A critical review of Operations Excellence programs: A petrochemical company as case study

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ABSTRACT

Operations improvement methodologies have been adopted by manufacturing companies since the early 20th century. Japanese manufacturers were able to offer products of high quality and efficient production costs through systems such as Lean. Manufacturers in the West soon adopted systems of their own thereafter. Operations Excellence is a generic term used to describe such systems, and can be described as a management system delivering competitiveness through the continuous improvement of operational performance.

This study provides a critical review of the implementation of an Operations Excellence program by examining the system adopted by a petrochemical company in South Africa. The review allowed the implementation shortcomings to be identified so that resolutions could be suggested, thus facilitating successful utilisation of the system.

An evaluation of Operations Excellence programs utilised globally and at the case study organisation was carried out as part of a literature study. This research included the critical success factors and lessons learnt from the systems employed by others.

Experimental field work was carried out to allow the critical evaluation of the implementation in the case study. The experimental method utilised a combination of qualitative and quantitative methods for data collection. The primary research instrument was a questionnaire designed to examine the degree in which critical success factors and Operations Excellence requirements were present in the organisation.

The implementation shortcomings were successfully identified through the experimental work undertaken. These shortcomings, together with the review of the available literature on Operations Excellence, allowed for the proposition of recommendations with the objective of successful utilisation of Operations Excellence programs for large enterprises.

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LIST OF ABBREVIATIONS

CI	Continuous Improvement
CV	Chlor-Vinyls
CVF	Competing Values Framework
DBR	Drum-Buffer-Rope
DMAIC	Define, Measure, Analyse, Improve and Control
OE	Operations Excellence
OEMS	Operations Excellence Management System
PDCA	Plan-Do-Check-Act
TLS	TOC Lean Six Sigma
TPS	Toyota Production System
TOC	Theory of Constraints

KEYWORDS

Operational Excellence, Operations Excellence, Lean, Six Sigma, Production Optimisation, Theory of Constraints, Cultural Change, Continuous Improvement

1. INTRODUCTION AND OVERVIEW

1.1 Introduction

In the current globalised marketplace, it has become important for manufacturing organisations to maintain their competitive edge. Countries using low cost labour methods and large scale production facilities make it challenging for global producers to remain cost competitive (McAdam & Hazlett, 2005). In addition to competition from low cost producers, the global economic downturn in 2009 had a negative impact on profitability of commodity producers such as Sasol Polymers, as can be seen from the company's financial results of that year (Sasol Limited, 2009). Even larger, publically listed companies had to take cost cutting measures such as reduction of staff and cutting out of non-core functions (Govender, 2010). The importance of running production facilities as efficiently as possible is thus clear.

Innovative production methods where popularised in Japan in the 1970s with companies such as Toyota offering customers exceptional quality products at competitive prices while achieving sustainable profits (Liker, 2004) through their Toyota Production System. The West soon began to adapt and adopt such methods themselves with work done by E.Goldratt and his Theory of Constraints as an example (Goldratt & Cox, 1992).

Operational or Operations Excellence (OE) is one take on an operations improvement methodology. Operations Excellence in a generic sense is a leadership strategy in which customer focus, continuous improvement, employee responsibility/empowerment and safe production methods are fostered (Business Dictionary, 2011)

In 2008, Sasol limited began the implementation of its version of an OE program. Sasol is a petrochemicals and energy producing company which started out in South Africa but has grown its business internationally as well (with listings on the JSE and NYSE), leveraging off its proprietary Fischer Tropsch synthesis producing high molecular weight hydrocarbons from coal and natural gas.

The need for an OE program was identified by the executive management of the organisation who saw the scope for improvement within the organisation in terms of profitability and sustainability through improved efficiencies and the removal of non-value adding activities (Parry, 2009). Sasol thus developed an OE management system for the organisation.

The system developed by Sasol involves the empowering of employees and enabling them to take ownership of the business in an effort to improve their contribution and thus the overall performance of the company. The goals included the building of a culture where the workforce works together as a team for the greater good and continuous improvement of the organisation so that sustainable profitability of the company is achieved.

The OE roll-out was carried out in stages through each of its various business units. One such business unit within its Polymers group is the Chlor-Vinyls business.
Chlor-Vinyls' operations facilities are located at the Sasolburg heavy industrial areas in the Free State province. The Chlor-Vinyls business operates various chemical plants in a value chain.

The primary end products are:

- Poly Vinyl Chloride (from the Vinyls division)
- Caustic Soda, Hydrochloric Acid and Chlorine derivatives (Chlor-Alkali division)
- Sodium Cyanide and other cyanide derivatives (from the Mining Reagents division)

The Chlor-Vinyls (CV) business was selected for a case study in a critical review of the implementation of OE programs, the results of which are presented in this research.

1.2 Problem Statement

The implementation and adoption of OE principles and metrics at CV began in 2008, amongst other Sasol Polymers businesses. CV utilises a team of process engineers to provide technical support to plant operations. Being part of this team allowed for close analysis of the culture and methods of plant operations from the impartial perspective of a support function. Examining the Operations Excellence Management System's (OEMS) expectations and processes, and comparing to the observed actual operations "style" showed clear gaps between the two. This was further substantiated through discussions with senior management. It was thus evident that the business was not in the position to fully benefit from the OE program. **Research into the causal factors of the apparent implementation shortfalls was required. Thus, a critical review of the implementation of the Sasol OE process at Chlor-Vinyls was to be carried out.**

The research attempts to provide insight into any shortcomings of the implementation undertaken with regard to the OEMS and the actual operations culture. Barriers to the OEMS succeeding in its objectives had to be identified.

Recommendations of how to achieve the intended benefits of an Operations Excellence program through maximum use of its metrics and philosophies was the eventual outcome of the review. These can be evaluated and executed, moving closer to the ultimate goal of the Operations Excellence program being fulfilled, viz. sustainable profitability of the business.

This is an outcome which would benefit all of the business stakeholders. Furthermore, the information and lessons learnt can assist Sasol as well other manufacturing company with the implementation of OE at their businesses.

1.3 Research Objectives

The research objectives are presented firstly as the high level research aim, followed by the lower level specific objectives which describe the processes that would lead to research aim being achieved.

1.3.1 Research Aim

Operations Excellence is a system which looks at addressing the competencies of people and the effectiveness of processes and systems. This will enable the company to achieve the main objective of sustainable profitability in an increasingly global market (Sasol Limited, 2008).

The high level aim of the research was to critically review the implementation of OE at Sasol Chlor-Vinyls and identify the inhibiting factors to its successful implementation and recommend corrective measures so that the desired world class operation of its petrochemical assets will be achieved.

1.3.2 Specific Research Objectives

- Investigate OE models and similar programs created and implemented in other organisations to enable critical evaluation of the Sasol system.
- Study the culture and operations processes of the Chlor-Vinyls business and compare to the OE implementation requirements identified in literature
- Critically review the implementation of OE with reference to the case study.

1.4 Layout of the Dissertation:

Chapter 2: Literature Study

The first section focuses on scholarly sources external to Sasol. The implementation of production and operations improvement methods at organisations globally was carried out.

An introduction to the case study follows, with a detailed study of Sasol's OE processes and expectations using reference material internal to Sasol.

Chapter 3: Experimental Design

The details of how the data capturing methods were selected and designed are carried out in chapter 3. A description of the statistical and qualitative data analysis methods is also included. The chapter outlines the deployment and handling of the data capturing questionnaire as well.

Chapter 4: Presentation and Discussion of Results

The results of the empirical study and the accompanying discussion are presented in this chapter. The analysis of the raw data obtained from the field work is presented, followed by the discussion and interpretation of the data and concludes with the verification of results.

Chapter 5: Conclusions and Recommendations

Conclusions drawn from the research as a whole are found in this chapter. The fulfilment of the research objectives initially selected is explored. Recommendations to the case study organisation based on knowledge from the literature survey and empirical study are also given, as well as recommendations regarding limitations of the study and future research.

To fully understand the implementation difficulties and critically review the implementation of OE programs, a study of the available literature from sources globally, as well as in reference to the case study, is required. This is carried out in Chapter 2 which follows.

2. LITERATURE STUDY

2.1 Introduction

The approach to the literature study was to initially study in detail the available literature from scholarly sources external to the organisation selected for the case study (referred to as the "Operational Excellence Literature" in this report). This was carried out to investigate the various OE definitions and models that have been created historically. The implementation of such programs in other organisations, with regard to aspects such as organisational culture, was studied in this section.

In the second portion of the literature study ("Case Study Literature"), the case study is introduced. After discussing the organisation's background, the OE program used at Sasol is examined. From this, a picture of where the organisation desires to be, in terms of its behaviour, culture and operating methods was developed. Similarities between Sasol's model and those developed externally are investigated.

As the researcher was employed by Sasol at the time of the review, this "case study literature" was made available for review. The information cited in this portion of the study is thus largely from unpublished Sasol sources.

The Literature Study was then used for the experimental design, as well as for the analysis of results and the drafting of conclusions and recommendations.

2.2 Operational Excellence Literature

2.2.1 Definition of Operational Excellence

There is no single and concise definition of Operational Excellence found in the literature. Authors attempt to state the attributes of OE with varying degrees of emphasis on the aspects of the programs. In addition, organisations that implement OE often develop their own model and accompanying definition. Although the exact definitions may differ, the underlying principles remain similar, as illustrated by the examples that follow.

A Swedish group of scholars (Eriksson *et al.*, 2012) describes OE as a way for an organisation to "re-engineer" its current operations methods toward one that is productive, efficient and profitable. They further elaborate on some of the benefits that such a program brings, stating that it allows the organisation to continuously improve its operations performance through clear goals and strategies, facilitating team work, problem solving, focusing on customer needs, empowering employees and optimising the use of existing assets.

Barr and Cook (2009) describe it as a *corporate wide management system* with the drive toward continuously improving operational performance. Functions such as human resources, safety health and environment, and quality are included in these corporate wide OE systems. Again, the focus of the program is on customer orientation, empowering employees and optimising systems and processes.

Leadership consultant Spencer Stuart (SpencerStuart, 2009) gives the following statement which highlights how other well-known operations improvement methodologies are incorporated in OE (elaborated on in section 2.2.2):

“Six Sigma, lean manufacturing, total quality management. These are just a few of the programs companies are implementing to increase profitability and eliminate waste. When integrated under the umbrella of operational excellence and applied across the organization, however, a new way of doing business emerges — one that produces higher yields, reduces waste, improves quality and increases customer satisfaction.”- (SpencerStuart, 2009)

Ozumba (2010) attempted to summarise some of the many explanations found in the literature. He describes OE as a management system which allows focus and alignment on the requirements for the organisation to increase its competitiveness through world leading operations performance. This is achieved by integrating people, processes and tools. The gain in competitive advantage is through improved cash flow, return on assets and growth.

There are some common OE attributes that are seen from the literature definitions. It can be said that Operational Excellence is an organisational management system that:

- Increases the competitive edge of the business
- Increases profitability through increased efficiencies
- Maximises returns from investment in assets
- Utilises best practices
- Develops a competent and empowered work force (including leaders)
- Strives for continuous improvement
- Is quality and customer focused

OE is deployed practically in organisations through the implementation of an OE program or model. Many forms of these models have been created which are described in the sections that follow.

2.2.2 Operations improvement methodologies

Operations improvement methods have been in practice since the early 20th century (circa 1920s). Early examples include the creation of “scientific management”, largely attributed to the engineer Frederick Winslow Taylor, and the contributions of Henry Ford who kicked-off mass production of goods by using production lines and division of labour (Stevenson, 2007).

In the 1970s, Japanese manufacturers took the next big step in operations improvement, introducing systems such as Lean (Liker, 2004), with manufacturers elsewhere soon following suite (Goldratt & Fox, 1986).

Improvement methodologies such as Lean and Six Sigma have been used widely since developed and those philosophies, if implemented correctly, are considered tools or technologies used in achieving improved productivity and success (Ozumba, 2010). An evaluation of these “OE tools” follows.

