.481
5	VA to Company by CRD	X35	14	6.286	2.525	9	7.667	2.915	0.547

a) **Relationship assessment between 0-39 and 40+ age group:**

Value added to the company through CSD and FD variables are indicating no practical significance in the mean values between a 0-39 and 40+ age group.

Value added to the company through MCD (d-values = 0.514) and CRD (d-values = 0.547) variables are indicating that a medium practical significance strength exists between an 0-39 and 40+ age group, where an 40+ age group has a higher mean than an 0-39 age group.

**Value added to the company through CSP** (d-values = 0.968) variable is indicating that a **strong practical significance strength** exists between an 0-39 and 40+ age group, where an **40+ age group has a higher mean than an 0-39 age group**.

### 5.3.2.2 Relationship assessment between engineering qualifications and VA by CD

The following table indicates the relationship between the five value added through company department variables and one operational personnel demographic variable engineering qualification, indicating the mean (  $\bar{x}$  ), standard deviation (s) and effect size (d-values) of the relationship.

Table 39: Relationship assessment between engineering qualification and VA by CD

Engineering Qualification			None - National Diploma			Degree - Post Graduate			Comparison
Item	Variable Description	Variable	N	[ $\bar{x}$ ]	[s]	N	[ $\bar{x}$ ]	[s]	d
1	VA to Company by CSP	X31	9	10.556	6.023	13	7.000	3.440	0.590
2	VA to Company by CSD	X32	9	11.000	5.050	13	11.154	6.094	0.030
3	VA to Company by MCD	X33	9	10.222	5.449	13	8.231	5.069	0.365
4	VA to Company by FD	X34	9	12.222	4.410	13	10.346	4.661	0.425
5	VA to Company by CRD	X35	9	7.444	2.242	13	6.538	3.072	0.404

**a) Relationship assessment between none-national diploma and degree-post graduate engineering qualification:**

Value added to the company through CSD, MFD, FD and CRD variables are indicating no practical significance in the mean values between a none-national diploma and degree post-graduate engineering qualification.

Value added to the company through CSP (d-values = 0.590) variable is indicating that a medium practical significance strength exists between a none-national diploma and degree post-graduate engineering qualification, where an degree post-graduate engineering qualification has a lower mean than an a non-national diploma engineering degree.

**5.3.2.3 Relationship assessment between business qualifications and VA by CD**

The following table indicates the relationship between the five value variables added through company department and one operational personnel demographic variable business qualification, mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values) are shown in the analysis tables.

**Table 40: Relationship assessment between business qualification and VA by CD**

Business Qualification			None			Diploma - Post Graduate			Comparison
Item	Variable Description	Variable	N	$[\bar{x}]$	[s]	N	$[\bar{x}]$	[s]	d
1	VA to Company by CSP	X31	12	7.333	4.830	11	10.727	5.515	0.703
2	VA to Company by CSD	X32	12	10.417	6.815	11	11.727	3.608	0.192
3	VA to Company by MCD	X33	12	7.917	5.401	11	9.909	4.888	0.369
4	VA to Company by FD	X34	12	10.417	4.719	11	12.227	4.309	0.384
5	VA to Company by CRD	X35	12	6.500	2.844	11	7.182	2.639	0.240

**a) Relationship assessment between none and diploma-post graduate business qualification:**

Value added to the company through CSP, CSD, MCD, FD and CRD variables are indicating no practical significance in the mean values between a none and diploma-post graduate business qualification.

Value added to the company through CSP (d-values = 0.703) variable is indicating that a medium practical significance strength exist between a none and diploma-post graduate business qualification, where an diploma-post graduate engineering qualification has a higher mean than an a none business degree.

### 5.3.2.4 Relationship assessment between management level and VA by CD

The following table indicates the relationship between the five value variables added through company department and one operational personnel demographic variable management level, indicating the mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values) of the relationship.

**Table 41: Relationship assessment between management level and VA by CD**

Management Level			Director - Manager			Technical - Administrator			Comparison
Item	Variable Description	Variable	N	$[\bar{x}]$	[s]	N	$[\bar{x}]$	[s]	d
1	VA to Company by CSP	X31	15	8.467	5.167	8	9.875	5.890	0.273
2	VA to Company by CSD	X32	15	10.267	6.076	8	12.500	3.928	0.368
3	VA to Company by MCD	X33	15	8.600	5.138	8	9.375	5.476	0.151
4	VA to Company by FD	X34	15	12.500	4.702	8	9.000	3.295	0.744
5	VA to Company by CRD	X35	15	7.533	2.825	8	5.500	2.000	0.720

#### a) Relationship assessment between director-manager and technical administrator management level:

Value added to the company through CSP, CSD, MCD, FD and CRD variables are indicating no practical significance in the mean values between director-manager and technical-administrator management level.

Value added to the company through FD (d-values = 0.744) and CRD (d-values = 0.720) variables are indicating that a medium practical significance strength exists between director-manager and technical-administrator management level, where an director-manager management level has a lower mean than an technical-administrator management level.

## 5.4 Assessment of operational personnel's perceptions towards how much value is added (VA) to the company through different operational department activities (OA)

### 5.4.1 Assessment of VA by OA

The third part of this literature review focused on the value added and the value chain concept introduced by Michael Porter. Identifying a company's value chain and using it for operations management analysis is a highly effective tool. Each department and activity within a company adds a certain amount of value to the company. Throughout the literature review it became evident that the value added and the understanding of this concept by the company themselves plays an important part in operations management.

Examining value based management, which is a value added management technique, it was identified that the professional employee plays an important part in a service oriented company, such as a consulting engineering company. Therefore it can be stated that the professional employee and their understating of the company strategy and workings are central to the success of a service oriented company. It is thus important that these professional employees understand the value added concept correctly and that their perceptions towards value added to the company through different departments and operational activities are in line with corporate and operational strategies.

Section A of the questionnaire used in the survey captured operational personnel's perceptions on the amount of value added to the company through departmental and operational activities. This was done by depicting a simple generalisation of such a value chain for a consulting engineering company. Respondents were asked to study this diagram and to indicate on this diagram how much value according to their perceptions, are added by each departmental activity. It was also noted that the total value added to the company may exceed or be less than 100%.

All project value added perceptions are based on a 0 to 100 percentage scale, where 0 is defined as 0% value added by the specific activity and 100 is defined as 100% value added by the specific activity.

The following table portrays the results of the descriptive statistical analysis of the perceptions from operational personnel within the surveyed consulting engineering company towards. This perception is about the amount of value added to the company (or to the operations management department) through different operational activities.

**Table 42: Operational personnel's perceptions towards VA by OA results**

Item	Variable Description	Variable	N	Mean [ $\bar{x}$ ]	Std. Deviation [s]
1	VA to Company by Strategic Department Management (SDM)	X41	23	7.065	3.069
2	VA to Company by Service Offering Process (SOP)	X42	23	8.500	5.029
3	VA to Company by Tooling (T)	X43	23	8.065	3.632
4	VA to Company by Loading (L)	X44	23	8.978	4.018
5	VA to Company by Project Planning and Management (PPM)	X45	23	14.935	11.046
6	VA to Company by Operational Hierarchy & Culture (OHC)	X46	23	5.522	2.447
7	Total Average			8.844	2.165

The variable **SDM** ( $\bar{x} = 7.065$ ) has the lowest average score indicating the lowest perceived value added percentage by this operational activity. The construct **PPM** ( $\bar{x} = 14.935$ ) has the highest average score indicating the highest perceived value added percentage by this operational activity.

Four of the 6 value added through operational activities variables, **SDM** ( $\bar{x} = 7.065$ ), **SOP** ( $\bar{x} = 8.500$ ), **T** ( $\bar{x} = 8.065$ ) and **OHC** ( $\bar{x} = 11.283$ ) are below the average mean of **all the variables** ( $\bar{x} = 8.522$ ).

The standard deviation of the 6 variables are far outside 1, meaning that the surveyed data does not resemble a normal distribution and that the perceptions of operational personnel toward the value added concept are not in line with each other.

These results indicate that operational personnel perceive that most value is added through the project planning and management operational activity and that the rest of the value is evenly spread throughout the other departments except where the perceptions were that the operational hierarchy and culture adds the least value to the company.

## 5.4.2 Relationship assessment between respondent demographics and VA by OA

### 5.4.2.1 Relationship assessment between age group and VA by OA

The following table indicates the relationship between the six value variables added through operations management activity and one operational personnel demographic variable age group, indicating the mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values) of the relationship.

**Table 43: Relationship assessment between age groups and VA by OA**

Age Group				<=39		40+		Comparison	
Item	Variable Description	Variable	N	$[\bar{x}]$	[s]	N	$[\bar{x}]$	[s]	d
1	VA to Company by SDM	X41	14	6.857	3.325	9	7.389	2.781	0.160
2	VA to Company by SOP	X42	14	9.429	6.161	9	7.056	2.007	0.385
3	VA to Company by T	X43	14	8.393	4.297	9	7.556	2.404	0.195
4	VA to Company by L	X44	14	9.714	4.358	9	7.833	3.335	0.432
5	VA to Company by PPM	X45	14	16.821	11.996	9	12.000	9.260	0.402
6	VA to Company by OHC	X46	14	5.571	2.277	9	5.444	2.833	0.056

#### a) Relationship assessment between 0-39 and 40+ age group:

Value added to the company through SDM, SOP, T, L, PPM and OHC variables are indicating no practical significance in the mean values between a 0-39 and 40+ age group.

### 5.4.2.2 Relationship assessment between engineering qualification and VA by OA

The following table indicates the relationship between the six value variables added through operations management activity and one operational personnel demographic variable engineering qualification, indicating the mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values) of the relationship.

Table 44: Relationship assessment between engineering qualification and VA by OA

Engineering Qualification			None - National Diploma			Degree - Post Graduate			Comparison
Item	Variable Description	Variable	N	$[\bar{x}]$	[s]	N	$[\bar{x}]$	[s]	d
1	VA to Company by SDM	X41	9	7.222	3.346	13	7.115	3.070	0.032
2	VA to Company by SOP	X42	9	8.889	6.412	13	8.115	4.302	0.121
3	VA to Company by T	X43	9	7.000	4.000	13	9.038	3.294	0.510
4	VA to Company by L	X44	9	8.222	3.346	13	9.808	4.433	0.474
5	VA to Company by PPM	X45	9	12.000	9.138	13	16.962	12.534	0.543
6	VA to Company by OHC	X46	9	5.333	2.500	13	5.692	2.594	0.144

#### a) Relationship assessment between none-national diploma and degree-post graduate engineering qualification:

Value added to the company through SDM, SOP, L and OHC variables are indicating no practical significance in the mean values between a none-national diploma and degree-post graduate engineering qualification.

Value added to the company through T (d-values = 0.510) and PPM (d-values = 0.543) variables are indicating that a medium practical significance strength exist between a none-national diploma and degree-post graduate engineering qualification, where an degree-post graduate engineering qualification has a higher mean than an a none-national diploma engineering degree.