- **Lean:**

Jeffrey K Liker's "The Toyota Way" is a Shingo Award winning book on Lean manufacturing (Liker, 2004) created from his study of the Toyota Motor Corporation and provides an ideal reference for an analysis of Lean manufacturing methods. Toyota Production System (TPS) or Lean was invented by Toyota Motor Corporation in 1950s, with developments and improvements of the system carried out throughout the decades which followed. It is a system comprising of the tools needed to remove "waste" from the production process.

Waste is defined as any activities in the process which do not add value to the end product which a customer wants to buy. In other words, it is a management philosophy concerned with the reduction of resource usage in the manufacturing process for any activities that the customer is not paying for (non-value adding). This leads to cost reduction and better production efficiencies. It also includes the reduction of production rate variations to create "smooth" production (Liker, 2004).

Waste is categorised into eight forms, according to Liker (Liker, 2004):

- Overproduction: This is producing more than demand dictates. This ties up money in the form of working capital and wastes resources for storage and transportation. The removal of this form is via "demand pull manufacturing". This is a paradigm shift for many producers.

- Waiting: This is wasted man hours due to workers standing around unproductively e.g. during breakdowns, or upstream/downstream constraints as well as supervising automated machines.

- Transport: This includes unnecessary moving of parts between processes and finished products in and out of storage.

- Over processing: Stems from over working of products through inefficient design of processes as well as exceeding quality requirements.

- Inventory: Inventory ties up raw materials which cannot be sold. Inventory also masks problematic equipment/processes.

- Unnecessary movement: Any unnecessary movement of workers which wastes time and creates inefficiencies.

- Defects: Wasted time and resources due to production of substandard products (quality)

- Unused employee creativity: Wasted skills of workers, wasted ideas and possible solutions to problems due to poor communication with workers etc.

The "waste" in a process is illustrated in the example below (figure 2.2-1), courtesy of (Liker, 2004):

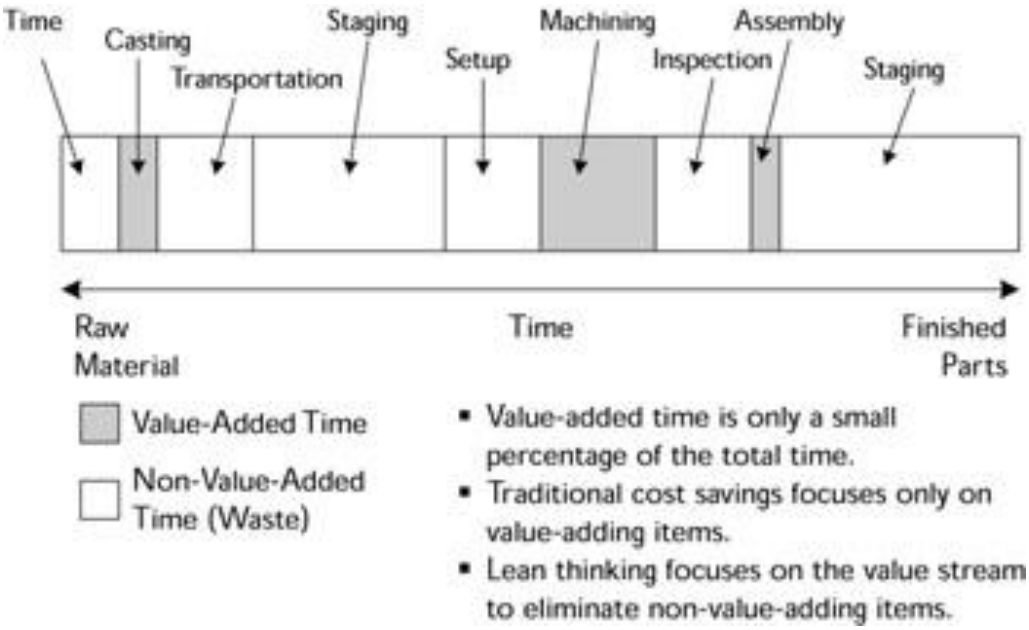

Figure 2.2-1: Waste in a value stream, courtesy of Liker (2004)

Toyota's method of reducing waste in its processes is carried out through the Lean manufacturing system known as Toyota Production System (TPS). The system has been represented diagrammatically (Figure 2.2-2) in what has become known as the "TPS house" or the "Lean temple" (Van Tonder, 2011):

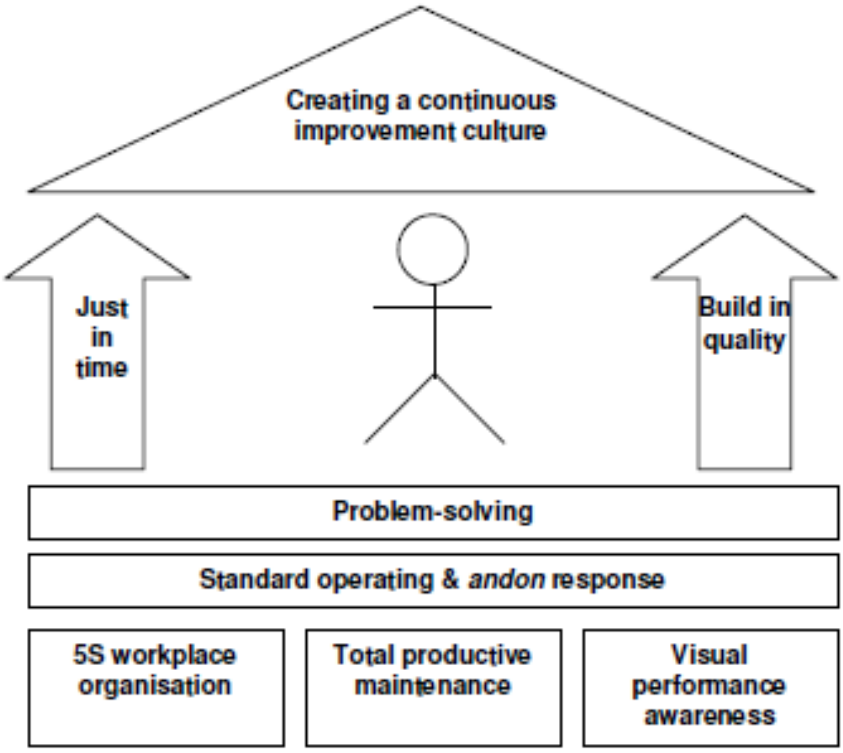

Figure 2.2-2: Lean Temple, courtesy of Van Tonder (2011)

According to Van Tonder (2011), the Lean Temple was created by Toyota's President Fujio Cho for teaching purposes. The analogy was created to show the

importance of keeping the foundations and pillars of the system strong to keep the entire structure erect.

Liker (2004) describes the roof of the house as the goals of the system, namely low cost of production, best quality and short lead times. These goals are the aspects of the system which give an organisation a competitive edge.

The foundation of the structure is based on standardisation of operations and best practices, resolving of problems in the production system through efficient work place organisation, production levelling and stability.

Just-in-time (one of the two pillars) is the “pull system” utilised to control the flow of parts into the production process according to demand at the end of the line. This allows for the minimisation of work in progress inventory which is said to bring to surface the problem areas in the production line by reducing buffers. When a problem arises, the entire production line is halted, forcing detailed problem solving and preventing recurring stoppages.

The second pillar focuses on “in station quality” or the philosophy of never letting defects pass from one station to the next. Its methods include bringing defects to the surface, automatic line stops, utilisation of automation with a human touch and root cause problem solving.

At the centre of the structure is “people”, without whom the system would not be able to attain the stability needed to function.

In his study of Toyota Liker analysed the Operational Excellence methods employed by the organisation:

“The incredible consistency of Toyota’s performance is a direct result of operational excellence. Toyota has turned operational excellence into a strategic weapon. This operational excellence is based in part on tools and quality improvement methods made famous by Toyota in the manufacturing world, such as just-in-time, kaizen, one-piece flow, jidoka, and heijunka.” - (Liker, 2004)

The operational philosophies of the company were further referred to as the “Toyota Way”. The ideologies of the Toyota Way are summarised into 14 principles, further grouped into four categories (the 4P model) as seen in Figure2.2-3:

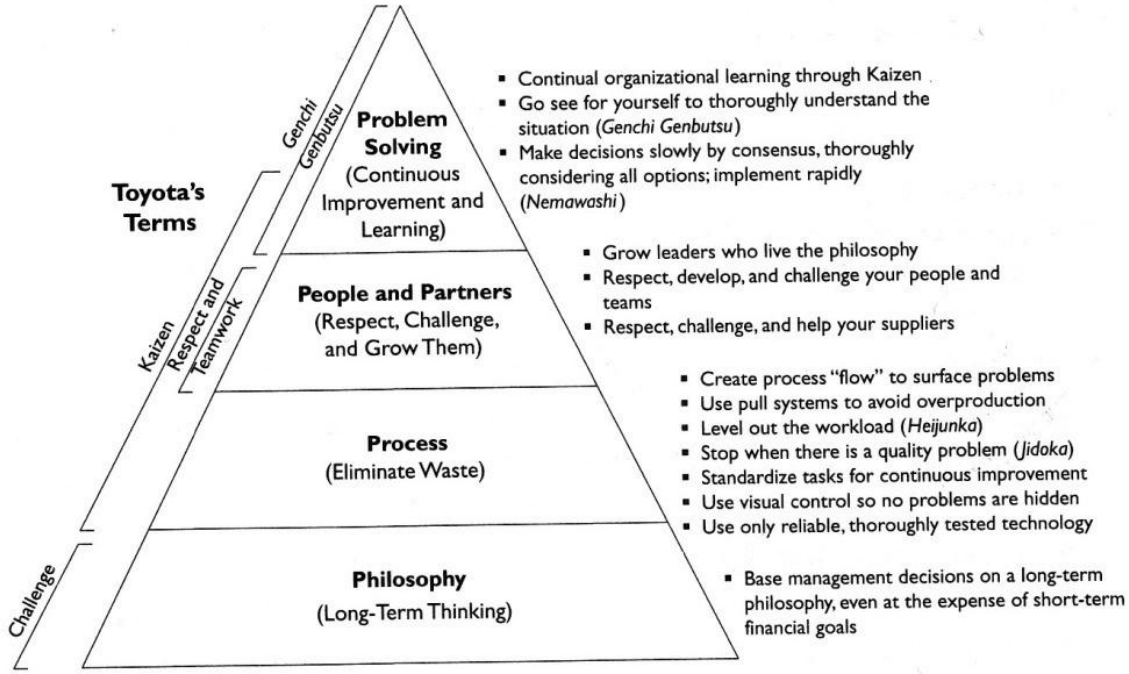

Figure 2.2-3: The 4 P Model of the Toyota Way (Liker, 2004)

By analysing the 4P model of the Toyota Way and comparing to the characteristics listed for OE systems in section 2.2.1, it is seen that the Toyota Way is a form of an Operational Excellence model. It exhibits many of the OE characteristics stated in the definitions, such as continuous improvement, focus on customers and quality, optimisation of processes and empowering people.

The Lean manufacturing system or TPS is not to be confused with the Toyota Way. In reference to TPS, Liker states the following:

"When looked at more broadly, TPS is about applying the principles of the Toyota Way" - (Liker, 2004)

Thus, Lean/TPS is the system used to *practically apply* Toyota's OE model, the Toyota Way. This further justifies categorising Lean as an "OE tool"

Investigation into the implementation of Lean systems in organisations would thus be insightful when evaluating the implementation of OE programs as a whole. This is carried out in section 2.2.5.

- **Six Sigma:**

Six Sigma is an operations improvement method which is centred on improving the *quality* of the end products sold to customers. It was first utilised by Motorola in the 1980s and became popular after its adoption by General Electric and has since further developed it into an improvement initiative with a focus on improving business processes as a whole. These improvements lead to improved business performance for the organisation (Kettinger & Grover, 1995).