### 5.4.2.3 Relationship assessment between business qualification and VA by OA

The following table indicates the relationship between the six value variables added through operations management activity and one operational personnel demographic variable business qualification, mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values) are shown in the analysis tables.

Table 45: Relationship assessment between business qualification and VA by OA

Business Qualification			None			Diploma - Post Graduate			Comparison
Item	Variable Description	Variable	N	$[\bar{x}]$	[s]	N	$[\bar{x}]$	[s]	d
1	VA to Company by SDM	X41	12	6.083	2.644	11	8.136	3.256	0.776
2	VA to Company by SOP	X42	12	9.500	6.557	11	7.409	2.417	0.319

3	VA to Company by T	X43	12	8.375	4.040	11	7.727	3.289	0.160
4	VA to Company by L	X44	12	8.750	4.731	11	9.227	3.281	0.101
5	VA to Company by PPM	X45	12	19.625	13.241	11	9.818	4.513	0.741
6	VA to Company by OHC	X46	12	5.083	2.539	11	6.000	2.366	0.361

**a) Relationship assessment between none and diploma-post graduate business qualification:**

Value added to the company through SOP, T and OHC variables are indicating no practical significance in the mean values between a none and diploma-post graduate business qualification.

Value added to the company through SDM (d-values = 0.776) variable is indicating that a medium practical significance strength exist between an none and diploma-post graduate business qualification, where a diploma-post graduate engineering qualification has a higher mean than a none business degree.

Value added to the company through PPM (d-values = 0.741) variable is indicating that a medium practical significance strength exist between an none and diploma-post graduate business qualification, where a diploma-post graduate engineering qualification has a lower mean than a none business degree.

#### 5.4.2.4 Relationship assessment between management level and VA by OA

The following table indicates the relationship between the 6 value added through operations management activity variables and one operational personnel demographic variable management level, indicating the mean ( $\bar{x}$ ), standard deviation (s) and effect size (d-values) of the relationship.

**Table 46: Relationship assessment between management level and VA by OA**

Management Level			Director - Manager			Technical - Administrator			Comparison
Item	Variable Description	Variable	N	$[\bar{x}]$	[s]	N	$[\bar{x}]$	[s]	d
1	VA to Company by SDM	X41	15	6.633	3.003	8	7.875	3.227	0.414
2	VA to Company by SOP	X42	15	9.300	5.922	8	7.000	2.330	0.388
3	VA to Company by T	X43	15	7.500	3.354	8	9.125	4.121	0.484
4	VA to Company by L	X44	15	7.767	3.321	8	11.250	4.432	1.049
5	VA to Company by PPM	X45	15	16.100	13.115	8	12.750	5.574	0.255
6	VA to Company by OHC	X46	15	5.333	2.526	8	5.875	2.416	0.214

**a) Relationship assessment between director-manager and technical administrator management level:**

Value added to the company through SDM, SOP, T, PPM and OHC variables are indicating no practical significance in the mean values between director-manager and technical-administrator management level.

***Value added to the company through L*** (d-values = 1.049) variable is indicating that a ***strong practical significance strength*** exist between director-manager and technical-administrator management level, where a ***director-manager management level has a lower mean than a technical-administrator management level***.

## 5.5 Relationship assessment between operational personnels perceptions towards VA to the Company and OMP

Throughout the literature review it was determined that the underlying operations management elements and perceptions towards how much value is added to the company through company department or operations management activities are important in any consulting engineering company.

Each of these main study elements were assessed in this chapter by providing, interpreting and assessing the statistical analysis results of each element that came out of the survey.

One of the objectives of this study was to determine if a potential link or relationship exists between operations management performance and the perceptions of operational personnel towards how much value they perceive is added to their company through departments or operations management activities.

Relationship analysis was done with the use of the basic statistical correlation concept to determine whether a potential relationship exists and if one of these study elements does affect the other.

The correlation coefficient values indicates practical significance, for the purpose of this study values  $\leq 0.1$  means small significant difference, values between 0.1 and 0.3 means medium practical significant difference and values  $\geq 0.5$  means large practical significant difference.

The sig (2-tailed) values indicates statistical significance, for the purpose of this study any values smaller than 0.05 means indicates statistical significance,

The following table depicts the statistical correlation analysis between the underlying operations management performance constructs and the value added to the company through company department variables.

Table 47: Relationship assessment between VA to the company by CD and OMP results

Item	Variable Description	Variable	Relationship Description	VA by CSP	VA by CSD	VA by MCD	VA by FD	VA by CRD
				X31	X32	X33	X34	X35
1	SDM	X21	Correlation Coefficient	0.303	0.247	0.165	-0.031	-0.068
			Sig. (2-tailed)	0.160	0.256	0.451	0.890	0.757
			N	23.000	23.000	23.000	23.000	23.000
2	SOP	X22	Correlation Coefficient	0.219	0.090	-0.166	0.152	-0.159
			Sig. (2-tailed)	0.316	0.682	0.448	0.489	0.470
			N	23.000	23.000	23.000	23.000	23.000
3	T	X23	Correlation Coefficient	0.254	0.099	0.238	-0.026	-0.210
			Sig. (2-tailed)	0.243	0.655	0.275	0.907	0.337
			N	23.000	23.000	23.000	23.000	23.000
4	L	X24	Correlation Coefficient	0.388	0.125	-0.110	-0.013	-0.071
			Sig. (2-tailed)	0.067	0.571	0.616	0.955	0.747
			N	23.000	23.000	23.000	23.000	23.000
5	PPM	X25	Correlation Coefficient	0.458	-0.168	0.104	0.204	-0.039
			Sig. (2-tailed)	0.028	0.443	0.638	0.349	0.858
			N	23.000	23.000	23.000	23.000	23.000
6	OHC	X26	Correlation Coefficient	0.077	0.012	-0.032	0.069	-0.101
			Sig. (2-tailed)	0.727	0.958	0.884	0.755	0.646
			N	23.000	23.000	23.000	23.000	23.000
7	OMP	X2	Correlation Coefficient	0.317	0.107	0.100	0.077	-0.150
			Sig. (2-tailed)	0.141	0.627	0.651	0.725	0.496
			N	23.000	23.000	23.000	23.000	23.000

A medium to strong relationship between the *Value Added by Corporate Strategic Planning* variable and *Project Planning and Management* construct of operations management performance is indicated by a *correlation coefficient of 0.458* and a *p-value of 0.028*.

It can thus be concluded that if operational personnel perceive that more value is added by Corporate Strategic Planning, Project Planning and Management Performance may have the potential to increase.

The following table depicts the statistical correlation analysis between the underlying operations management performance constructs and the value added to the company through operations management activity variables.

**Table 48: Relationship assessment between VA to the company by OA and OMP results**

Item	Variable Description	Variable	Relationship Description	VA by SDM	VA by SOP	VA by T	VA by L	VA by PPM	VA by OHC
				X41	X42	X43	X44	X45	X46
1	SDM	X21	Correlation Coefficient	0.226	0.123	-0.089	0.073	-0.254	-0.073
			Sig. (2-tailed)	0.300	0.577	0.687	0.742	0.241	0.742
			N	23.000	23.000	23.000	23.000	23.000	23.000
2	SOP	X22	Correlation Coefficient	0.470	0.064	-0.260	0.311	-0.086	0.063
			Sig. (2-tailed)	0.024	0.771	0.232	0.149	0.698	0.774
			N	23.000	23.000	23.000	23.000	23.000	23.000
3	T	X23	Correlation Coefficient	0.186	0.166	-0.159	0.096	-0.172	-0.110
			Sig. (2-tailed)	0.395	0.450	0.469	0.663	0.431	0.617
			N	23.000	23.000	23.000	23.000	23.000	23.000
4	L	X24	Correlation Coefficient	0.263	0.099	-0.193	0.159	-0.094	0.080
			Sig. (2-tailed)	0.225	0.652	0.377	0.469	0.670	0.717
			N	23.000	23.000	23.000	23.000	23.000	23.000
5	PPM	X25	Correlation Coefficient	0.269	0.219	-0.455	-0.135	-0.227	-0.293
			Sig. (2-tailed)	0.215	0.315	0.029	0.539	0.298	0.175
			N	23.000	23.000	23.000	23.000	23.000	23.000
6	OHC	X26	Correlation Coefficient	0.504	0.206	-0.151	0.245	-0.164	0.066
			Sig. (2-tailed)	0.014	0.346	0.493	0.260	0.454	0.766
			N	23.000	23.000	23.000	23.000	23.000	23.000
7	OMP	X2	Correlation Coefficient	0.307	0.209	-0.235	0.100	-0.248	-0.051
			Sig. (2-tailed)	0.154	0.338	0.281	0.651	0.255	0.817
			N	23.000	23.000	23.000	23.000	23.000	23.000

A medium to strong relationship between the *Value Added by Strategic Department Management* variable and *Service Offering Process* construct of operations management performance is indicated by a *correlation coefficient of 0.470* and a *p-value of 0.024*.

A medium to strong relationship between the *Value Added by Strategic Department Management* variable and *Operational Hierarchy and Culture* construct of operations

management performance is indicated by a **correlation coefficient of 0.504** and a **p-value of 0.014**.

A medium to strong relationship between the **Value Added by Tooling** variable and **Project Management and Performance** construct of operations management performance is indicated by a **correlation coefficient of -0.455** and a **p-value of 0.029**.

It can thus be concluded that if operational personnel perceive that more value is added by Strategic Department Management of the operations management department, Service Offering Process and Operational Hierarchy and Culture Performance may have the potential to increase.

Furthermore, it can be concluded that if operational personnel perceive that more value is added by Tooling of the operations management department, Project Planning and Performance may have the potential to decrease.

## **5.6 Assessment of relationship between Operations Management Performance (OMP) and Project Performance (PP)**

Throughout the literature review it was determined that the underlying operations management elements and project performance elements are important in any consulting engineering company.

Each of these main study elements were assessed in this chapter by providing, interpreting and assessing the statistical analysis results of each element that emerged from the survey.

One of the objectives of this study was to determine whether a potential link or relationship exists between operations management performance and project performance.

Relationship analysis was done with the use of the basic statistical correlation concept to determine if a potential relationship exists and if one of these study elements does affect the other.

The correlation coefficient values indicate practical significance, for the purpose of this study values  $\leq 0.1$  means small significant difference, values between 0.1 and 0.3 means medium practical significant difference and values  $\geq 0.5$  means large practical significant difference.

The sig (2-tailed) values indicate statistical significance, for the purpose of this study any values smaller than 0.05 means indicates statistical significance.

The following table depicts the statistical correlation analysis between the underlying operations management performance constructs and the project performance variables.

**Table 49: Relationship assessment between OPP and PP**

Item	Variable Description	Variable	Relationship Description	Project Quality	Project Program	Project Financial
				X11	X12	X14
1	Strategic Department Management (SDM)	X21	Correlation Coefficient	0.320	0.421	-0.100
			Sig. (2-tailed)	0.016	0.001	0.465
			N	56.000	56.000	56.000
2	Service offering Process (SOP)	X22	Correlation Coefficient	0.341	0.184	0.146
			Sig. (2-tailed)	0.010	0.174	0.284
			N	56.000	56.000	56.000
3	Tooling (T)	X23	Correlation Coefficient	0.316	0.151	0.013
			Sig. (2-tailed)	0.018	0.268	0.926
			N	56.000	56.000	56.000
4	Loading (L)	X24	Correlation Coefficient	0.313	0.288	-0.013
			Sig. (2-tailed)	0.019	0.032	0.925
			N	56.000	56.000	56.000
5	Project Planning & Management (PPM)	X25	Correlation Coefficient	0.238	0.274	-0.041
			Sig. (2-tailed)	0.077	0.041	0.766
			N	56.000	56.000	56.000
6	Operational Hierarchy & Culture (OHC)	X26	Correlation Coefficient	0.282	0.349	-0.015
			Sig. (2-tailed)	0.035	0.008	0.915
			N	56.000	56.000	56.000
7	Operations Management Performance	X2	Correlation Coefficient	0.381	0.374	0.042
			Sig. (2-tailed)	0.004	0.004	0.759
			N	56.000	56.000	56.000

A low to medium relationship between the **Project Quality** variable (underlying variable of project performance) and **Strategic Department Management, Service Offering Process, Tooling, Loading, Operational Hierarchy and Culture and Operations Management Performance** construct (underlying constructs of operations management performance) is indicated by **correlation coefficient between 0.274 and 0.381** and a **p-values between 0.004 and 0.041**.

A low to medium relationship between the **Project Program** variable (underlying variable of project performance) and **Strategic Department Management, Loading, Project Planning and Management and Operational Hierarchy and Culture** constructs (underlying

constructs of operations management performance) is indicated by a **correlation coefficient between 0.274 and 0.374** and a **p-values between 0.004 and 0.032**.

A medium to strong relationship between the **Project Program** variable (underlying variable of project performance) and **Strategic Department Management** construct (underlying constructs of operations management performance) is indicated by a **correlation coefficient of 0.421** and a **p-value of 0.001**.

It can thus be concluded that if the performance of five of the six operations management performance (SDM, L, PPM, and OHC) constructs are increased, Project Quality Performance may have the potential to increase.

Furthermore it can thus be concluded that if the performance of four of the six operations management performance (SDM, SOP, T, L and OHC) constructs are increased, Project Program Performance may have the potential to increase.

No potential relationship was found between Project Financial variable (underlying variable of project performance) and any underlying constructs of operations management performance.

## 6. SUMMARY

The primary objective of this research study was to assess operations management performance, project performance, operational personnel's interpretation of the value added (VA) concept with regard to operational management (OM). The aim was to determine whether a relationship exists between these three study elements in a consulting engineering company in South Africa that was selected by the researcher.

The empirical study was conducted by developing a questionnaire that could measure different aspects of these three main study elements. This questionnaire was distributed to 34 identified operational personnel from a selected consulting engineering company in South Africa. They were asked to complete the questionnaire and also to identify three projects each (a potential of 102 engineering projects) and to answer operational questions surrounding these projects. After all questionnaires were returned a second exercise was executed by gathering financial and operational data from the company's financial database for each project that were identified inside each questionnaire by the approached operational personnel.

Operational personnel as well as project demographics were depicted and analysed. Project demographic variables examined the following aspects: project type, client type, leverage classification, project duration classification and project engineering discipline classification while operational personnel demographics variables looked age group, gender, race, highest engineering qualification, highest business qualification, management level and focused engineering discipline.

Assessing the study element Project Performance the construct **Overall Project Performance** ( $\bar{x} = 6.837$ ) was calculated as the average of the three underlying variables Project Quality, Project Program and Project Financial Performance. Two of the three project performance variables, **Project Quality Performance** ( $\bar{x} = 7.571$ ) and **Project Program Performance** ( $\bar{x} = 8.551$ ) are above the average mean **Overall Project Performance** ( $\bar{x} = 6.837$ ). Furthermore one of the three project performance variables, **Project Financial Performance** ( $\bar{x} = 4.391$ ) is below the average mean **Overall Project Performance** ( $\bar{x} = 6.837$ ).

These results indicate the existence of an average to strong project performance inside the surveyed consulting engineering company, but also indicate room for improvement with the focus falling on the **Project Financial Performance** ( $\bar{x} = 4.391$ ) variable.

Assessing the study element Operations Management Performance the construct **Operations Management Performance** ( $\bar{x} = 3.583$ ) was calculated as the average of the six underlying operations management constructs. Four of the six operations management constructs, **Strategic Department Management** ( $\bar{x} = 3.601$ ), **Loading** ( $\bar{x} = 3.683$ ), **Project Planning & Management** ( $\bar{x} = 3.933$ ) and **Operational Hierarchy & Culture** ( $\bar{x} = 3.832$ ) are above the average mean **Operations Management Performance** ( $\bar{x} = 3.583$ ). Two of the six operations management constructs, **Tooling** ( $\bar{x} = 3.087$ ) and **Service Offering Process** ( $\bar{x} = 3.364$ ) are below the average mean **Operations Management Performance** ( $\bar{x} = 3.583$ ).

These results indicate the existence of an average strong operations management system and good performance within the surveyed consulting engineering company, but also indicated room for improvement with the focus placed on the **Tooling** ( $\bar{x} = 3.087$ ) and **Service Offering Process** ( $\bar{x} = 3.364$ ) constructs.

The third assessment was focused on the perceptions of operational personnel of the amount of value, according to them, is added to the company through company departments or operational activities.

Five of the six value variables added through departmental activities, **Corporate Strategic Planning** ( $\bar{x} = 8.957$ ), **Clients Department** ( $\bar{x} = 11.043$ ), **Marketing and Communication's Department** ( $\bar{x} = 8.870$ ), **Financial Department** ( $\bar{x} = 11.283$ ) and **Corporate Service Department** ( $\bar{x} = 6.826$ ) are below the average mean of all the variables ( $\bar{x} = 16.667$ ), while **Operations Management Department** ( $\bar{x} = 53.065$ ) are above the average mean of all the variables ( $\bar{x} = 16.667$ ).

These results indicate that operational personnel perceive that most value is added through the operations management department and that, according to them, the rest of the value is evenly spread throughout the other departments except where the perceptions were that the corporate service departments adds the least value to the company.

Four of the six value variables added through operational activities, **SDM** ( $\bar{x} = 7.065$ ), **SOP** ( $\bar{x} = 8.500$ ), **T** ( $\bar{x} = 8.065$ ) and **OHC** ( $\bar{x} = 11.283$ ) are below the average mean of all the variables ( $\bar{x} = 8.522$ ), while **Loading** ( $\bar{x} = 8.978$ ) and **Project Planning and Management** ( $\bar{x} = 14.935$ ) are above this mean.

These results indicate that operational personnel perceive that most value is added through the project planning and management operational activity, and that the rest of the value is seemingly spread evenly throughout the other departments. This is except where the perceptions indicated that the operational hierarchy and culture adds the least value to the company.

The standard deviation of the value added assessments are far outside 1. This means that the surveyed data does not resemble a normal distribution and that the perceptions of operational personnel towards the value added concept are not in line with each other. Therefore a conclusion can be made that operational personnel in the surveyed company do not feel the same about the value added activities.

Further analysis was conducted to determine the relationship between any project or operational personnel demographic variable and the variables and constructs of the three main study elements. This chapter was concluded by analysing whether a potential relationship exists between the three main study elements themselves. This was done

through a simple statistical correlation test between the underlying variables and constructs of these main study elements.

In the next chapter conclusions will be drawn from the findings discussed in this chapter.

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# CHAPTER 4:

# CONCLUSIONS & RECOMMENDATIONS

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## 1. INTRODUCTION

In chapter 1 the whole research study was defined and outlined; the chapter gave an introduction and background to the specific study and explained how the literature review and empirical study would be executed. Chapter 2 started with the literature study where the main study elements and the underlying variables that formed part of these elements were outlined and discussed. At the end of chapter 3, a company value chain and operations management value chain were created from which a measuring instrument was formulated.

Chapter 3 started by taking another look at the empirical framework discussed in chapter 1 and elaborating on it. The last section of this chapter, which was the main focus of chapter 3, dealt with the results and statistical analysis of the data-set created from the empirical study.

In this chapter, the last chapter, the main objective is the drawing of conclusions from the findings of the empirical study, as presented in chapter 3, while taking into consideration the primary and secondary objectives of this study as discussed in chapter 1.

The first section of this chapter discusses and illustrates the conclusions made regarding project performance, operations management performance and the perception on how much value is added to the company through different departments and operations management activities. The relevance of respondents and project demographic variables are discussed, as well as the existence of relationship elements between these three main study elements.

This last chapter concluded the study by discussing what objectives were reached by indicating the link between the objectives of this study as defined in chapter 1 and the conclusions and results as discussed in chapter 4.

Further recommendations for future research are proposed.

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## 2. CONCLUSIONS OF THE EMPIRICAL STUDY

### 2.1 Operational personnel's demographic information

Demographic information of operational personnel in the surveyed consulting engineering company was obtained regarding, age group, gender, race, highest engineering qualification, highest business qualification, management level and focused engineering discipline. From the results of the questionnaire and the statistical analysis of the empirical data-set the following conclusions on operational personnel's demographic information can be made:

- a) The majority of the respondents (60.87%) are below 40 years of age while 39.13% are above 40 years of age.
- b) The gender representation in the surveyed consulting engineering company is uneven with 82.61% males compared to 17.39% woman.
- c) Most of the operational personnel are white (91.30%).
- d) The largest group of respondents (43.48%) has a national degree while 17.39% of respondents have no engineering qualification, 4.35% of respondents obtained a national certificate, 17.39% of respondents obtained a national diploma, and 13.04% of respondents obtained a post-graduate degree.
- e) The largest group of respondents (52.17%) do not have any qualification regarding business administration. However, 13.04% of respondents obtained a national certificate, 17.39% of respondents obtained a national diploma, 8.7% of respondents obtained a national degree and 8.7% of respondents obtained a post-graduate degree.

Taking the above into consideration it can be concluded that operational personnel in the surveyed consulting engineering company consisted mainly of white males below 40 years of age who have a national degree in engineering but no business administration qualifications.