The word “sigma” is used in mathematics to refer to standard deviation and when used in the context of business processes, refers to defects or variations in those processes (Chowdhury, 2001). “One Sigma” equates to 700,000 defects per million opportunities (DPMO) or 30% “good performance”. “3.8 Sigma” equates to getting it right 99% of the time. This may seem like a high level of quality, but even a 1% error adds up in time. Chowdhury (2001) states that most companies operate between 3 and 4 sigma (or 67,000 and 6,000 DPMO respectively). In contrast, Six Sigma would equate to 3.4 DPMO or 99.99966% yield (Van Tonder, 2011).

The focus of the system is on the *customer’s requirements* and striving to reduce deviations from what the customer wants and would pay for. Competitiveness in the market is improved in this manner. Chowdhury (2001) uses the analogy of a football match to illustrate this.

In the analogy it is stated that a game of football can be won in one of two ways. The one involves defeating the opponent using extraordinary plays, utilising great skill and individual brilliance. The second is to make fewer *mistakes* throughout the game (fewer penalties, fewer fumbles, and fewer interceptions). The second strategy is easier to implement since the first method requires exceptional players, playing to their full potential, whereas all players can focus on making fewer mistakes.

This is analogous to companies, in that competitiveness in the market can be obtained by either making “big plays” through the creation of exceptional products (which requires exceptional resources), or through reducing mistakes in the products or services offered (which can be achieved by all resources). Six Sigma is a system created to achieve the latter.

According to Chowdhury (2001), the improvement of quality is often misconceived as the primary objective of Six Sigma. In actuality, the improved quality is the means to an end. The customer satisfaction derived from the improved quality is what really matters, since this is what ultimately leads to higher revenues.

Juran and Gryna (1993) describe Six Sigma as the system of activities with the aim of achieving customer satisfaction, empowered employees, increased turnover and reducing costs. This description reinforces the point made by Chowdhury (2001) regarding the goals of Six Sigma. In addition, the description captures the features outlined for an OE program as defined earlier.

The improvement tool deployed in a Six Sigma program is the **DMAIC methodology**, which is an abbreviation for Define, Measure, Analyse, Improve and Control. The process is described as reactive, identifying a particular problem and resolving it (Stamatis, 2000). The system is often utilised in continuous or incremental improvement initiatives.

The DMAIC methodology is a proven problem solving method which provides the tools and method of application for those tools (Rath & Strong, 2003). Another key aspect is that the system is data driven, removing any biased opinions and speculation from the process. The fact that it is scientifically and factually based is one of the reasons for its success (Britz, 2008).

An illustration showing the iterative nature of the DMAIC process is shown in figure 2.2-4 below.

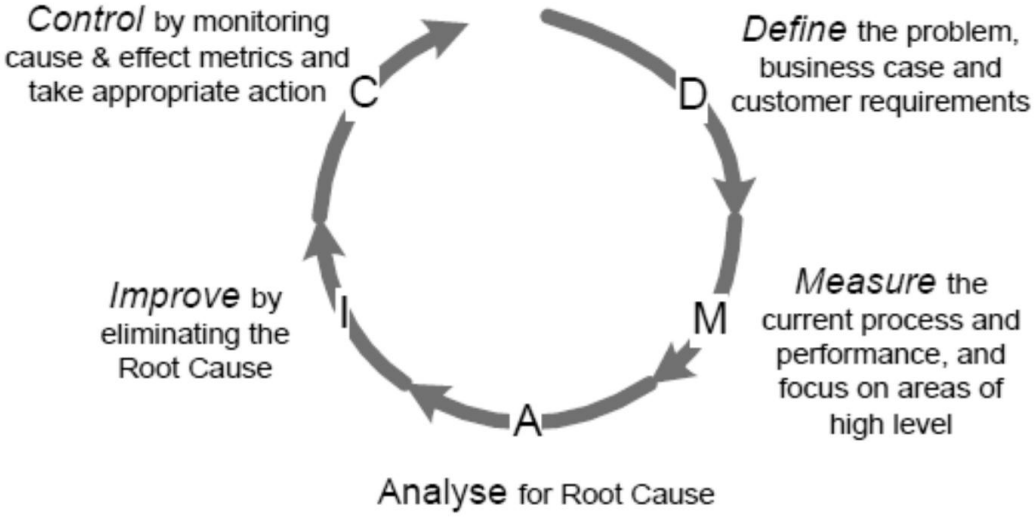

Figure 2.2-4: The DMAIC process, courtesy of Pyzdek (2001)

The five phases of the DMAIC process are described further below (Rath & Strong, 2003):

- Define:

  In this phase, the problem is clearly defined and formalised. The desired business outcomes and business case (why it is important to resolve the issue) is drafted. The team develops a charter, which forms the agreement between themselves and the project sponsor. The business process is mapped out and the stakeholders of the change are identified. Data regarding the customer issues are collected, leading to the Critical to Quality (CTQ) factors being identified. Gate reviews with the project sponsors are carried out at the end of each phase to review the work done by the team and to ensure that progression is as expected.

- Measure:

The focus of this phase is on analysing the variables that affect the process outputs. Actual data is collected which is used to narrow the potential causes which the team will analyse further in the next phase. The capabilities of the current process in meeting customer requirements are thus determined (current sigma value).

- Analyse:

In the analysis phase, the process is studied to determine causes of process deviations. Cause and effect diagrams are used to display possible root causes. Root causes are verified using statistical tools. Once the root causes are finalised, the team is ready for the next phase.

- Improve:

The solutions of the identified root causes are identified in this phase using solution generation methods such as brainstorming. A cost/benefit analysis is carried out on the chosen solution. Implementation risks are studied and the implementation is undertaken. If possible, the change is trialled on a pilot level before being adopted throughout the organisation.

- Control:

Before the project can be completed the new process is documented and metrics are put in place to monitor it. Plans are developed to maintain the new operating position. The results of the change are determined and accepted. Training is also carried out. Once all the required control measures are in place, the project is handed over to the project owner and the process is complete.

As with other improvement methods, the success of Six Sigma in improving operations performance is influenced by how well the system is deployed. Implementation difficulties are studied further on in this chapter (section 2.2.5).

- **Theory of Constraints (TOC):**

The Theory of Constraints (TOC) was devised by Dr Eliyahu M Goldratt and was put forward in his novel titled “The Goal” (Goldratt & Cox, 1992). It is a production optimisation philosophy which is centred on the saying “a chain is only as strong as its weakest link”. It is a systemic approach in that it does not focus on sub-systems, but the system as a whole (Dettmer, 1997). The so called “weak link” in the chain is the constraint which prevents the organisation from achieving its manufacturing goals. There can only be a single weakest link or constraint at any given time.

“The Goal”, as described by Goldratt & Cox (1992), of any non-profit organisation is simply to “make money”. All other activities are means to achieving this over bearing aim. This seems logical, but it can be lost in the many metrics and financial measures which a company can adopt, diluting its focus.

Three concepts and measurements are introduced to aid in moving toward the goal. They are to:

- Increase throughput (defined as the rate of sales of products, or simply "money in").
- Decrease inventory (investment made to create products e.g. work in progress, machinery etc. This also can be described as money held within the business).
- Decrease operating expenses (costs involved in turning inventory into throughput, money outflow)

These three measures must be carried out simultaneously for movement to be made towards the goal, according to Goldratt & Cox (1992).

In contrast to Lean manufacturing which employs demand pull (through Kanban) to determine the flow of material and products, it is stated in "The Goal" that one should not balance capacity with market demand. The reason for this is twofold:

Dependant Events: These are steps or events in a process which precede other events or groups of events. The event is dependent on those that occurred before it.

Statistical fluctuations: these are demand fluctuations which occur without warning. It refers to future uncertainty in the process.

As an example, if the demand for a certain part suddenly increases (statistical fluctuation), the delivery of that part is dependent on the rate at which the work in progress moves through the various stages of production (dependent events). If the rate of the preceding step is slower than required, delays are created, and if it is faster, work in progress inventory increases.

When referring to a production process, the maximum throughput that can be obtained is governed by the rate of the constraint or bottle-neck (Goldratt & Cox, 1992).

A constraint is defined as a resource which cannot meet the demands placed on it. Localised maxima only serves to increase inventory and operating expenses. TOC stipulates that the constraint should thus govern the flow of materials through the process and emphasis is made on maximising the rate through the constraint at all times.

To identify the constraints, Goldratt & Cox (1992) state that first you have to identify the market demand. All resources which are slower than the market demand are constraints. Constraint resources also have high amounts of work in progress inventory ahead of them.

Constraints can be either internal (those the organisation have control over) or external (those arising from the external environment, e.g. the market)

Internal constraints can be due to:

- Equipment/Machinery: Output constraints due to sub-optimal operation of equipment.
- Human/Personnel: Skills shortages, behavioural issues and mental blocks.
- Policy: Company or government written or unwritten policies that hinder production (e.g. trade restrictions).

The TOC proposes ***Five Focusing steps*** to achieve maximum rates through the constraint (Dettmer, 1997):

1. Identify the constraint: Determining the internal or external constraint preventing achieving the goal

2. Decide how to exploit the constraint: Determine how to maximise use of the constraint as it is, i.e. without investing capital for upgrades.

3. Subordinate all other processes: Focus all of the sub-systems on supporting the decision made above. The aim is to achieve the maximum usage of the constraint by changing operation of the supporting sub-systems e.g. either increasing or decreasing rates. A verification check is performed to determine if the constraint has been removed. If so, proceed to step 5.

4. Elevate the constraint: If the constraint still exists some major change needs to be made e.g. upgrading of machinery

5. Once the Constraint has been removed return to Step 1. Don't let inertia become the constraint. This means that one should not become complacent, as removal of one constraint creates another. In this way continuous improvement is achieved.

A synchronised manufacturing system was created to level production according to the system constraint. This was published in “The Race” (Goldratt & Fox, 1986) and was titled Drum-Buffer-Rope (DBR). An illustration from the book explaining the process is shown in Figure 2.2-5:

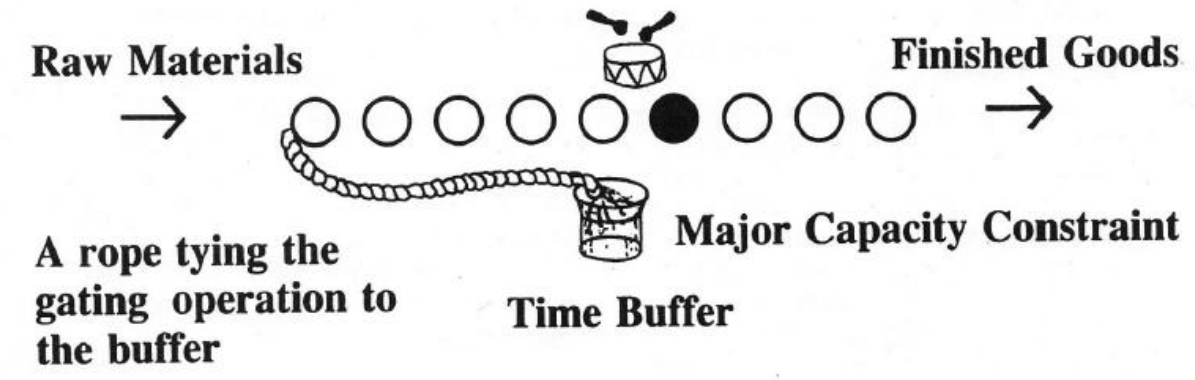

Figure 2.2-5: Drum-Buffer-Rope, reproduced from Goldratt & Fox (1986)

The constraint in the production line “beats the drum” to set the flow through the plant, a “buffer” is employed before the constraint to allow for any deviations before the constraint and a “rope” is used to control the flow of raw materials into the system. By employing the system correctly, Goldratt & Fox (1986) explain that an organisation will reduce inventory, which has positive financial benefits for the manufacturer. Thus, utilising TOC will assist in improving operations performance and moving toward OE.

When comparing DBR to Lean, the key difference between the two would be the fact that the constraint sets the pace of the plant, as opposed to the demand pull from the customer used in Lean. This would thus lead to inventory before the constraint and delays after. This falls into the “waste” categories which Lean would attempt to reduce.