### 2.2 Project demographical information

Demographic information of completed projects in the surveyed consulting engineering company was obtained regarding project type, client type, leverage classification, project duration classification and project engineering discipline classification. From the results of the questionnaire and the statistical analysis of the empirical data-set the following conclusions about operational personnel's demographic information can be made:

- a) The largest group of projects indicated by operational personnel fall into the experience category (58, 93%). Projects in the experience category are executed by operational personnel, who have the necessary skills and expertise, but still require a senior operational person to deal with more complex challenges. The rest of the projects are distributed between the efficiency category (25.00%) where project work becomes almost repetitive and the expertise category (16.07%) that requires specialists.
- b) All identified projects are spread evenly over the following client types: government local (23.21%), government provincial (25.00%), parastatals (21.43%) and private client types (19.64%), while the smallest portion of all the projects fall under government central client type.
- c) Operational leverage classification among these projects are evenly spread from 1 to 8 with the largest portion of projects (33.93%) falling into the 2-4 leverage classification, and the smallest portion of projects (5.36%) reaching an 8+ leverage classification. This means that all projects exhibit operation leverage meaning that more junior hours are used than senior hours on a project while the biggest portion of project exhibit two to four times more junior hours than senior hours.
- d) The majority of projects (42.86%) are completed between 6 and 12 months while 85.72% of projects are completed inside an 18 month period.
- e) All identified projects are electrical engineering projects (80.6%) while the rest of the projects are divided between mechanical, utility and other engineering projects.

Taking the above into consideration, it can be concluded that the projects executed inside the surveyed company are mostly experience type projects. This means operational personnel have the skills and expertise to execute such a project, but still require a more senior operational person due to the fact that these types of projects do have challenges to overcome.

Examining the operational leverage aspect it can be seen that operational leverage is being executed throughout all projects were it is common for a project to have two to four times more junior hours to be spend than senior hours.

All of these projects are evenly spread through all types of clients (government, private & parastatals) were most of the projects are between 6 and 12 months long while projects going up 18 months are not unfamiliar territory.

## 2.3 Assessment of main study elements

The first part of the primary objective was to assess operations management performance (OMP), project performance (PP) and operational personnel's interpretation of the value added (VA) concept with regard to operational management (OM).

The assessments of these main study elements, as well as the conclusions gained from the results, are discussed in the following section.

### 2.3.1 Project Performance (PP)

A mean score of  $\bar{x} = 5.00$  on a 10 point scale was used as a benchmark. Any mean score below 5.00 is interpreted as being indicative of a lower than average occurrence, identifying areas that can be improved on to increase overall project performance. Any mean score above 5.00 is interpreted as being indicative of a higher than average occurrence, identifying strong areas that contribute positively to the overall performance of projects.

Taking the results depicted and discussed in chapter 3 into consideration, it is clear that overall project performance ( $\bar{x} = 6.837$ ) of the projects selected by the respondents are executed in a medium to good manner. Two of the three variables evaluated for project performance were above the overall project performance mean.

Conclusions for each individual project performance variable are discussed below.

**a) Project quality performance:**

Project quality performance has the second highest rating with  $\bar{x} = 7.571$ . It seems from the respondents' perspective that operational personnel do execute projects in such a manner that they deliver an average to good quality project.

**b) Project programme performance:**

Project programme performance has the highest rating with  $\bar{x} = 8.551$ . From the respondents' perspective it seems that operational personnel do execute projects in such a manner that projects are delivered almost always on time.

**c) Project financial performance:**

Project financial performance has the lowest rating with  $\bar{x} = 4.391$ . From the database of the surveyed company it can be concluded that the projects executed by the company do not deliver good financial value to the company itself.

To summarise, the overall project performance is average to good, with good scores on project quality and programme performance variables, leading to an increase in the overall performance. However a lower than average project financial performance variable score brought the overall project performance down.

If we look at the results of this survey from a management point of view, it seems that management places a large amount of pressure on operational personnel to execute a project in such a manner that the project is of good quality and is delivered in time and within budget constraints. But if one only looks at the financial side of the company, the results show that these projects are being managed in a non-profitable manner. The cause of this can range from using too many resources on the project, using the wrong resources, or selling at too low rates, etcetera.

It must be noted that project quality and programme performance variables measured the perceptions of operational personnel, while project financial performance variables measured the true financial effect as recorded on the company's financial database. This means that operational personnel may perceive the execution of projects to be more efficient and effective than it really is.

### **2.3.2 Operations Management Performance (OMP)**

A mean score of  $\bar{x} = 3.00$  on a 5 point Likert scale was used as a benchmark. Any mean score below 3.00 is interpreted as being indicative of a lower than average occurrence, identifying areas that can be improved on in order to increase overall project performance. Any mean score above 3.00 is interpreted as being indicative of a higher than average occurrence, identifying strong areas that contribute positively to the overall performance of projects.

Taking the results depicted and discussed in chapter 3 into consideration, it is clear that overall operations management performance ( $\bar{x} = 3.583$ ) of the projects selected by the respondents are executed in an average manner. Four of the six constructs evaluated for operations management performance were above the overall operations management performance mean, while the other two constructs were below the overall operations management performance mean.

Conclusions for each individual operations management performance construct are discussed below.

**a) Strategic department management:**

The strategic department management construct obtained the fourth highest rating with  $\bar{x} = 3.601$ . Respondents agreed to some extent with the following statements: the strategic department management element exhibits ownership and responsibility; key performance indicators are used to manage and make decision inside the department on a regular basis; the overall structure of this department is of good quality.

**b) Service offering process:**

This construct obtained the second lowest score ( $\bar{x} = 3.364$ ) amongst the six constructs. Some of the operational personnel were of the opinion that the service offering process is well designed, balanced with company capabilities and client type; that the process design guides operational personnel through the marketing, selling and project execution process; and that the administrative burden is minimised. Although some of the operational personnel fully agreed with these statements a large percentage of the other operational personnel did not fully agree.

**c) Tooling:**

The tooling construct as a measure of operations management performance achieved the lowest score ( $\bar{x} = 3.087$ ). Some of the operational personnel were of the opinion, while others did not fully agree, that the focus is on increasing operational personnel's generalized, technical and soft skill sets in order to increase productivity, flexibility and quality in the service offering process. It is furthermore important that the tangible (operational systems and processes) and intangible (knowledge and experience) assets are captured and shared throughout the company and that training and education are recognized, seen as important, and rewarded.

**d) Loading:**

Operational personnel indicated that focus was placed on the loading aspect, thus obtaining the third highest score ( $\bar{x} = 3.683$ ). This meant that some of the respondents agreed on the following statements: project owners and administrators are allocated to projects, where they exhibit responsibility and have the authority to manage and make decisions as required by the project. Furthermore, resources are assigned to projects according to a certain model or method, which takes into consideration opportunity, staff availability, individual preferences, staff experience, tooling an operational capacity and the fact that these resources are managed throughout the projects.



**e) Project planning and management:**

The construct project planning and management obtained the highest score ( $\bar{x} = 3.933$ ). Most of the operational personnel were of the opinion that project planning and management are executed in a good manner. This is done by defining, discussing and communicating the client's needs and project deliverables clearly, defining the communication and project flow structure clearly, making sure that all aspects of the projects are completed and handed over to the client and ensuring that overall good project management principles are executed during projects.

**f) Operational hierarchy & culture:**

This construct achieved the second highest score ( $\bar{x} = 3.832$ ). Most of the operational personnel agreed with the following statements: the operational hierarchy and culture is of good quality and that this hierarchy and culture portrays an environment of responsibility, integrity and entrepreneurship inside and outside the company borders.

Taking all six operations management performance constructs into consideration, most operational personnel maintains that operations management performance is of average quality and that there is definitely room for improvement within the surveyed company.

From a management perspective the results indicate that management focuses on executing the project in a good and professional manner; the results obtained for project performance in the previous section indicate this as well. The results give some insight into this matter by showing that the operational hierarchy and culture element is of good quality, which is exactly what is needed to encourage ownership and responsibility, which in turn is needed for good project management.

Although management focuses on the right elements, they are also neglecting important elements, such as the service offering process, tooling and loading management elements. It is important for the professional employee to be guided to understand the services offering process. Furthermore, the service offering should be balanced with the capability of the professional employee, thus being tooled accordingly, and the professional employee should be assigned to projects in such a manner that the work load and operational capacity are balanced accordingly.

One of the reasons for not having a good tooling, loading and service offering process design may be because of management not spending enough time on strategic planning and managing the operations management department, as indicated by the results.

Furthermore, insight may be gained into the weak profit performance of projects, as identified in the previous section project performance. This can be done by looking into the operations management performance matter. As stated above, tooling, loading and the service offering process element performances are weak. This may transfer to weak project profit management due to operational personnel taking longer than they should and operational personnel capacity not being managed accordingly. This means personnel are using more overtime and committing more errors.

### **2.3.3 Relationship between project demographic and PP & OMP**

The previous chapter contained an analysis and a discussion, from a practical point of view, of the significance of relationships between project demographic and project performance and operations management performance variables.

These demographics include: project type, client type, leverage classification, project duration classification and project engineering discipline classification. It also analysed the relationship between, project performance (PP) and operations management performance (OMP). Concluding remarks on these relationships follow below.

#### **2.3.3.1 Relationship assessment between project type, PP & OMP**

The average performance of the project quality variable for an efficiency type project is from a practical significant point of view less, compared to an (d-values = 0.670) expertise type project, as well as an (d-values = 0.968) experience type project.

The average performance of a project program variable for an efficiency type project is from a practical significant point of view less, compared to an (d-values = 0.952) expertise type project, as well as an (d-values = 0.633) experience type project.

From an operations management performance perspective, strategic department management and tooling indicated a practical significance between different client types; however, no practical significance could be found between the overall operations management performance construct and the different project types.

Although some of the effect sizes (d-values) indicated a low to medium, and others a strong practical significance, a general remark can be made stating that project performance elements are affected by the categorisation of the project type. This effect has not been fully proved in this study and may require further investigation. Nevertheless the results indicate that an efficiency type project performs weaker than an expertise type and an experience

type project, while an experience type project performs weaker than an expertise type project.

This phenomenon can be explained by the different types of engineers involved with these projects. For example, a more experienced type of engineer is required for an experience or expertise type project, someone who exhibits greater project management skills, therefore being able to execute these projects in a better manner than an engineer with less experience in efficiency type projects.

### **2.3.3.2 Relationship assessment between client type, PP & OMP**

The average performance of the project quality variable for a government local type client is from a practical significant point of view less, compared to a (d-values = 0.728) government provincial type client, (d-values = 0.689) private or (d-values = 0.621) parastatal type client.

The average performance of the project programme variable for a government provincial type client is from a practical significant point of view less, compared to a (d-values = 0.723) parastatal type client.

From an operations management performance perspective, strategic department management, tooling, loading and project planning and management indicated a medium to strong practical significance between the different client types. The overall operations management performance construct for a government provincial type client from a practical significant point of view less, compared to a (d-values = 1.036) private or (d-values = 0.734) parastatal type client.

Although some of the effect sizes (d-values) indicated a low to medium, and others a strong, practical significance, a general remark can be made stating that project performance elements are affected by the categorization of the client type. This effect has not been fully proved in this study and may require further investigation, but the results indicate that a government local type client performs weaker than a government provincial, private and parastatal type client.

Furthermore, a statement can be made that operations management performance is affected by different client types. This was not fully proved in this study due to effect size ranging from small to medium to strong, and thus requiring further investigation.

### **2.3.3.3 Relationship assessment between leverage, PP & OMP**

The results indicated no practical significance between the project demographic variable leverage and any project performance and operations management performance variable.

### 2.3.3.4 Relationship assessment between project duration, PP & OMP

The results indicated no practical significance between the project demographic variable project duration and any project performance and operations management performance variable.

### 2.3.4 Operational personnel's perceptions towards how much value is added (VA) to the company through different company departments (CD)

All project value added perceptions are based on a 0 to 100 percentage scale, where 0 is defined as 0% value added by the specific activity and 100 is defined as 100% value added by the specific activity.

Taking the results depicted and discussed in chapter 3 into consideration, it is clear that the average added value to the six departments was 16.67%. Five of the six added values for specific departments had a mean below the average added value for the 6 departments. It was only the value added by the operations management department that had a mean above the average value for the 6 departments.

The standard deviation of the 6 value added through company department variables are far outside 1. This means that the surveyed data does not resemble a normal distribution and that the perceptions of operational personnel towards the value added concept are not in line with each other. The conclusion can therefore be made that operational personnel in the surveyed company differ from each other.

Conclusions for each individual value added through departmental activity variables are discussed below.

#### a) VA to company by corporate strategic plan:

This variable obtained the third lowest score ( $\bar{x} = 8.957$ ). Operational personnel perceived that 8.957% of the total value added to the company is achieved through the strategic planning and management department of the company. This department is responsible for drafting the vision and mission of the company, setting the strategic objectives, designing the business portfolio, setting strategic KPI's, etcetera.

#### b) VA to company by client department:

This variable obtained the third highest score ( $\bar{x} = 11.043$ ). Operational personnel perceive that 11.043% of the total value added to the company is achieved by the

clients department of the company. This department is responsible for building client relationships and managing client databases.

**c) VA to company by marketing and communications department:**

The second lowest score was obtained by this variable ( $\bar{x} = 8.870$ ). Operational personnel perceived that 8.870% of the total value added to the company is achieved through the marketing and communications department of the company. The responsibilities of this department ranges from internal and external communications, identifying market place and client needs, drafting marketing strategies, and corporate identity and branding.

**d) VA to company by financial department:**

Value added through the financial department obtained the second highest score ( $\bar{x} = 11.283$ ). Operational personnel perceive that 11.283% of the total value added to the company is achieved through the financial department of the company. The work of this department includes general book keeping, cash flow management, Vat and tax management, managerial accounting and financial planning and management.

**e) VA to company by corporate services department:**

The lowest score ( $\bar{x} = 6.826$ ) among all departments was achieved by the corporate services department. Operational personnel perceived that 6.826% of the total value added to the company is achieved through the corporate services department of the company, which entails human resources management, risk management, IT management, quality management, asset management etcetera.

**f) VA to Company by operations management department:**

The highest score ( $\bar{x} = 53.065$ ) was achieved by this variable. Operational personnel perceived that 53.065% of the total value added to the company is achieved through the operations management department of the company. This department is responsible for tooling, loading, service offering process, project planning and management, and operational hierarchy and culture.

By comparing all six departments, the operational personnel judged that the operations management department created by far the most value for the company while corporate services department created the least amount of value for the company.

Form a management perspective, the results indicate that operational personnel place a huge emphasis on the operations management department, but do not feel that that the

other departments have a key slot in adding value to the company. Summing up, it can be stated that operational personnel has the perception that the operations management department is responsible for 50% of the total value that is added to the company while the other 5 departments are responsible for the other 50%.

Due to the operational personnel's perception that their department adds so increasing value to the company, they may feel that the other departments are inferior to theirs. This could negatively affect team work among the departments.

Marketing, communications and clients are the key words in a service oriented organisation. The researcher are of the opinion that operational personnel are unaware of the significant importance that these elements play in a service oriented organisation, and that management of the company may have to look into this phenomenon.

### **2.3.5 Operational personnel's perceptions towards how much value is added (VA) to the company through different operational department activities (OA)**

All project value added perceptions are based on a 0 to 100 percentage scale, where 0 is defined as 0% value added by the specific activity and 100 is defined as 100% value added by the specific activity.

Taking the results depicted and discussed in chapter 3 into consideration, it is clear that the average added value gained throughout the six operational activities is 8.84%. Four of the six added values gained through operational activities had a mean below the average value gained for the six operational activities. The value added through loading and project planning, as well as through management activities, had a mean above the average added value for the six operational activities.

The standard deviation of the six variables is far outside 1. This means that the surveyed data does not resemble a normal distribution and that the perceptions of operational personnel on the value added concept are not in line with each other.

The results indicate that the operational personnel perceive that most value is added to the operations management department through project planning and management, and the least through operational hierarchy and culture. The rest of the value is evenly distributed across the other four operational activities.

It is the opinion of the researcher that the perceived distribution of value through the operational activities seems to be logical and acceptable. The purpose of this exercise is to

investigate how operational personnel perceive value added activities. Managers can then analyse these perceptions and the results thereof, and decide whether these perceptions are in line with their current strategic goals.

### **2.3.6 Relationship between operational personnel's demographics and perceptions towards VA to the company through CD and OA variables**

The previous two sections contained an analysis and discussion, from a practical point of view, of the significance of relationships between operational personnel demographics (such as age group, gender, race, highest engineering qualification, highest business qualification, and management level and focused engineering discipline) and perceptions towards value added to the company through company departments and operational activities. Concluding remarks on these relationships follow below.

#### **2.3.6.1 Relationship between age group and VA by CD and OA**

Value added to the company through corporate strategic planning (CSP) (d-values = 0.968) variable indicates that a strong practical significance strength exists between the 0-39 and 40+ age group, where the 40+ age group has a higher average mean than the 0-39 age group.

No practical significance could be found between the value added variables regarding the other company departments and operational activities and the demographic variable age group.

Taking the above into consideration, it can be concluded that more experienced operational personnel of 40 years and above perceive that more value is added to the company through corporate strategic planning.

#### **2.3.6.2 Relationship between engineering qualifications and VA by CD and OA**

The results indicate no practical significance between the demographic variable engineering qualification of the operational personnel and any perceptions towards value added to the company through company departments and operational activity variables.

#### **2.3.6.3 Relationship between business qualifications and VA by CD and OA**

Value added to the company through corporate strategic planning (CSP) (d-values = 0.703) and strategic departmental management (SDM) (d-values = 0.776) variables indicate that a medium practical significance strength exists between a diploma post-graduate business

qualification and no diploma post-graduate qualification, where a diploma post-graduate engineering qualification has a higher average mean than a business degree.

Value added to the company through project planning and management (PPM) (d-values = 0.741) variable indicates that a medium practical significance strength exists between a diploma-postgraduate business qualification and no diploma post-graduate qualification, where a diploma postgraduate engineering qualification has a lower average mean than a non-business degree.

No other practical significance could be found between the other company departmental and operational activity value added variables and the demographic variable business qualification.

Some of the effect sizes (d-values) indicate a medium practical significance. Operational personnel with a business degree are of the opinion that more value is added to corporate strategic planning and strategic departmental management, and less value is added to project planning and management. Operational personnel with no business qualifications do not share this opinion.

It therefore seems as if operational personnel's opinion on the amount of value added to strategic, departmental and project planning and management is affected by the business qualification of these personnel. However, this study did not prove this statement due to the medium strong effect sizes. Further investigation is therefore required.

## **2.4 Relationship between main study elements**

The second part of the primary objective was to determine if a potential link or relationship exists between operations management performance and the perceptions of operational personnel about the amount of value added to their company through departmental or operations management activities, operations management performance and project performance.

Relationship analysis was done with the use of statistical correlation to determine if a potential relationship exists and if these study elements do affect each other.

The correlation coefficient values indicate practical significance (for the purpose of this study values  $\leq 0.1$  means small significant difference, values between 0.1 and 0.3 means medium practical significant difference and values  $\geq 0.5$  means strong practical significant

difference) and the sig 2-tailed values indicate statistical significance (for the purpose of this study any values smaller than 0.05 means indicates statistical significance).

The relationship assessment results and conclusions are discussed in the following sections.

#### **2.4.1 Relationship between perceptions of operational personnel with regards to value added activities and OMP**

The results of the correlation analysis between operations management performance and the perceptions of operational personnel on the amount of value they perceive is added to their company through departmental or operations management activities indicated the following:

- a) A medium to strong relationship between the Value Added by Corporate Strategic Planning variable and Project Planning and Management construct of operations management performance is indicated by a correlation coefficient of 0.458 and a p-value of 0.028.
- b) A medium to strong relationship between the Value Added by Strategic Department Management variable and Service Offering Process construct of operations management performance is indicated by a correlation coefficient of 0.470 and a p-value of 0.024.
- c) A medium to strong relationship between the Value Added by Strategic Department Management variable and Operational Hierarchy and Culture construct of operations management performance is indicated by a correlation coefficient of 0.504 and a p-value of 0.014.

The results indicated that with a more positive perception by operational personnel of corporate strategic planning the potential does exist to increase the performance of project planning and management. Furthermore, with a more positive perception by operational personnel of operations management department strategic planning the potential does exist to increase the performance on the service offering process and operational hierarchy and culture.

It is the researcher's opinion that these results do not fully prove a relationship between the perceptions of operational personnel and the performance of operations management (due to the practical significance strength as medium) and thus further studies are required to fully prove this argument.

Although further investigation is needed, it can be concluded that the perceptions regarding strategic planning in a consulting engineering company do affect to some extent operations management performance elements.

#### **2.4.2 Relationship between operations management performance (OMP) and project performance (PP)**

The results of the correlation analysis between operations management performance and project performance indicated the following:

- a) A low to medium relationship exists between the Project Quality variable (underlying variable of project performance) and Strategic Department Management, Service Offering Process, Tooling, Loading, Operational Hierarchy and Culture and Operations Management Performance construct (underlying constructs of operations management performance). This relationship is indicated by correlation coefficient between 0.274 and 0.381 and a p-values between 0.004 and 0.041.
- b) A low to medium relationship exists between the Project Programme variable (underlying variable of project performance) and Strategic Department Management, Loading, Project Planning and Management and Operational Hierarchy and Culture constructs (underlying constructs of operations management performance). This is indicated by a correlation coefficient between 0.274 and 0.374 and a p-value between 0.004 and 0.032.
- c) A medium to strong relationship exists between the Project Programme variable (underlying variable of project performance) and Strategic Department Management construct (underlying constructs of operations management performance) is indicated by a correlation coefficient of 0.421 and a p-value of 0.001.

The results indicate that with an increase in performance of five out of the six operations management performance (SDM, L, PPM, and OHC) and Project Quality Performance may have the potential to increase. Furthermore, the results indicate that if the performance of four out of the six operations management performance (SDM, SOP, T, L and OHC) constructs are increased, Project Programme Performance may have the potential to increase.