In addition, where Lean strives to remove buffers at all costs, DBR employs one deliberately. Removal of buffers brings to the surface problems in the process which need to be resolved, fostering continuous improvement and root cause analysis, according to Lean methodology (Liker, 2004). The phenomenon of statistical fluctuations makes the time buffer necessary in the TOC philosophy. Lean and its continuous focus on reduction of waste and flow levelling would thus have to minimise these statistical fluctuations to achieve its goals.

Lean and TOC thus use different approaches to achieve similar outcomes, namely improved operations performance through optimised “flow”.

- **Combined Methodologies:**

The methods outlined above utilise differing approaches to achieve operations improvements. To benefit from the aspects and philosophies of the methods, some practitioners have attempted to implement combined improvement methods.

One such method is *Lean Six Sigma*. Six Sigma alone has been widely used to improve quality and reduce deviations, but it does not improve the “speed” of the process (Atmaca & Girenes, 2011). This is the reason for incorporating Lean methods which improves process flow and reduces cycle times.

Lean Six Sigma has been utilised since 1997 by the Indian company BAE Systems Controls, with other large companies such as Xerox, General Electric, Johnson & Johnson and Dell following suit (Brett & Queen, 2005).

The benefits of the combined process have been reported in work carried out by Brett & Queen (2005), Atmaca & Girenes (2011) and Devane (2004), as well as others.

J. Liker (2004) expressed the negative side of Lean Six Sigma, based on his personal experience in which the two were implemented as sets of tools. He explained that the persons working in the company would favour one set of tools over the other (Lean or Six Sigma), thus preventing proper incorporation of the two and ultimately leading to the failure of the system.

The important lesson from this he states as:

“This is not to say the company should throw out Six Sigma or lean tools. Both are extremely powerful tool kits, but in the end, they are just tools. What companies need to be told over and over is that lean tools represent only one aspect of the broader philosophy of the Toyota Way. It seems like this is the most difficult lesson to get across to companies that want to go lean.” - (Liker, 2004)

Thus OE tools and the combination of them have been shown to be successful in leading organisations toward its OE goals, but much of the success is dependent on how well the OE philosophies (such as The Toyota Way) have been developed and implemented.

A second combined methodology caters for the realisations of constraint theory, and is known as TOC Lean Six Sigma (TLS). The combination was shown to be effective in increasing the contribution to savings realised, even more so than Lean and Six Sigma alone according to the survey results reported by Pirasteh & Farah (2006).

A TLS system was later developed and implemented by Jonker Sailplanes (Van Tonder, 2011), the results of which were increased throughput and reduced operating costs, both characteristics of OE.

The TLS method reported by Pirasteh & Farah (2006) is implemented in three parts:

- Firstly, the application of TOC is carried out to identify the constraint in the process. This is the key difference from carrying out Lean first, as the constraint in the system provides the starting point for focussing improvements (Van Tonder, 2011). Lean on the other hand is a global system. The TOC five focussing steps are then used to maximise throughput at the constraint.

- Identification of the constraint then allows a starting point for Lean initiatives (waste reduction, demand pull systems etc.). These measures optimise throughput and stabilises flow.

- Once the process is stabilised, Six Sigma processes such as DMAIC can be employed to identify and resolve process variations and improve the quality of the products. It also assists in maintaining the new baseline and keeps continuous improvement momentum going once the first two improvement stages are complete (Van Tonder, 2011).

2.2.3 Strategic Planning

Operations strategy refers to the long term planning measures undertaken to facilitate the optimal use of operations resources to meet the long term corporate strategy of the organization (Davis *et al.*, 2005). Examples of some issues to be addressed by the operations strategy are given by Davis *et al.* (2005):

- How large do we make our facilities?
- What type of process(es) do we install to make the products or provide services?
- What will our supply chain look like?
- What will be the nature of our workforce?
- How do we ensure quality?

Barnes (2008) states the need for operations to adhere to strategic plans:

"The relationship between an organization's strategy and its operations is a key determinant of its ability to achieve long-term success or even survival. Organisational success is only likely to result if short-term operations activities are consistent with long-term strategic intentions and make a contribution to competitive advantage." - (Barnes, 2008)

The organisational success factors described above are also those of OE programs. With regard to Operational Excellence, it has been stated that without strategic vision, OE alone cannot guarantee or sustain business success (Kaplan & Norton, 2008b). The above statements are evidence of a link between OE and strategic planning, viz. that the success of the one, in terms organisational improvement, can be increased by implementing the other.

Further evidence of this link is described in a case study reported by Davis *et al.* (2005). The subject of the case study is a Canadian steel manufacturer who had been finding it difficult to stay in business due to competition from global suppliers. Their previous strategy was to "compete on cost" which it was not able to do any longer. The solution was the creation of a new business strategy which included OE methods, technology and innovation, and a customer focus. This allowed them to offer specialised applications and high quality products.

The development and adherence to a good business and operating strategy (which included OE methods) was successful in this case, as the producer became the most profitable steel company in North America by 1999, placed first in an independent customer satisfaction survey of North American steel companies in 2000, as well as rated one of the best companies to work for in Canada according to a business magazine (Davis *et al.*, 2005).

Although strategic planning can improve organisational performance, 60% to 80% of companies do not achieve the predicted outcomes of their strategies, according to Kaplan & Norton (2008a). One reason given for this is the failure to balance operations and strategy. Instead of focusing and realigning with the strategy during management meetings, operations discussions take focus, especially during times when the operational targets are not being met.

The solution to the issue, according to Kaplan & Norton (2008a), is a closed loop management system which links strategy and operations. A diagrammatic representation of a five step system created by Kaplan and Norton follows in figure 2.2-6.

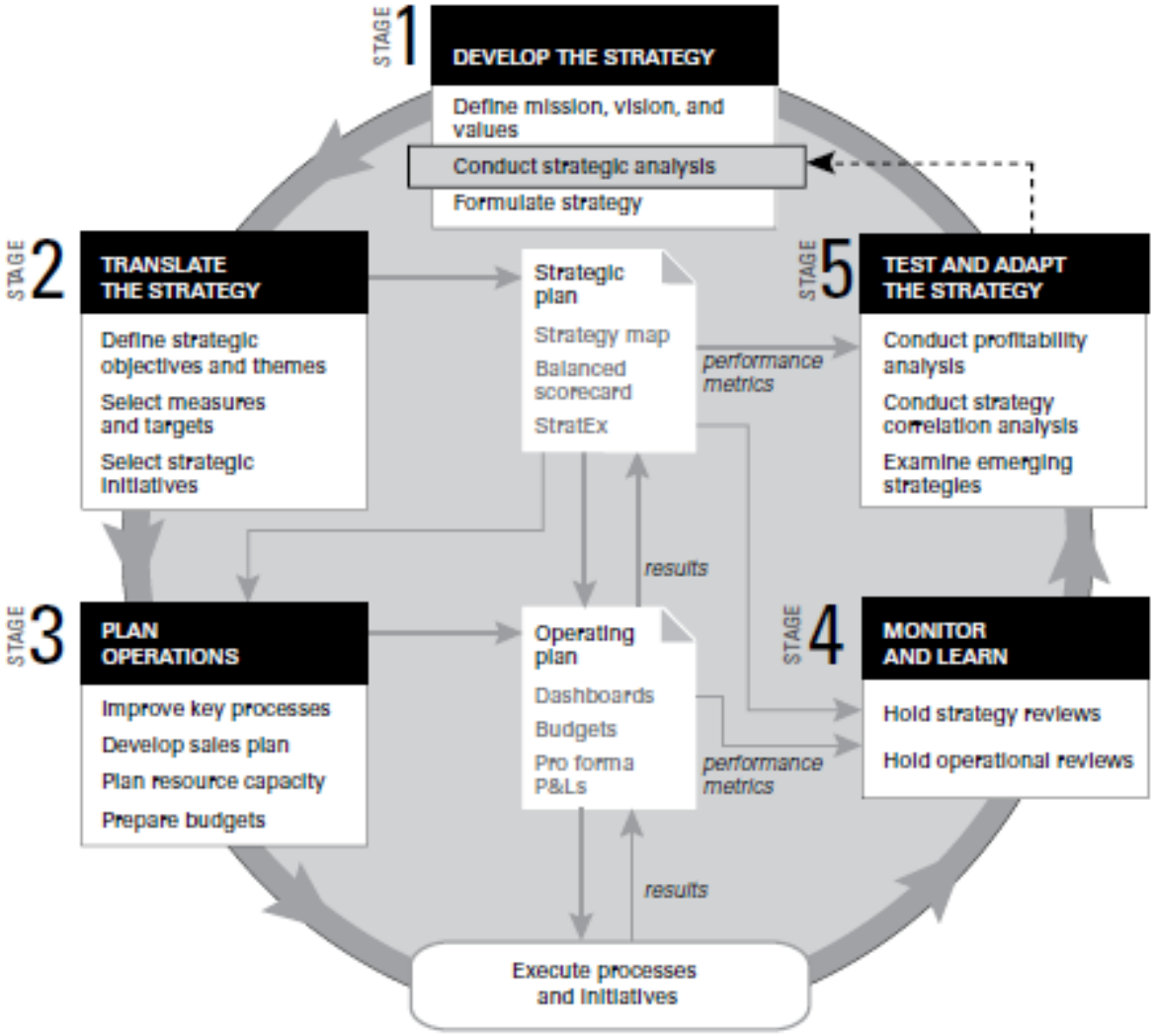

Figure 2.2 6: Closed-Loop Strategic Management System, courtesy of Kaplan & Norton (2008a)

The management system depicted allows for the development of an overall strategy (step one) and the creation of the strategic objectives for medium term future (step two). A Strategic Map is developed at this point, with the strategy grouped into themes, each with cause and effect relationships. This grouping allows for a person to be assigned and held accountable for a particular strategic theme, such that it doesn't fall away. The Strategic Map also allows for a condensed and easily understandable version of the strategic objectives to be made available to all levels of the organisation.

A generic example of a themed Strategic Map is shown in figure 2.2-7:

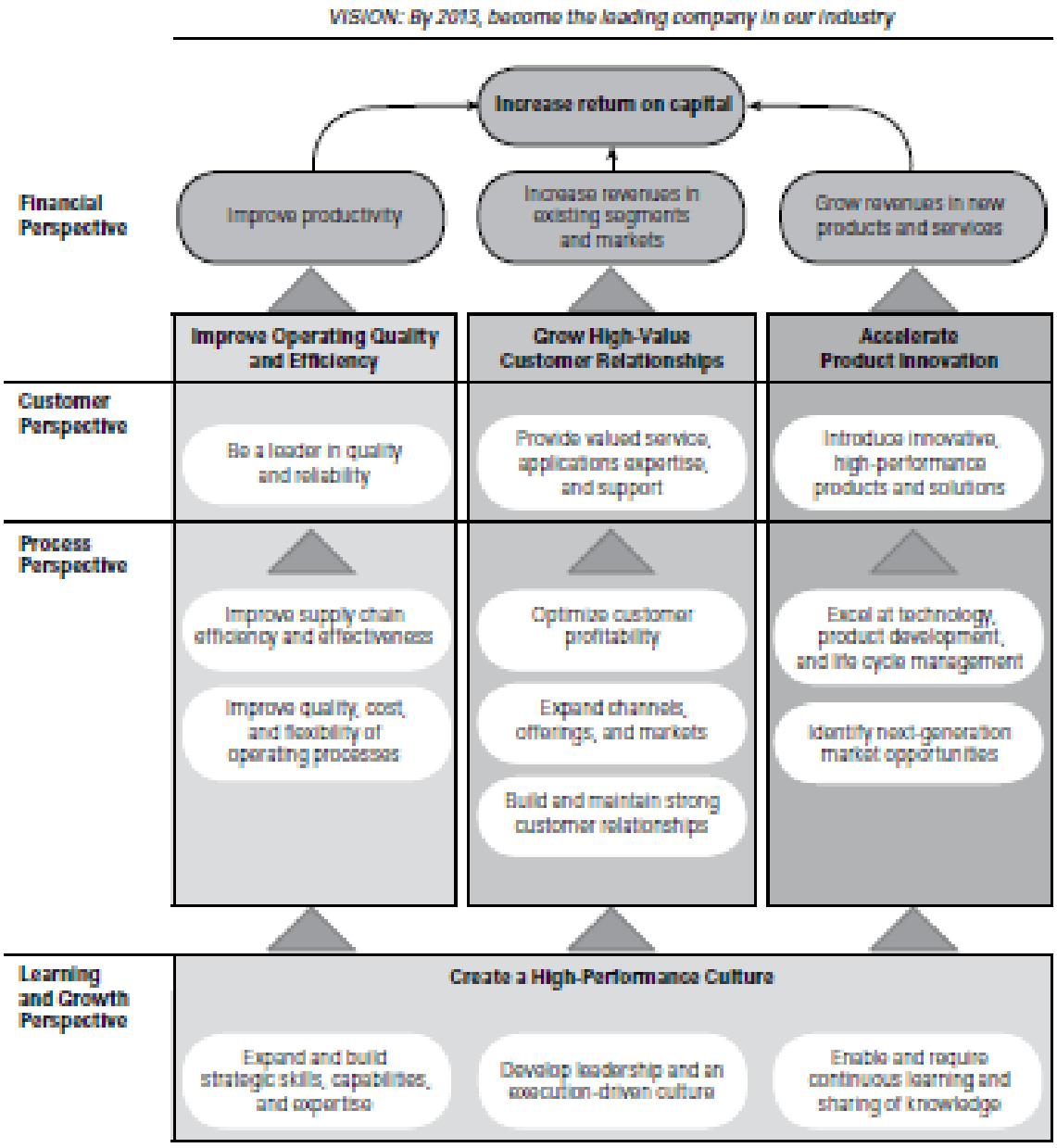

Figure 2.2-6: Themed Strategic Map, from (Kaplan & Norton, 2008a)