No potential relationship was found between Project Financial variable (underlying variable of project performance) and any underlying constructs of operations management performance.

It is the researcher's opinion that these results do not fully prove a relationship between operations management performance and project performance, due to the practical significance strength being medium. Further studies are therefore required to prove this argument thoroughly. Although further investigation is required, it can be concluded that operations management performance elements do affect to some extent project performance elements.

### **3. EVALUATION OF THIS STUDY**

The evaluation of the success of this study is based on the achievement of the research objectives set out in chapter 1. The achievement of these objectives is discussed in the following sections.

#### **3.1 Secondary objective**

The secondary objectives of this study as defined in chapter 1 are as follows:

- a) Conducting a literature review in order to gain insight into the dynamics of the consulting engineering industry.
- b) Determining through a literature review the underlining value chain activities that make out the general consulting engineering company's value chain, with the focus on operations management.
- c) Pointing out through a literature review the different underlining elements/variables that make out operations management in the consulting engineering industry.
- d) Pointing out through a literature review the different underlining elements/variables that make out project performance and health in the consulting engineering industry.
- e) Creating a general company value chain depicting the different department activities out of which a consulting engineering company consists.
- f) Creating a general operations management value chain that depicts the different operations management elements needed for a consulting engineering company.
- g) Using the general company and operations management value chain to create a measuring instrument capable of gauging the performance of operations management as well as the operational personnel's perceptions on the amount of value added to the company through different company departments and operational department activities.

- h) Identifying a consulting engineering company in South Africa that is willing to participate in this research study and then collecting data on the different study elements by distributing this measurement instrument throughout the company.

The first four objectives were reached by conducting a literature review on the different study elements; the results can be seen through the whole chapter 3. The fifth and sixth objectives were reached by using the knowledge gained through the literature review exercise to create a generalised representation of the consulting engineering company's value chain and an operations management department's value chain. All of this was achieved in chapter 3 under section 7. These two value chains can be found in annexure A and B.

The seventh objective was reached by using the knowledge gained throughout the literature review, as well as using the self-developed representations of a consulting engineering companies value chains, in order to develop a measuring instrument able to capture information on operations management performance, project performance and perceptions of value added to the company. This measuring instrument can be found in annexure C.

The final secondary objective was achieved by approaching a specific consulting engineering company with the idea of evaluating the three main study elements. The company approved of this study and decided to make available operational personnel, financial database, as well as information on completed projects.

### **3.2 Primary objective**

The primary objective of this study was to assess operations management performance (OMP), project performance (PP) and operational personnel's interpretation of the value added (VA) concept with regard to operational management (OM), and to determine whether a relationship exists between these three elements in a consulting engineering company in South Africa selected by the researcher.

This primary objective was achieved by surveying a selected engineering consulting company. This entailed collecting operations management performance, project performance and information on perceptions of value added to the company with the help of a self-developed measuring instrument.

The data gathered was used to build a data-set and descriptive statistical analysis was used to assess the main 3 study elements; this was done in chapter 3 under sections 5.1, 5.2, 5.3

and 5.4. The results obtained from the assessment in chapter 3 were used to draw conclusions which appear in chapter 4 under section 2.3.

Furthermore, relationship analysis was done with the use of statistical correlation. The aim was to determine if a potential relationship exists and if study elements do affect each other. This was done in chapter 3 under sections 5.5 and 5.6. The results obtained from the relationship assessment in chapter 3 were used to draw conclusions which appear in chapter 4 under section 2.4.

## **4. LIMITATIONS OF THE STUDY**

As the study continued the following limitations were identified:

- a) Lack of research: Operations are usually focused on the production industry and there is a lack of research on operations in the professional service industry focussing on consultant engineers in South Africa. Reasons for this are the complex characteristics that these professional service companies exhibit and the big differences that exist between them.
- b) Small sample size: Only one company was analysed. Therefore the results can only be generalised to apply to that specific consulting engineering company and not to the consulting engineering industry in South Africa as a whole.
- c) The sample sizes were small, which meant the demographic groups were too small to measure statistical significance.
- d) The quality of the company's project database depends on engineers writing down the correct amount of time spent on each project; the accurateness of this database is therefore subject to human error.
- e) The quantitative research was subject to employee's perception and understanding of the concept at hand and therefore the accurateness of this information is subject to human error.
- f) The success of this quantitative research depended on the employee's willingness to participate in this study.

## 5. RECOMMENDATIONS FOR FUTURE RESEARCH

This study focused on concepts in the consulting engineering industry: the concepts of value being added, operations management and project performance. The study measured and assessed these elements within one consulting engineering company. It was found that some kind of relationship exists between these elements. The results of this study can only be applied to the chosen consulting company, but they do indicate that these factors may play a role in the consulting engineering industry in South Africa.

Based upon this, the literature study can be expanded to increase the quality of this study. The empirical study can be expanded to such an extent that a conclusion on the consulting engineering industry in South Africa can be made. This study encompasses such a wide variety of different subjects that by focusing only on one element, literature and empirical wise, one would be able to formulate new research studies.

Taking this research study and concepts into consideration, the following suggestions are made regarding future research in the consulting engineering industry on the concepts of operations management and the adding of value.

- a) Expanding this research study:
  - Research question: In consulting engineering companies in South Africa, there are diversified perceptions of company directors and managers on the amount of value added by company departments. Do these different perceptions lead to weak operations management, which translate into weak project performance in these companies?
  - Literature study: The quality of study can be increased by discussing the current elements in this literature study in more detail. This will help form a better understanding of the different elements of operations management and project performance. Using these literature elements, a more detailed and focussed measuring instrument can be constructed to measure project performance and operations management.
  - Empirical study: Different engineering consulting companies in South Africa are selected, and the three concepts are measured throughout all the companies. Firstly, the perceptions of operational personnel on the type of activities that add value to the company are measured. Secondly, operations management performance of the whole company is measured and thirdly, project performance

throughout the company is measured. The results of this study is statistically analysed to determine what sort of relationship and the characteristics thereof exist between these elements. Furthermore, recommendations can be made on how such companies can improve operations management and project performance.

b) Focused research studies:

- Examining the difference between operations management in a service and manufacturing oriented company, and how operations management can be measured and improved in a service oriented company such as consulting engineers.
- Value based management in a consulting engineering company: how to implement improve and manage such a management system.
- Entrepreneurship plays an important role in consulting engineering companies. Entrepreneurship and the impact thereof can be measured in a consulting engineering company and recommendations can be made on how to improve the entrepreneurial climate in such a company.
- The value added concept can be used to measure how all employees within a company perceive the adding of value and to measure how these employees' or departments' perceptions towards value being added to the company differ. It can also measure whether these perceptions are in line with the greater company strategy. Recommendations can be made on how to re-align these perceptions.
- Each of the six operational elements (strategic department management, service offering design, tooling, loading, project planning and management, and operational hierarchy and culture) identified in this study can be investigated further. This can enable one to see how each element has an effect on operations management in a service oriented company and how each element can be improved.

## 6. SUMMARY

In this last chapter conclusions were drawn from the findings of the empirical study as presented in chapter 3.

The demographic information for operational personnel indicates that the company surveyed consists mainly of white males below 40 years of age who have a national degree in engineering but have no business administration qualifications. Furthermore, the demographic information of the projects indicates that the projects executed within the surveyed company are mostly experience type projects spread over all types of clients. Most of the projects are executed over a 6-18 months period in such a manner that 2 to 4 times more junior hours are spend than senior hours.

The results on project performance (first study element) indicate that overall project performance is of good quality. Project quality and programme performance variables achieved high scores, but the project financial performance variable achieved a low score. From a management point of view, it was found that management places an extensive pressure on operational personnel to execute a project in such a manner that the project is of good quality and is delivered on time and within budget constraints; however, the financial side of the company is neglected. It must be noted that operational personnel may perceive the execution of projects to be more efficient and effective than it really is.

The assessment of operations management (second study element) indicates an average performance. These results indicate that management focuses on executing a project in an efficient and professional manner; which is in line with the results obtained from the project performance variables. Although management focuses on the correct elements, the results also indicate that they are neglecting important elements, such as the service offering process, tooling and loading elements of operations management. The low scoring values on project performance from a financial point of view may be the result of a weak service offering process, as well as tooling and loading management systems.

The assessment of the third study element, value added perceptions of operational personnel, indicate that operational personnel perceive that the most value added to the company is created through the operations management department. There is a feeling that other departments are inferior to the operations management department and this can impact negatively on team work between the departments.

Marketing, communications and the client's department are key elements in a service oriented organisation. Operational personnel are thus not aware of the important role these departments play in acquiring and nurturing work for the company.

Further examination of the value added perceptions of operational personnel, the results indicate that they perceive value is added evenly throughout all operational activities to the operations management department. This is done except where the project planning and management construct receive the highest value adding score.

Examining the relationship off these three main study elements, it is the researcher's opinion that the results do not fully prove any relationship between these main study elements and therefore further studies are required

Although further studies are needed, it can be concluded that the perceptions on strategic planning in a consulting engineering company do affect to some extent operations management performance elements, and that operations management performance elements do affect to some extent project performance elements.

This chapter was concluded by demonstrating that all the study objectives were reached, limitations of the study was identified and recommendations for future research were made.

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# APPENDIXES

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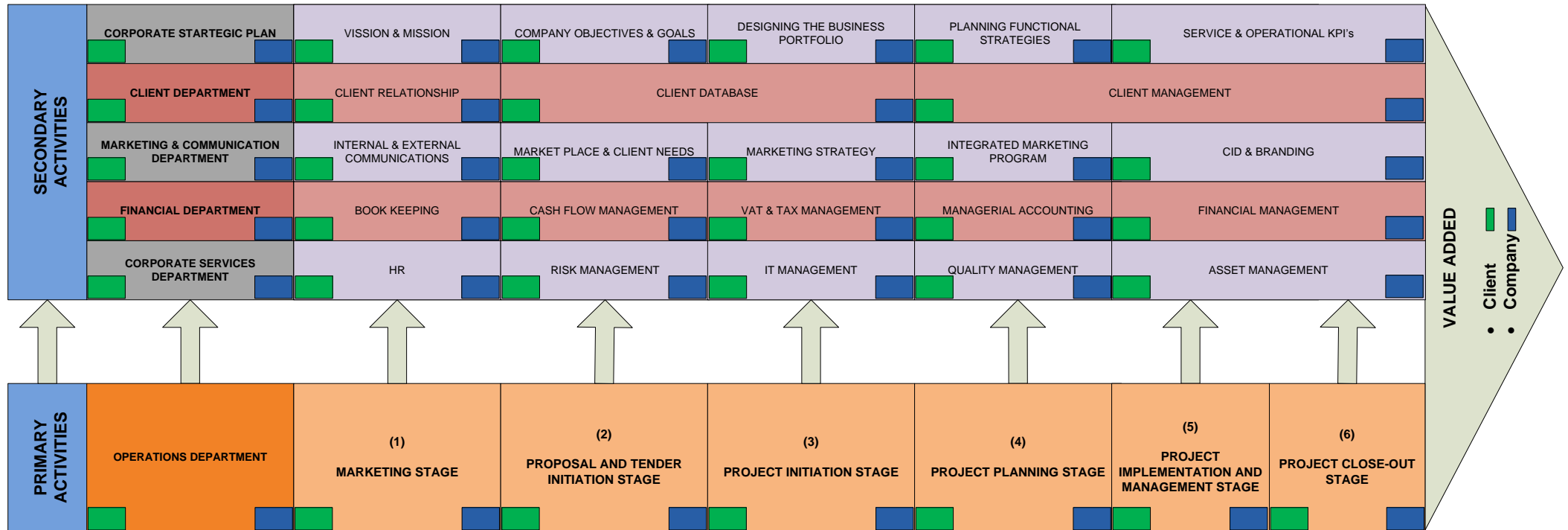
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# APPENDIX A

## CE Company Value Chain

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Figure 22 - Consulting Engineers Company Value Chain.