Operations Excellence methods enter the strategic management system at step 3, “Plan Operations”. OE is incorporated in a manner that operations improvements are in line with the objectives in the Strategic Map. The short term operations improvements are lead on from the long term strategic priorities.

The evaluation of the performance of the organisation in meeting its objectives is carried out in step 4. This is done through operational reviews and strategic review meetings (Kaplan & Norton, 2008a).

Step 5 brings in the closed-loop or iterative portion of the system, the lack of which leads to the failure of many strategies (Kaplan & Norton, 2008a). The strategic assumptions may be obsolete or incorrect at the time of creation, and this step allows for re-evaluation, based on the performance to date and new data that may be available.

In summary, it is beneficial for the organisation to utilise proper strategic planning for it to visualise how it intends to leverage its strengths in the marketplace. OE programs form part of the strategic plan and cater for how the operations function intends meeting strategic objectives.

2.2.4 OE Models deployed in industry

Organisations have developed improvement programs which have been formally titled “Operational Excellence” Models. These are in addition to the organisational improvement methods such as Lean. Examples of OE models published are examined in this section.

- **The Shingo Principles of OE:**

Dr Shigeo Shingo was one of the most influential and respected consultants concerning Japan’s manufacturing industries (Shingō, 1990). He worked with industry leader Taiichi Ohno in the development of TPS (discussed in 2.2.2).

The Utah State University paid tribute to Shingo in 1988 when its Jon M. Huntsman School of Business created the Shingo Prize for Operational Excellence (The Shingo Prize for Operational Excellence Ltd., 2012). The prize is awarded annually to those companies showing exceptional OE standards and performance.

The organisation is non-profit with the following mission:

“The mission of The Shingo Prize is to create excellence in organizations through the application of timeless, universal, and self-evident principles of operational excellence; alignment of management systems; and the wise application of improvement techniques across the entire organisational enterprise” - (The Shingo Prize for Operational Excellence Ltd., 2012)

The organisation considers its OE model to be the benchmark for which to judge all other excellence centred programs. The model itself has been based on the systematic study of many of the existing improvement methods such as Six Sigma, Lean and JIT (The Shingo Prize for Operational Excellence Ltd., 2012).

The model is *principle* based; focussing more emphasis on guiding principles than on the improvement tools alone. The importance of this approach was also reinforced by J Liker (2004), as reported in the discussion on Lean in section 2.2.2.

The principles forming the basis of the Shingo OE model have been summarised in similar fashion to Lean, taking the form of the “Shingo House” as shown in Figure

2.2-8. Discussion of the model follows with reference made to the model's guidelines (The Shingo Prize for Operational Excellence Ltd., 2012).

The "house" has been divided vertically into two sections, namely the guiding principles (of which there are ten) and the supporting concepts. The principles are grouped horizontally into four categories or dimensions which are cultural enablers, continuous process improvement, enterprise alignment, and results. Five core business processes are encompassed at the centre of the house: product/service development, customer relations, operations, supply, and management support functions.

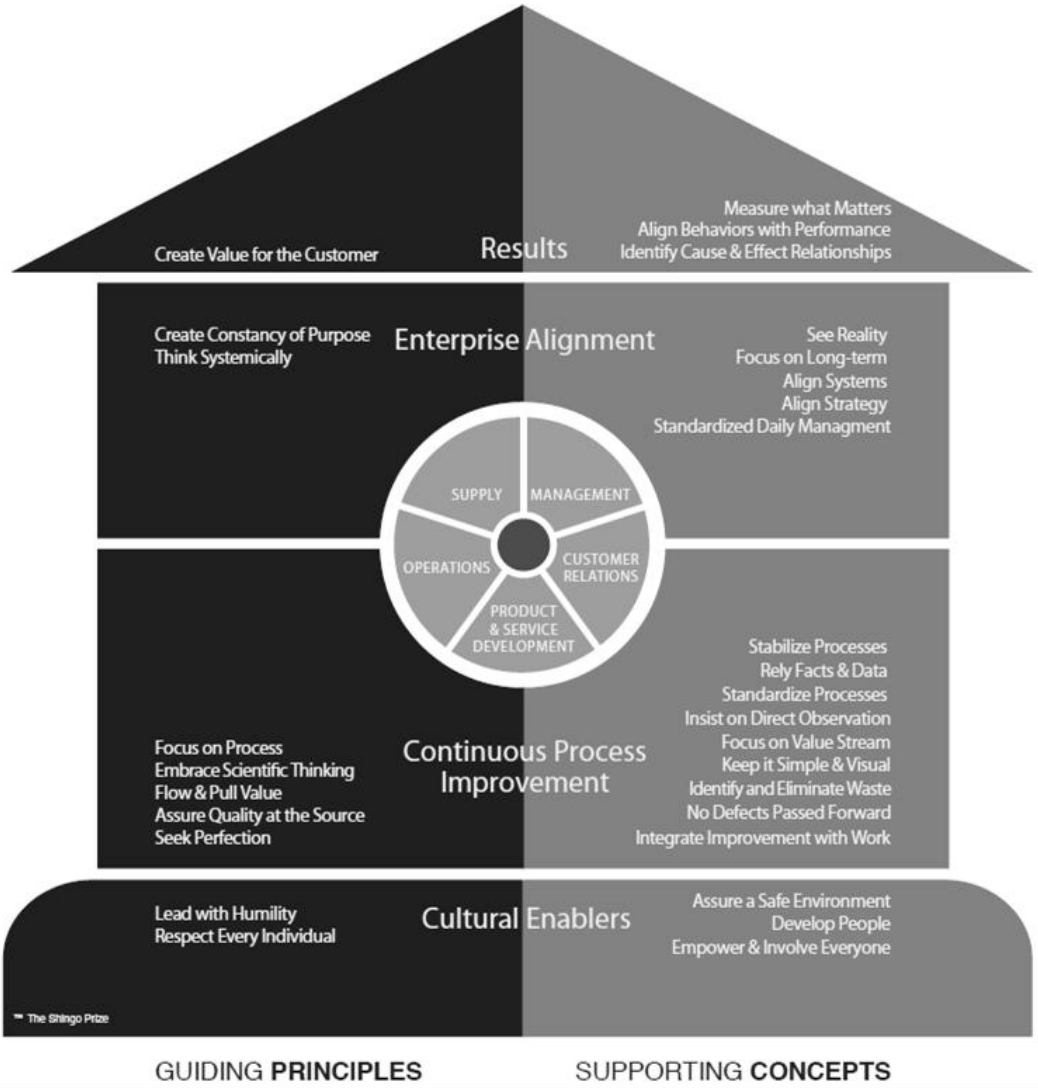

Figure 2.2-7: The "Shingo House" of OE principles, courtesy of The Shingo Prize for Operational Excellence Ltd. (2012)

*"**Cultural Enablers**"* is the dimension at the base of the house. It allows for the employees of the organisation to be involved with and understand the OE transformation process. For OE to be successful there has to be a cultural shift in the organisation. This change cannot be forced on employees from the top, but must be accepted and committed to from all levels. This is why the focus is on implementing principles and not tools. If the employees understand and embrace the principles, they would develop the values required to realise those principles.

The guiding principles within the dimension “Cultural Enablers” are “Respect every individual” and “Lead with humility”
These principles, as well as the link between principles and the organisations values, are illustrated nicely by example statements authored by The Shingo Prize for Operational Excellence Ltd. (2012):

Respect every individual:

“Because we respect every individual (the principle); therefore, we always place safety first (the value). Because we have respect for every individual (the principle); therefore, we empower people to act independently (the value). Because we have respect for every individual (the principle); therefore, we make all of our communications open and transparent (the value). When people understand the “why,” they are far more capable of consistently interpreting the correct behavioural implications of the value, the “what.” ”

Lead with humility:

“Because I Lead with Humility (the principle); therefore, I am open to good ideas and innovation from anywhere in the organization (the value). Because I Lead with Humility (the principle); therefore, I accept responsibility and enable change (the value). Because I possess humility (the principle); therefore I seek, trust, and follow the direction of those with a responsibility to lead (the value).”

The second dimension is “***Continuous Process Improvement***”. According to Dr Shingo, there are four goals of improvement, and that is to make things “easier, better, faster and cheaper”. Continuous improvement, as stated in the model, refers to the continuous removal of all non-value adding “waste” in the process, again a concept in line with Lean manufacturing.

The principles of this dimension are:

Focus on Process: This refers to focusing effort on identifying the process deficiencies and carrying out proper problem solving measures to improve it, rather than focusing on the person or individual (the “culprit”). All outputs are as a result of processes acting on the inputs, thus process improvements can lead to improved outputs.

Embrace scientific thinking: Scientific thinking should be employed in the problem solving activities when looking at the process improvements. This is similar to the Six Sigma methodologies discussed earlier, in that scientific methods are recommended when approaching problems, such as in DMAIC.

Flow and pull value: This principle has to do with reducing lead times by eliminating waste and improving flow. It also stipulates the use of a demand pull system. The benefits include “better safety and morale, more consistent quality with fewer defects, increases in on-time delivery and flexibility, and lower costs” (The Shingo Prize for Operational Excellence Ltd., 2012)

Assure Quality at the Source: The principle requires identifying and removing quality defects before passing it on in the process. It stipulates stopping to fix errors as soon as possible and respecting the role of humans in analysis and problem solving to prevent defects occurring again.

Seeking Perfection: Improvement must be an iterative process. Once problems are resolved, the process must be reviewed to identify further improvement. This ideal of always looking for problems when there seemingly are none is what provides the energy for true continuous improvement.

Dimension number three is **"*Enterprise Alignment*".** This dimension deals with the need to align management processes and strategy with the principles of the organisation. OE is referred to as the "definition of successful strategy deployment, achieved through processes that are aligned with the principles of the organisation". The Shingo model thus also recognises the link between OE and strategic planning as discussed in section 2.2.3. Two principles make up this dimension:

Create constancy of purpose: Although things are forever and inevitably changing in an organisation, from managers, to processes, to customers, one thing should remain constant- the purpose of the organisation. The purpose is "why the organisation exists". Since the guiding principles of the organisation are constants which are universal and timeless, they are used to achieve constancy of purpose. Strategy and performance metrics are aligned with the guiding principles which should never change.

Think Systemically: Systemic thinking brings together all principles of the model and aids in maintaining constancy of purpose and continuous improvement. It requires the employment of both analytical (convergent) and synthesis (divergent) thinking processes. The former requires one to "take things apart", whereas the later requires one to "see how the parts work together".

The fourth dimension, "***Results***" focuses on one principle:

Create Value for the Customer: The results of the organisation are centred on the flow of value to the customer/stakeholder, with value being something that the customer is willing to pay for. All aspects of the organisation should be focused on this as the goal.

Stakeholders include:
"Customers willing to pay; investors willing to invest; communities willing to support; and employees willing to commit their trust, confidence, and careers" - (The Shingo Prize for Operational Excellence Ltd., 2012)

Examples of factors that influence value are quality, responsiveness to customers and return made to stakeholders in the form of growth and the "triple bottom line" (profit, people and planet).

Looking systemically at the Shingo OE model, a slant toward Lean systems with regard to the principles and processes is noticed. Many similarities can be seen

between The Toyota Way and the Shingo model, which is to be expected given Dr Shingo's experience with those and other Japanese improvement systems.

The *Shingo Prize for OE Organisation* provides a set of evaluation guidelines to be used for applicants wishing to receive one of their awards for excellence in manufacturing. These guidelines were used in the creation of data collections questionnaire discussed in Chapter 3.

- **The Chevron OE Management System (OEMS):**

Chevron is an international integrated energy company which developed and incorporated an OE model through their OEMS. The goal of the management system is to effectively govern the process of attaining and sustaining industry and world leading standards for safety, health, environment, efficiency and reliability (Chichester, 2005).

The vision for Chevron OEMS is along similar lines:

"With respect to operational excellence, our vision is to be recognized and admired by industry and the communities in which we operate as world-class in process safety, personal safety & health, environment, reliability and efficiency."- (Chevron Corporation, 2010)

According to the Chevron OEMS guidelines (Chevron Corporation, 2010), the OEMS is divided into three sections:

Leadership Accountability- The importance on strong leadership in facilitating the success of the OE system is stated by Chevron. The role of the leader includes the creation of the vision and objectives which drive improvement in the organisation. Leadership drives the Management System Process.

Management System Process (MSP) - this process refers to performance based, systematic improvement measures undertaken to move toward the OE vision. The MSP is used to integrate OE objectives, plans and activities into daily operations. The vision and OE objectives are set, gap analysis is undertaken, planning is carried out to meet objectives and close the gaps, plans are executed and finally the performance is reviewed.

OE Expectations- The expectations of the OE system from the corporate level are defined in 13 elements. These are the requirements for the effective management of safety, health, environment, reliability and efficiency. The elements are supported by the creation and adoption of processes and standards. Leadership is accountable for the success of the processes in meeting the expectations.

The immediate difference between the Shingo Model and that of Chevron is the lack of focus on a set of "principles to live by" in the latter. Instead, the Chevron approach is to focus on a set of management rules (13 expectations), which if adhered to would lead to the outcomes the organisation desires (as per the Chevron OE vision

statement). The reason for adopting an emphasis on principles is given by The Shingo Prize for OE, by stating the following in reference to their guiding principles:

“When taken in their totality, these timeless principles become the basis for building a lasting culture of excellence in the execution of one’s mission statement.” - (The Shingo Prize for Operational Excellence Ltd., 2012)

The thirteen elements taken from the Chevron OEMS guidelines are as follows (Chevron Corporation, 2010):

1) “Security of Personnel and Assets: Provide a physical and cyber security environment in which business operations may be successfully conducted.

2) Facilities Design and Construction: Design and construct facilities to prevent injury, illness and incidents and to operate reliably and efficiently and in an environmentally sound manner.

3) Safe Operations: Operate and maintain facilities to prevent injuries, illness and incidents.

4) Management of Change: Manage both permanent and temporary changes to prevent incidents.

5) Reliability and Efficiency: Operate and maintain wells and facilities to ensure asset integrity and prevent incidents. Maximize efficiency of operations and conserve natural resources.

6) Third-Party Services: Systematically improve third-party service performance through conformance to Operational Excellence.

7) Environmental Stewardship: Strive to continually improve environmental performance and reduce impacts from our operations.

8) Product Stewardship: Manage potential health, environmental, safety (HES) and integrity risks of our products throughout a product’s life cycle.

9) Incident Investigation: Investigate and identify root causes of incidents to reduce or eliminate systemic causes and to prevent future incidents.

10) Community and Stakeholder Engagement: Reach out to the community and the workforce to engage in open dialogue to build trust and long-term positive relationships.

11) Emergency Management: Prevention is the first priority, but be prepared to respond immediately and effectively to all emergencies involving Chevron wholly owned or operated assets. For company products or interests such as common carriers, chartered vessels and facilities operated by others, be prepared to monitor the response and, if warranted, take appropriate actions.

12) Compliance Assurance: Verify conformance with OE requirements in applicable company policy and government laws and regulations. Train the workforce regarding their OE-related responsibilities.

13) Legislative and Regulatory Advocacy: Work ethically and constructively to influence proposed laws and regulations, and debate on emerging issues."

The three sections of the OEMS come together to achieve the OE vision in the following manner:

Five focussing groups of processes and standards are created, namely personal safety and health, reliability, process safety, environmental stewardship and efficiency. These five focus areas form the foundation to the model.

The five groups of processes are created based on the 13 expectations. The execution of the five focus areas thus facilitates compliance with expectations.

Through complying with the expectations, the objectives of the OEMS are achieved. This leads to the fulfilment of the OE Vision, around which the objectives themselves were created. This bottom up approach is again illustrated in a "house model", as shown in figure 2.2-9.

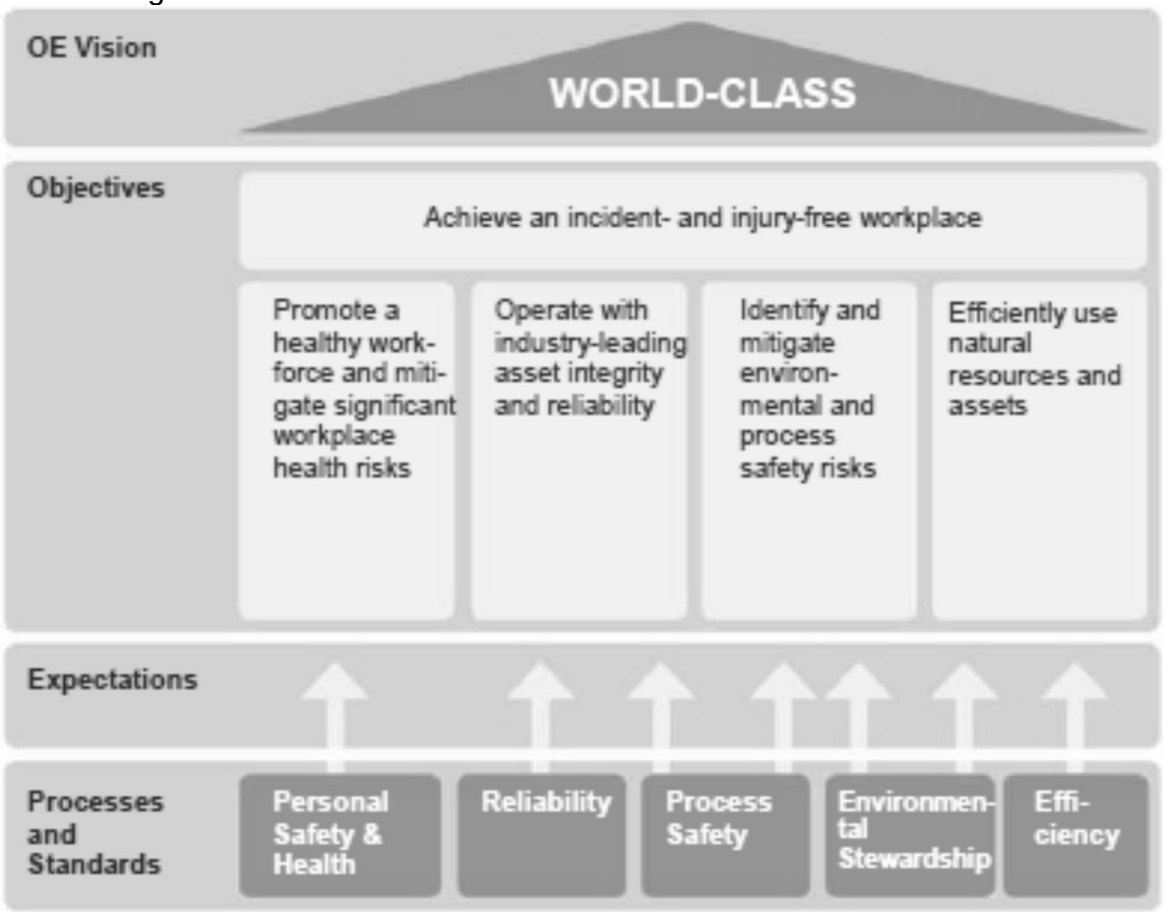

Figure 2.2-8 Navigating the Chevron OEMS, reproduced from Chevron Corporation (2010)

It can be seen that the Chevron OE model is focused on the *desired outcomes* of the process (become world-class in process safety, personal safety & health, environment, reliability and efficiency) with the OEMS designed as a *systematic* system employed to achieve those outcomes. As stated earlier, this is in contrast to the *principles based* approach of the Shingo Model. Chevron *prescribes* leadership accountability, whereas a principles based approach would incorporate such accountability inherently in the culture.

- **DuPont Operational Excellence Model:**

DuPont is an American based chemicals company with thirteen business units in diverse markets such as electronics, polymers, paint and agricultural chemicals (Ramabhadran, 2011). The company operates over 175 operating facilities globally and has a reputation for good industrial safety. The vision statement for the company is:

"To be the world's most dynamic science company, creating sustainable solutions essential to a better, safer, healthier life for people everywhere." - (Ramabhadran, 2011)

DuPont (DuPont, 2008) makes reference to findings of the Board of Manufacturing and Engineering Design of the US, stating the need to integrate manufacturing improvement systems with *disciplined practices*. This form of discipline is known as Operational Discipline by DuPont, defined as "the deeply rooted dedication and commitment by every member of an organization to carry out each task the right way every time." (Rains, 2010).

The OE model developed by DuPont provides evidence of the success that can be achieved by incorporating operational discipline with improvement methods. The company reports a 10% to 15% lower cost of production than the industry average, which it attributes to the application of OE (DuPont, 2008). The company also provides management consultation services to other organisations so that they may also achieve sustainable productivity improvements.

The implementation of the DuPont model provides an organisation the following benefits: Strategic alignment (the importance of which was discussed in 2.2.3), development of an improvement driven culture, design of processes for competitive edge, the breakdown of the transformation journey and alignment with objectives and execution (DuPont, 2005).

The model itself is divided into three "foundation blocks" or management systems: Asset Productivity, Capital Effectiveness and Operations Risk Management. The model is illustrated graphically in figure 2.2-10. Details of foundation blocks follow with reference made to DuPont (2005).

Figure 2.2-9 DuPont OE integrated Management Systems, courtesy of DuPont (2005)

Asset Productivity: This aspect of the model focusses on the direct improvement of operating performance of the current asset base, a dimension that manufacturing improvement tools such as TOC focus on solely. The cost efficiencies of the organisation are increased through the implementation of DuPont's best practices, manufacturing processes and results based KPIs.

DuPont implements Asset Productivity management systems at the organisations utilising its OE model through an Asset Productivity delivery model which is aligned with the implementation of projects in Six Sigma. The five steps are shown below courtesy of (DuPont, 2005):

1. "Business Level Analysis – understand "what" is happening (GAP analysis).
2. Assessment – discover "why" things are the way they are (begin the change process).
3. Consensus/Implementation Planning – develop "how" to make a change/impact (chartering for action).
4. Implementation – put the plan into action (realisation).
5. Sustaining/Control Plan – keep the gains (build on success)."