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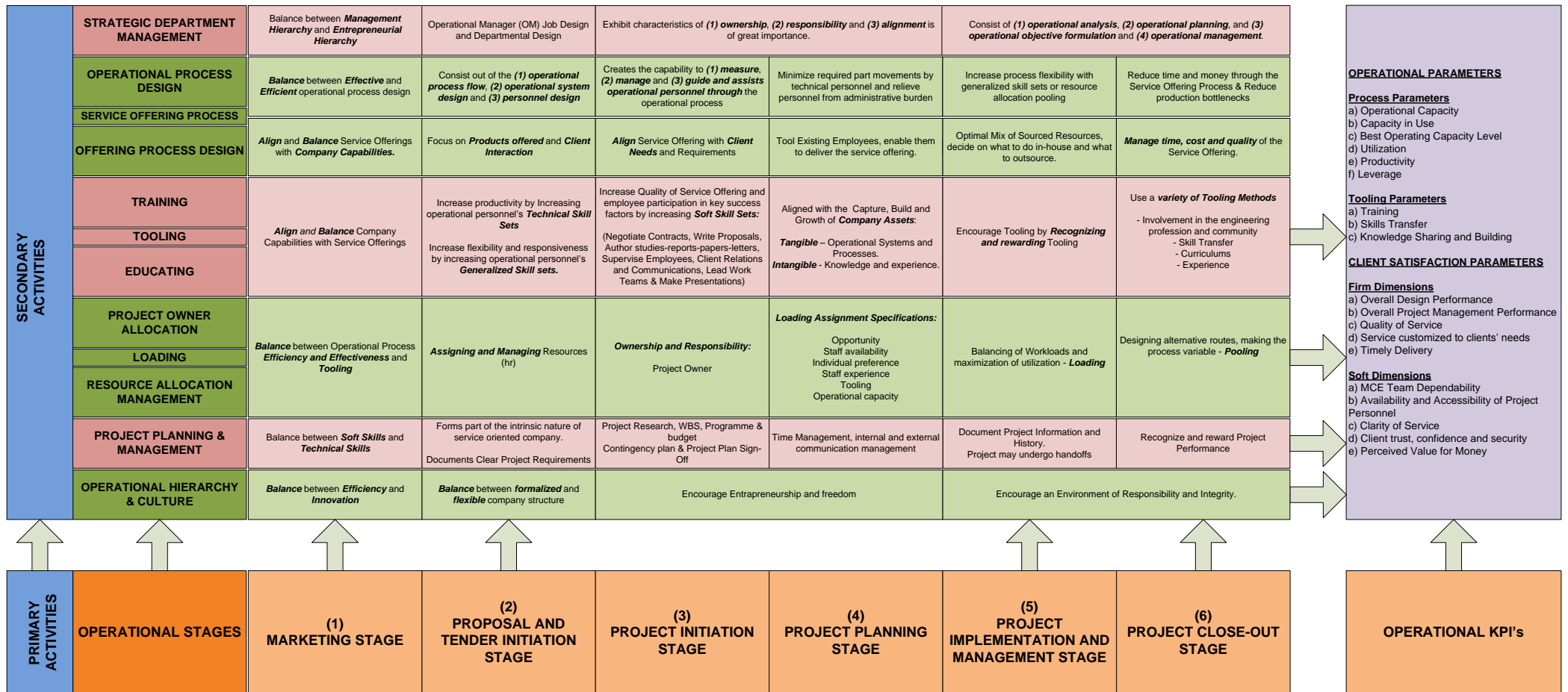
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# APPENDIX B

## CE Operations Management Value Chain

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Figure 23 – Consulting Engineers Operations Management Value Chain.



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# APPENDIX C

## Measuring Instrument

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NORTH-WEST UNIVERSITY  
YUNIBESITI YA BOKONE-BOPHIRIMA  
NOORDWES-UNIVERSITEIT  
POTCHEFSTROOM CAMPUS

**RESEARCH STUDY**

**VALUE ADDED APPROACHED TO OPERATIONS MANAGEMENT IN  
THE CONSULTING ENGINEERING INDUSTRY**

**VALUE ADDED MEASURING INSTRUMENT**

**CONFIDENTIAL**

Note: All response are confidential and neither the individual nor the organisation would be identified in any report or release.

**Copyright © reserved**



## VALUE ADDED APPROACHED TO OPERATIONS MANAGEMENT IN THE CONSULTING ENGINEERING INDUSTRY

### VALUE ADDED MEASURING INSTRUMENT

#### Dear Respondent

The consulting engineering industry in the world and the engineers they employ play an important part economically, socially and politically in each country and while most of society is not consciously aware of it, they rely on the technical expertise of engineers for everyday living

Taking into consideration the important role consulting engineering companies play in the world and in South Africa and the importance of successfully implementing and completing engineering projects, it is thus important that engineering projects are executed with the necessary skills and experience and operational processes in place to deliver these projects with in time and under budget operationally.

Operations management can be defined as the process whereby resources, flowing within a defined system are combined and transformed by a controlled manner to add value in accordance with policies communicated by management.

The way managers perceive projects and themselves toward maximizing the value that can be added to their company affects the strategies that are implemented and indorsed by top management. Any misinterpretation of the value added concept by project managers and company directors, may lead to ineffective and inefficient operations management strategies and processes that may lead to poor project performance and health.

The focus of this study is on operations management, project performance and the perceived value added that is added to the company through different value chain activities by project managers. This research study wants to determine if a relationship exists between these elements. This Measuring instrument attempts to measure these different elements.

*Thank You for participating in this study, we hope that you find this exercise interesting and stimulating.*

**Please complete every section & question / statement to ensure the validity and reliability of the study.**

#### General Instructions

This measuring instrument is broken up into three sections, each section is displayed on a different tab and each sections instructions are given on that specific tab. Please follow these instructions, if you require assistance please contact the person as stipulated below for assistance or appointments.

#### Section A

This section aims at measuring the perception of project managers towards value added to the company though value chain activities.

#### Section B

This section aims at measuring operations management and project performance for different projects and capturing project characteristic information.

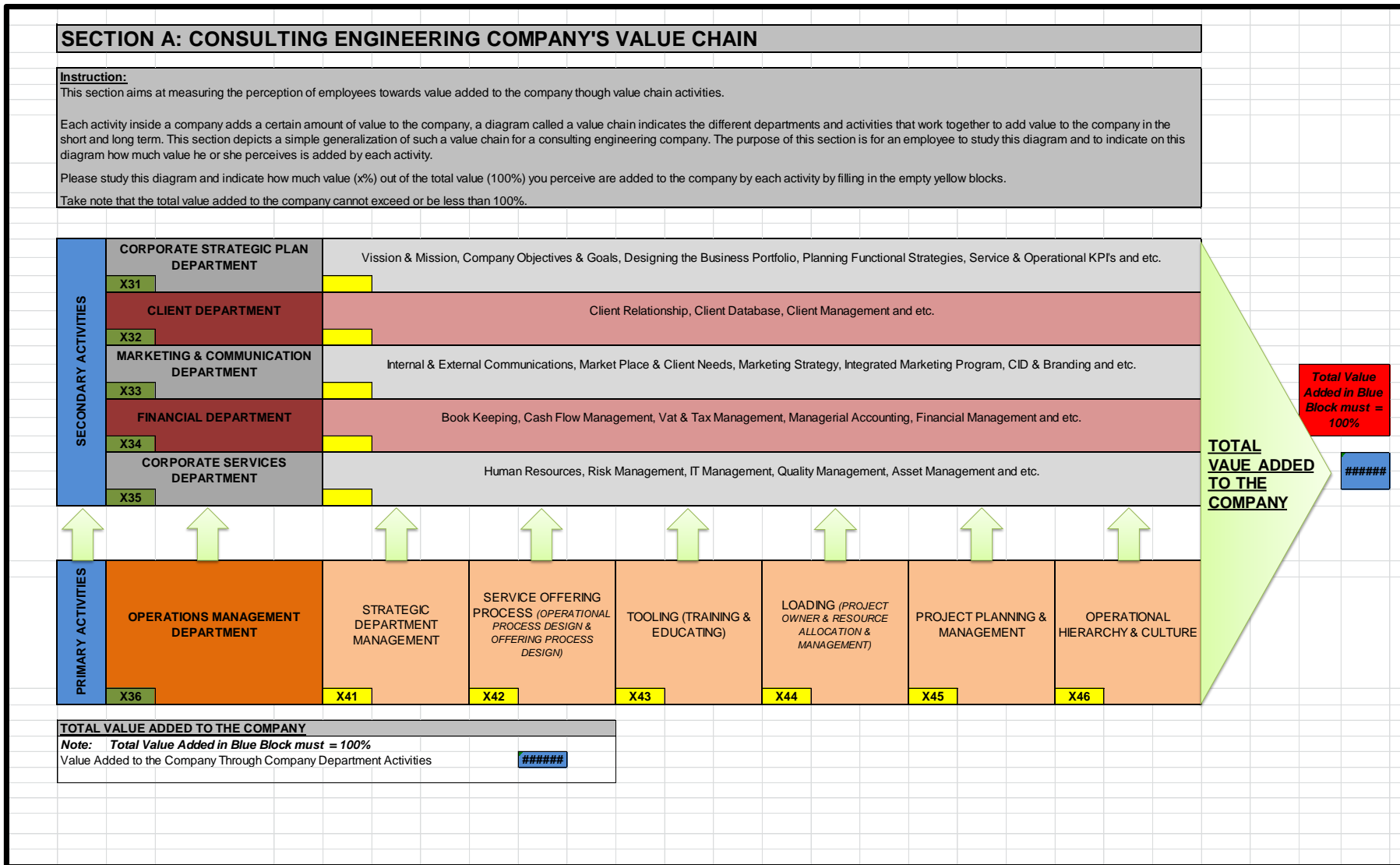
#### Section C

This sections aims at capturing the project manager's demographic information.