The *Operational Discipline* required to achieve and sustain the improved asset productivity is carried out by implementing six elements:

1. Maintenance and Reliability Systems- This is a multi-disciplinary implementation of change processes and work management systems with the aim of lowering maintenance costs, improving system reliability and equipment performance. This is carried out by identifying root causes of instability and poor performance and putting measures in place to address these causes. This element incorporates tools such preventative maintenance strategies, Reliability Centred Maintenance and uptime monitoring software.

2. Manufacturing Capacity- The production rates of the equipment is increased through implementation of improvement methodologies such as Lean (work flow management, one piece flow) and de-bottlenecking (TOC).

3. Energy Optimisation- This element focuses on energy efficiency, cost reduction, safety and reliability of the asset base. Sustainable improvement measures are based on best practices, audits and knowledge sharing.

4. Facilities Infrastructure- The integrity of the existing infrastructure (trenches, sumps, roads, life safety equipment, structural integrity) is re-evaluated such that it can cope with the demands placed on it when production volumes are pushed and maintenance of equipment is not carried out in an effort to reduce costs. The DuPont Infrastructure Maintenance Audit (IMA) Process facilitates this activity. It utilises a systematic method of optimising these maintenance costs.

5. Mechanical Integrity- This element fits into both Process Safety Management (PSM) and Risk Management initiatives. It is a program that focuses on reliability of equipment through the creation of a framework ranking mechanical integrity activities. This ensures regulatory compliance and a reduction of fugitive emissions and failures. The element is delivered through materials of construction selection, specification, and fabrication, non-destructive testing and condition assessment and maintenance strategies.

6. Product Quality and Process Control- In this element, DuPont creates competitive advantage for the client through improved quality and yields. This is carried out through Six Sigma quality improvement methods as well as DuPont proprietary products such as “Performance Surveyor™” and “Advanced Statistical Process Estimation and Control Tool (ASPECT)”

Capital Effectiveness: The DuPont model differs from the Chevron model in that it incorporates programs for the effective spending of capital (in addition to operations and Safety, Health and Environment (SHE) improvements). They offer consultancy detailing the critical steps in carrying out engineering projects. This is based on over a century’s worth of experience in carrying out global projects.

DuPont's *Facilities Engineering Process* is as follows, from DuPont (2005):

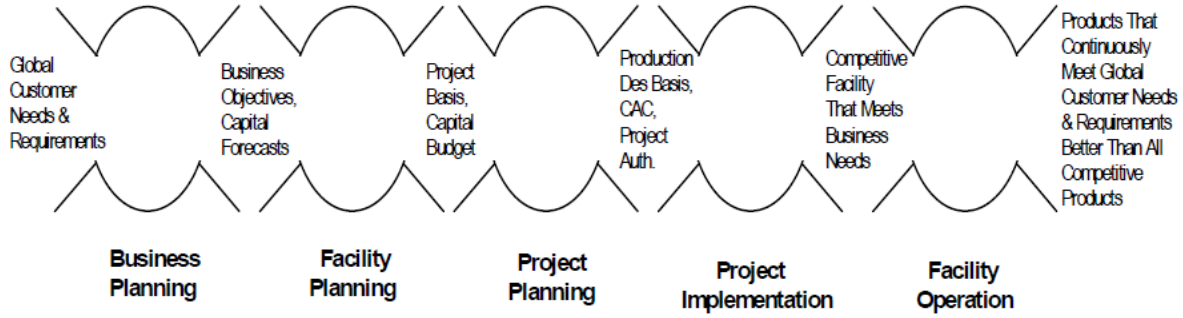

Figure 2.2-10 DuPont Facilities Engineering Process, courtesy of DuPont (2005)

1. "Business Planning – Ensures that the business objectives are recorded, understood, and accepted by all who contribute to the project.
2. Facility Planning – Transforms business objectives into project objectives and a project capital budget.
3. Project Planning –Transforms project objectives into a production design basis and authorization estimate.
4. Project Implementation – Launches production design, procurement, and construction.
5. Start-up and Initial Operations – Begins plant commissioning, operations, and maintenance.
6. Value-Improving Practices (VIPs) – Uses applicable VIPs to improve cost, schedule, and operability.
7. Contractor Effectiveness – Identifies and completes contracted work for best value.
8. Shutdown/Turnaround Practices – Creates more effective shutdowns with longer intervals between shutdowns, while increasing Uptime."

The *Facilities Engineering Process* is comparable to the Life Cycle Stage models in Systems Engineering theory. INCOSE (2006) compares various life cycle models. The US Department of Energy model illustrated by INCOSE (2006) is shown as an example in figure 2.2-12:

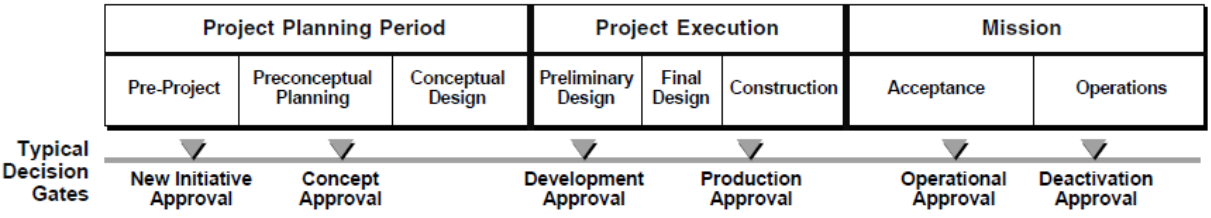

Figure 2.2-11 System Engineering life cycle stages, reproduced from INCOSE (2006)

It can be stated that the DuPont Capital Effectiveness program uses a Systems Engineering approach to project execution.

Operations Risk Management: The third foundational block in the OE model focuses on controlling and managing risks. DuPont is considered an industry leader in this regard, with a cost of managing risk that is seven times lower than the industry average, according to a third party benchmarking survey (DuPont, 2005). Their integrated risk management system incorporates PSM and behavioural safety aspects under seven elements (DuPont, 2005):

1. Technology and Facility Safety Systems- SHE management systems are deployed to plant, offices, laboratories and other facilities. Services within this element include Process Hazard Analysis (PHA), emergency response planning, facility siting studies, inherently safe design and standards and procedures.

2. Electrical- The existing process is evaluated and management systems are employed to reduce the risk of electrical injuries. The improvement initiatives include electrical safety training and guidelines, incident Investigations, short circuit studies and arc-flash hazards

3. Fire and Explosion- This management system provides the framework, processes, procedures, tools, and skills needed to successfully manage the risks from fires and explosions. The system covers fire and explosion incidents, fire safety training, fire and explosion modelling and emergency preparedness.

4. Environmental- The SHE management system is used to provide tools in identifying and resolving environmental risks. This addresses the air, water and solid waste issues of the plant. The services covered in this element are environmental permitting, water treatment, ground contamination remediation, air dispersion modelling and solid waste management.

5. Product Stewardship- this element deals with systems ensuring product risk management

6. Distribution- The management of the distribution of hazardous materials and the risks associated there-off are covered. The system includes processes which lead to understanding and meeting of regulatory requirements, a properly trained workforce, and the carrying out of audits of the existing facilities.

7. Occupational Health (OH) and Industrial Hygiene- The focus here is on the development and implementation of systems which serve to protect employees from the effects of chemicals and other job specific hazards. The systems include Metrics of OH Management, OH Audit Protocols and Wellness Programs.

To summarise, the DuPont OE model covers a much broader scope than the Chevron and Shingo models. It incorporates the OE tools such as Lean and Six Sigma to improve the operations performance (Asset productivity), as do the other

models. In addition, it incorporates the capital and risk management aspects present in the organisation as a whole. It is thus more of an integrated operations management system (DuPont describe it as such as well in figure 2.2-10).

The model leverages off the experientially developed proprietary systems and best practices of DuPont, making the model difficult to implement elsewhere without enlisting their consultancy services. In contrast, the Shingo Model recommends changes to the operating *philosophy* that the organisation should adopt. It is thus applied at a higher level than *management systems* used for daily plant operations.

The management systems are developed from the philosophy, which can be adopted universally, and are not prescribed. DuPont does however emphasise Operational Discipline, which is itself a philosophical concept that is employed within the management system. The Chevron system is similar to DuPont's, as it also incorporates systematic methods and a prescriptive approach to facilitating operations improvements.

2.2.5 OE Implementation Challenges and Success factors

The implementation of an Operational Excellence program can be affected by certain challenges or barriers. C.I. Ozumba (Ozumba, 2010) reported the following implementation obstacles:

Realising cultural change: As discussed with OE models such as The Toyota Way and The Shingo Model, OE is more than a set of management tools. A culture of excellence needs to be developed. A common aspect seen in the OE models and tools is the development of a continuous improvement culture. Such a paradigm shift is resisted by employees, who need to understand the value they can take from adopting such a change.

Deploying the right talent: It is important to ensure that the persons leading the OE implementation process are adequately skilled and knowledgeable to reduce the risk of the program failing. The identification or development of such skilled resources is a challenge in certain situations. Six Sigma programs utilise accredited and graded experts such as "green belts" and "black belts" to lead the projects.

Operational silos: "Silo mentality" prevents holistic thinking and does not allow cooperation and knowledge sharing throughout the operations function (and organisation as a whole). This prevents visibility of the strategy as well as performance. It also hinders the organisations response to change. This prevents OE goals from being achieved.

Inefficiencies in execution: This challenge arises when the organisation cannot effectively move from strategic vision to the realisation of executable actions, preventing OE. The organisation thus lacks an *Execution Culture* (Boltax, 2008). Boltax (2008) states that an Execution Culture is one in which people, strategy and operations plan come together to accomplish goals on time.

Reactive operational culture: This OE barrier arises when the operations function constantly focusses and reacts to the daily operating issues which arise and lose sight of the "bigger picture" or the long term strategic vision. This makes improvement difficult as the organisation is stuck in a reactive rather than proactive state. This type of culture can be a result of a lack of resources or skills.

The OE challenges identified by Ozumba (2010) have a common link in that all but one (deploying the right talent) has to do with either the existing behaviours/culture of the organisation or modifying the existing behaviour to that required for OE.

- **Lean Implementation Challenges and Success Factors:**

The organisation improvement/OE tools discussed in section 2.2.2 have been implemented widely and literature is available on their individual implementation challenges. As stated previously, these challenges are relevant to OE programs, as many OE models incorporate these tools.

Scherrer-Rathje *et al. (2009)* investigated the failed implementation of Lean manufacturing methods at the leading manufacturer of food processing machinery and equipment in Europe. The company, after failing initially and stopping the Lean program, embarked on a second (successful) Lean implementation attempt ten years later. The study analysed both implementation attempts, and summarised the lessons learned:

Lesson 1- Lean will not succeed without visible management commitment:

The lack of management support has been stated as the biggest cause of the failure of the company's first attempt at Lean implementation. The senior management team decided to allocate a Lean team to carry out the implementation on their behalf. The Lean team members were not seconded from their daily duties and had to carry out the Lean work as an aside. This soon reduced the energy and enthusiasm of the team.

In addition, management did not give the Lean team the required decision making powers, leading to delays in implementation. The team leader had to prepare and present the recommendations and needs to management, who often showed dis-interest and sometimes rejected recommendations that were critical to project success.

The management team's lack of support was further demonstrated by the sanctioning of independent improvement projects in parallel with Lean, leading to competition between the groups as well as employee confusion. This was further exacerbated by the accompanying lack of communication from management level regarding Lean goals and successes. The benefit of management commitment is supported through work carried out by (Crute *et al.*, 2003) who reported that organisations with a high degrees of support from management showed improvements from Lean twelve months sooner than those who did not.

Lesson 2- Develop formal mechanisms to encourage and enable autonomy:

As discussed above, the operations team needs to have some degree of autonomy to function successfully, the lack of which can lead to frustrations and long lead times on decisions. In the second Lean attempt outlined in the case study, automation was granted to the team, along with processes which enabled decision making quickly when needed. This gave the employees a sense of ownership and control over the Lean project, thus ensuring buy-in and commitment from those on the operations level.