#### Contact Information:

Tiaan Mocke  
018 464 9000  
071 877 4206

**THANK YOU VERY MUCH FOR YOUR VALUED I**



SECTION B: OPERATIONS MANAGEMENT PERFORMANCE					
<p><b>Instruction:</b>                      This section aims at measuring operations management performance at the time a specific project was implemented. Furthermore this sections aims at recording the performance of that specific project and project characteristic information. Complete this section of the questionnaire by choosing three different projects and entering their project numbers in the yellow blocks. Study the statements and answer each statement by using the scale column as guidance to answer each statement for each project you chose.</p> <p>When you answer these questions or statements think back to the operational environment at the time of the project. Please do not answer the same for each project, choosing three projects from different time periods in which the operational environment differed would make it easier to answer these questions more accurately.</p> <p>If you are new to the company or you are a project administrator or part of the drawing office and have not been an owner / project manager of a project, you do not have to choose projects, but answer this section in general.</p>					
SECTION	DESCRIPTION	SCALE	PROJECT Nr.		
			1	2	3
<b>B</b>	<b>OPERATIONS MANAGEMENT ELEMENTS</b>				
<b>B.1</b>	<b>STRATEGIC DEPARTMENT MANAGEMENT</b>				
B.1.1	I was aware that an operations manager at corporate level was looking at my projects at the time of the project.	(1) Strongly disagree, (2) Slightly disagree, (3) Neither agree nor disagree, (4) Slightly agree, (5) Strongly agree	X2101		
B.1.2	I was aware that an operations manager at branch level was looking at my projects at the time of the project.		X2102		
B.1.3	The operations manager exhibited ownership at the time of the project.		X2103		
B.1.4	The operations manager exhibit responsibility at the time of the project.		X2104		
B.1.5	At the time of the project I was aware of operational objectives and KPI's.		X2105		
B.1.6	At the time of the project, good project performance was recognized and rewarded.		X2106		
B.1.7	As a project manager I was aware of terminologies such as utilization, leverage & productivity.		X2107		
B.1.8	I as project manager fully understood terminologies such as utilization, leverage & productivity.		X2108		
B.1.9	At the time of the project operational system such as a tender management system was of good quality.		X2109		
B.1.10	At the time of the project operational system such as a knowledge sharing system was of good quality.		X2110		
B.1.11	At the time of the project operational system such as a project administration system was of good quality.		X2111		
B.1.12	At the time of the project operational system such as a project management system was of good quality.		X2112		
B.1.13	At the time of the project operational system such as a tooling (design procedures, design software, design information) system was of good quality.		X2113		
B.1.14	At the time of the project operational system such as a documenting (file, server & project history summarization) system was of good quality.		X2114		
B.1.15	I perceive that by increasing this operational element (Strategic department Management) will increase operations management performance (you can answer the same for each project).		X2115		
B.1.16	I perceive that this operational element (Strategic department Management) affects the performance of projects (you can answer the same for each project).		X2116		
<b>B.2</b>	<b>SERVICE OFFERING PROCESS</b>				
B.2.1	The operational process was balanced with the type of client during the project period.	(1) Strongly disagree, (2) Slightly disagree, (3) Neither agree nor disagree, (4) Slightly agree, (5) Strongly agree	X2201		
B.2.2	An operational process flow diagram for implementing and managing projects (different types of projects) existed at the time of the project.		X2202		
B.2.3	You were guided and assisted through the operational process by this operational process flow diagram or by a operations manager.		X2203		
B.2.4	The different steps to follow during the operational process at the time of the project were at a minimum.		X2204		
B.2.5	The administrative burden for you as project manager at the time of the project was at a minimum.		X2205		
B.2.6	The service that was offered to the client was balanced with company capabilities at the time of the project.		X2206		
B.2.7	The service offering at the time of the project was focused on the client's needs and requirements.		X2207		
B.2.8	The optimal mix of resources (example, outsourcing of work) was implemented for the project.		X2208		
B.2.9	I perceive that by increasing this operational element (Service offering process) will increase operations management performance (you can answer the same for each project).		X2209		
B.2.10	I perceive that this operational element (Service offering process) affects the performance of projects (you can answer the same for each project).		X2210		



B.3		TOOLING (Training & Educating)			
B.3.1	Focus was placed on increasing operational personnel's technical skill sets to increase productivity at the time of the project.	(1) Strongly disagree, (2) Slightly disagree, (3) Nethier agree nor disagree, (4) Slightly agree, (5) Stongly agree	X2301		
B.3.2	Focused was placed on increasing operational personnel's generalized skill sets to increase flexibility at the time of the project.		X2302		
B.3.3	Focused was placed on increasing operational personnel's soft skill sets to increase quality of the service offered.		X2303		
B.3.4	Tangible operational assets (operational systems and processes) were being captured after each project at the time of the project.		X2304		
B.3.5	Intangible operational assets (knowledge and experience) were being captured at the time of the project.		X2305		
B.3.6	Tangible and intangible operational assets were being shared throughout the company during the time of the project.		X2306		
B.3.7	Training and education was being recognized and rewarded.		X2307		
B.3.8	Project managers are free to indicate to their operations manager if they require or want training.		X2308		
B.3.9	Regular skill and experience transfer sessions are held between project managers.		X2309		
B.3.10	I perceive that by increasing this operational element (Tooling) will increase operations management performance (you can answer the same for each project).		X2310		
B.3.11	I perceive that this operational element (Tooling) affects the performance of projects (you can answer the same for each project).		X2311		
B.4		LOADING (Project Owner & Resource Allocation & Management)			
B.4.1	You as project managers was allocated to this project as project owner.	(1) Strongly disagree, (2) Slightly disagree, (3) Nethier agree nor disagree, (4) Slightly agree, (5) Stongly agree	X2401		
B.4.2	A project administrator was allocated to your project.		X2402		
B.4.3	You as project owner exhibited ownership and responsibility towards this project.		X2403		
B.4.4	You as project owner and manager had all the authority to make the decisions as it was required during the project.		X2404		
B.4.5	Resources (operational hours) was assigned to your project including yourself according to certain method or system.		X2405		
B.4.6	Resources were assigned to projects by taking the following into consideration: (opportunity, staff availability, individual preferences, staff experience, tooling or operational capacity).		X2406		
B.4.7	The allocation of resources including yourself was managed throughout the project.		X2407		
B.4.8	Your work load as project manager was balanced during the execution of this project.		X2408		
B.4.9	Utilization of operational personnel was always maximized.		X2409		
B.4.10	I perceive that by increasing this operational element (Loading) will increase operations management performance (you can answer the same for each project).		X2410		
B.4.11	I perceive that this operational element (Loading) affects the performance of projects (you can answer the same for each project).		X2411		
B.5		PROJECT PLANNING & MANAGEMENT			
B.5.1	Project financial plan was created before the project started and was managed during the project to ensure a profit margin.	(1) Strongly disagree, (2) Slightly disagree, (3) Nethier agree nor disagree, (4) Slightly agree, (5) Stongly agree	X2501		
B.5.2	Project program was created before the project started and was managed during the project to ensure client satisfaction and a profit margin.		X2502		
B.5.3	The client's needs were clearly defined, discussed and communicated to the client.		X2503		
B.5.4	The project deliverables were clearly defined, discussed and communicated to the client.		X2504		
B.5.5	Client satisfaction was managed on a regular basis during the project.		X2505		
B.5.6	Internal and external communications was defined and managed during the project.		X2506		
B.5.7	All financial and technical documentation was filed and stored during the project.		X2507		
B.5.8	All aspects of the project were completed and handed over to the client.		X2508		
B.5.9	I perceive that by increasing this operational element (Project planning & Management) will increase operations management performance (you can answer the same for each project).		X2509		
B.5.10	I perceive that this operational element (Project planning & Management) affects the performance of projects (you can answer the same for each project).		X2510		



B.6 OPERATIONAL HIERARCHY & CULTURE					
A.6.1	The operational environment was balanced between efficiency and innovation at the time of the project.	(1) Strongly disagree, (2) Slightly disagree, (3) Neither agree nor disagree, (4) Slightly agree, (5) Strongly agree	X2601		
A.6.2	At the time of the project the company structure was balanced between formalized and flexible structures.		X2602		
A.6.3	Entrepreneurship and management freedom was encouraged at the time of the project.		X2603		
A.6.4	An environment of responsibility and integrity were encouraged during the time of the project.		X2604		
A.6.5	I myself appreciate a more free and entrepreneurial climate in which I can manage my project.		X2605		
A.6.6	I perceive that by increasing this operational element (Operational hierarchy & culture) will increase operations management performance (you can answer the same for each project).		X2606		
A.6.7	I perceive that this operational element (Operational hierarchy & culture) affects the performance of projects (you can answer the same for each project).		X2607		
B.7 PROJECT PERFORMANCE ELEMENTS					
B.7.1	Quality of Project	10 = Excellent, 5 = Average, 0 = Bad	X11		
B.7.2	Project Completed in Time	% Over Time = Planned Months / Realized Months	X12		
B.7.3	Project Profit	% Profit = Outcome / Income	X13		
B.8 PROJECT CHARACTERISTICS ELEMENTS					
B.8.1	Project Type	(1) Expertise, (2) Experience, (3) Efficiency	X51		
B.8.2	Client Type	Government Central (1), Government Provincial (2), Government Local (3), Private (4), Parastatal (5)	X52		
B.8.3	Leverage	Junior hr / Seniors hr	X53		
B.8.4	Duration of Project	Months	X54		
B.8.5	Project Engineering Discipline	(1) Electrical, (2) Electronic, (3) Mechanical, (4) Software Development, (5) Utilities, (6) Other	X55		



## SECTION C: DEMOGRAPHIC INFORMATION

**Instruction:**

The following information is needed to help with the statistical analysis of data for comparisons among different interest groups. All your responses will be treated confidentially. Mark the applicable block by highlighting the chosen answer.

C1	Indicate your age group	18 - 29	30 - 39	40 - 49	50 - 59	60+	<b>X61</b>
C2	Indicate your gender	Male	Female				<b>X62</b>
C3	Indicate your race	Black	White	Coloured	Indian	Other	<b>X63</b>
C4	Indicate your highest engineering academic qualification						<b>X64</b>
		None					
		National Certificate					
		National Diploma					
		National Degree					
		Post Graduate qualifications					
		Other					
C5	Indicate your highest business academic qualification						<b>X65</b>
		None					
		National Certificate					
		National Diploma					
		National Degree					
		Post Graduate qualifications					
		Other					
C6	Indicate your management level						<b>X66</b>
		Company Director					
		Project Administrator					
		Project Manager					
		Technical					
C7	Indicate your focused engineering discipline						<b>X67</b>
		Electrical					
		Electronic					
		Mechanical					
		Software Development					
		Utilities					
		Other					

**THANK YOU VERY MUCH FOR YOUR VALUED INPUT**