Lesson 3- Openly disclose mid- to long-term Lean goals:

The need to communicate the projects objectives and goals to those on the operations level is the third lesson taken from the case study. The lack of such communication has been reported to cause anxiety and resistance amongst the workforce, who can begin to fear job losses etc. and become disillusioned with the process. Having short implementation goals only can lead to longer term goals being missed, due to the risk of these shorter goals diverging from the initial goals set-out (lack of realignment with the overall aim).

Lesson 4- Ensure mechanisms are in place for the long-term sustainability of Lean:

Processes have to be put in place to prevent the workforce from reverting back to the "old way" of carrying out operations. In the successful second attempt at Lean the organisation put the following measures in place:

- Permanently altering the plant processes to one supporting Lean
- Involving the personnel in the design and implementation of said changes so that there is a sense of involvement and ownership.
- Creating self-managed interdisciplinary teams
- Assigning certain employees the task of actively promoting Lean
- Encouraging employees to try new ideas without the risk of being reprimanded.

Lesson 5- Communicate Lean wins from the start:

Communication of the successes and the realisation of Lean goals must be carried out to all levels of the organisation, as this reinforces the merits of the program. This encourages acceptance and sustainability of the change initiative. In the successful implementation attempt discussed in the case study, a pilot project was selected which was predicted to give quick wins. The success achieved on the pilot project was then used as a motivator for accepting the Lean methods throughout the organisation.

Lesson 6- Continual evaluation during the Lean effort is critical:

Constant reflection and analysis is required to ensure that the Lean program is heading in the desired direction. Any mistakes in the implementation approach can be identified early on with proper evaluation, and corrective actions can be taken. Information from employees and process data are inputs into this process. Liker

(2004) supports this view, stating that lean requires becoming a learning organisation via continuous reflection and continuous improvement.

The role of leadership in the implementation of improvement initiatives such as Lean is a common theme which is exhibited when examining the lessons learnt as reported by Scherrer-Rathje *et al. (*2009). Leadership is the driver of the guidelines outlined in the lessons learnt.

- **Six Sigma Implementation Challenges and Success Factors:**

A study into the implementation factors affecting Six Sigma programs was carried out by Kwak & Anbar (2006), who cited Antony & Banuelas (2002) and Banuelas Coronado & Antony (2002) in the presentation of the following list:

- Management commitment and involvement.
- Understanding of Six Sigma methodology, tools, and techniques.
- Linking Six Sigma to business strategy.
- Linking Six Sigma to customers.
- Project selection, reviews and tracking.
- Organisational infrastructure.
- Cultural change.
- Project management skills.
- Linking Six Sigma to suppliers.
- Training.

Kwak & Anbar (2006) examined these factors, as well as those by other authors and experts, and reported four key elements of successful Six Sigma implementation:

Element 1: Management involvement and organisational commitment

This element is in line with the lessons learnt for Lean implementation. The authors make reference to the implementation carried out at General Electric, one of the pioneers of Six Sigma. Their CEO at the time was able to restructure the organisation and its culture to one supporting Six Sigma. Management needs to provide the resources, training, time, money and effort that Six Sigma projects require.

Element 2: Project selection, management, and control skills

The projects chosen for the Six Sigma process needs to be carefully selected such that the maximum benefits can be seen by the organisation. Since Six Sigma focusses on meeting customer requirements more often, the projects must have a customer focus as well. Continuous review and reflection needs to be carried out to ensure adherence to customer requirements, as well as the performance of the Six Sigma tools and methods. Documentation of the project constraints such as cost, schedule and scope must be maintained. Lessons learnt need to be documented and employed so that improvements can be carried forward to future projects.

Element 3: Encouraging and accepting cultural change

The importance of communication reported by Scherrer-Rathje *et al.(2009)* is reinforced by Kwak & Anbar (2006) , stating the need to instil understanding of the Six Sigma methods and what it has to offer throughout the levels of the organisation. Motivation of personnel and the removal of resistance to cultural change need to be facilitated. This is carried out through clear communication channels motivating and educating members internal to the organisation as well as customers. Another shared recommendation between the Lean lessons and the Six Sigma elements is the communication of project success. The challenges and obstacles are communicated so that these issues are not repeated and best practices can be developed.

Element 4: Continuous education and training

Training forms part of the communication techniques needed for Six Sigma implementation. The knowledge and skills needed to utilise the complex tools and processes of the program effectively has to be developed. Lack of correct training was also reported to be an OE implementation barrier by Ozumba (2010). Six Sigma utilises the belt system (Master, black, green and yellow) for the grading of team members at differing competency levels. The enlisting of these proven experts ensures smooth functioning of the project team. Well trained and knowledgeable black belts can ensure project success. Continuous learning and the adoption of new techniques outside the scope of Six Sigma is beneficial if such techniques are found to be complementary.

It is can be seen that the implementation challenges and critical success factors reported have common elements, regardless of the type of organisational improvement initiative. With regard to critical success factors of OE programs, Ozumba (2010) reported the following list, which supports those reported for Lean and Six Sigma:

- Leadership support – This is required for the same reasons as per Lean and Six Sigma programs.

- OE must be ingrained in company strategy- the system must become part of the organisations culture and make-up.

- Technical proficiency and strategic understanding- The required technical know-how and expertise is required to effectively utilise the tools of the program for decision making and performance monitoring.

- Project planning and execution – Planning and implementation skills are required for the successful execution of OE. Such skills include the ability to manage resources, facilitate change management, effective communication and fostering team work and collaboration.

2.2.6 Organisational Culture

In the preceding sections of the study, authors such as Ozumba (2010) stated the need to implement a change in the organisations culture, from its current position, to one which is in line with the Operational Excellence program. A further example is the Shingo Model for OE, which has Cultural Enablers as the base of the model (refer to section 2.2.4).

Cameron (2004), reported that highly successful companies in the US achieved success not by external, market related factors (such as barriers to entry and market share), but through an organisational culture which gave them a competitive advantage

Edgar H Schein stated that many organisational change initiatives that have been unsuccessful can attribute that failure to neglecting the cultural forces present in the organisation (Schein, 1990). Organisational culture is defined by him as follows:

Culture can be “defined as a pattern of basic *assumptions*, invented, discovered, or developed by a given group, as it learns to cope with its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore is to be taught to new members as the correct way to perceive, think, and feel in relation to those problems.” - (Schein, 1990)

Culture is exhibited in three levels according to Schein (1990). “Artefacts” are at the highest level, and refers to the impressions that one perceives when entering an organisation for the first time. It includes the dress code, degree of formality and emotional intensity.

At the (deeper) second level is the established “values” of the culture and includes the ideologies, philosophies and norms. The investigation of the reasons why certain observed phenomena occurs at the artefact level through (for e.g.) open ended questioning of personnel, brings to light these values.

The “assumptions” referred to in the definition are at the underlying third level of culture. These assumptions are usually taken for granted and made unconsciously. They are studied if the researcher is able to delve deeper than the adopted values of the culture. The assumptions determine the perceptions, thought processes, feelings and behaviour of the individual (Schein, 1990).

Schein (1990) presents a case study to demonstrate the levels of culture. The study also serves to demonstrate the need to look deep enough to identify the *assumptions*. A manufacturing organisation is examined and at face value the organisation seems to be frantic, informal and in situations of constant conflict (“artefact” level).

Investigating these behaviours further (“values” level) it emerges that since the company operates in a high-technology field, hard work, innovation and rapid solutions are required from the teams. Resources are recruited if they meet these strict screening requirements. Employees are also not punished for failures but moved to other projects instead.

Probing further to the level of “assumptions” the following set or pattern of assumptions emerges:

(a) Individuals are assumed to be the source of all innovation and productivity.
(b) It is assumed that truth can only be determined by committed individuals debating ideas until one is chosen and it is further assumed that ideas will not be implemented without consensus.
(c) It is assumed that every individual must think for him/herself and carry out the correct actions, even if against policy or management orders
(d) The important final assumption of the culture is that the members are part of the same “family” who ultimately care for and protect each other, even in the event of failure. This is what allows for teams to function in seemingly hostile environments.

The examples of the culture’s basic assumptions given in the above case study are similar to the *guiding principles* approach of the Shingo OE model, the difference being that the assumptions of a culture govern thoughts and actions involuntarily and are underlying, whilst the principles are stated openly as part of a formalised model. In formalising principles, the Shingo Model states the *desired cultural assumptions that the organisation wants to adopt.*

- **Developing Culture:**

Culture is created through learning according to Schein (1990), although the exact mechanisms for initial norms, beliefs and assumptions arising were not known fully (according to the author). One of the identified methods is referred to as “*Norm Formation around Critical Incidents*”. In this mechanism, norms are created by the observed manner in which the group reacts to critical incidents.

An example by Schein (1990) illustrates this aptly. Consider a group in which a team member shows disrespect and insubordination to the leader. Tensions and emotions are high. The reaction of the leader to this critical incident has a hand in developing a norm. If the leader retaliates without disapproval from the rest of the group and receives an apology from the insubordinate team member whilst still in the presence of others, the culture may begin to develop or change. This developing culture has a norm or belief that “one should never disrespect authority”. If the same behaviour is reinforced every time a similar incident occurs, it will eventually become an *assumption*.

The second mechanism reported by Schein (1990) is referred to as “Identification with Leaders”. In this method, the leadership of the organisation serves as a model to the subordinate groups who then adopt and accept the leader’s values and assumptions as their own.

When an organisation is first formed, the founding leaders provide the example of the assumptions, beliefs and values. The group then identifies which aspects of the leader’s belief system works best through their own experiences. This gradually leads to a belief system that is shared by the group as a whole. It then becomes difficult for the leader’s to change the belief system of the group any further, as the groups rely on their own learning. According to Schein (1990), leaders may attempt

to embed cultural changes in the organisational groups via two groups of mechanisms:

- Primary embedding mechanisms;

(a) Leadership focus areas (i.e. what leaders focus on, measure and control more than other areas)
(b) Leadership reaction to critical incidents and organisational crisis. This can be seen as a special form of "*Norm Formation around Critical Incidents*", focussing only on leadership reactions.
(c) Deliberate role modelling, mentoring and coaching.
(d) Operational criteria for the allocation of rewards and status e.g. bonuses based on safety statistics, if safety is the desired cultural belief.
(e) Operational criteria for recruitment, selection, promotion, retirement, and expulsion of employees.

- Secondary articulation and reinforcement mechanisms;

(a) The organisational structure.
(b) Organisational systems and procedures.
(c) The physical design of buildings and infrastructure
(d) The conveying of stories, legends, myths and symbols.
(e) Formal statements of organisational philosophy, creeds, and charters.

Cultural Evolution also occurs since organisations are "open systems" in that the environment in which people work is constantly changing, along with the people themselves who bring in new cultural elements. The guiding of the process of cultural evolution is of interest to the leadership of the organisation, as desirable elements can be reinforced while undesirable/dysfunctional cultural elements are driven out. Schein (1990) reports seven methods that leaders of the organisation may employ to facilitate the desired cultural changes. The methods may be employed in combination and are as follows:

1. The need for change is reinforced by the organisation's leaders, often stating the undesirable consequences of ignoring change. The leaders simultaneously provide motivation and encouragement such that the employees accept that change is possible and buy into the process.

2. Leaders may express outright the new beliefs, values and assumptions that the organisation should adopt, thus providing a new cultural model to adhere to. This may not have a significant impact on older organisations that tend to utilise their own group learning to create cultural behaviours.

3. The employees in key positions can be changed and replaced with individuals who adopt the desired cultural assumptions. These employees may exhibit the desired attributes within the organisation, or employed externally.

4. Positive reinforcement and recognition can be utilised to encourage adoption of the new belief system, whilst reprimanding those who adhere to the current status quo.

5. Organisation members may be forced into adopting new behaviours that are more consistent with new assumptions.

6. The “untouchable” widely accepted myths and beliefs that maintain the dysfunctional culture can be visibly debunked and discredited, along with the removal of related artefacts.

7. Leaders may create new symbols and artefacts around the new assumptions to be embraced, using the embedding mechanisms described earlier.

In severe cases, cultural change is carried out by removing the groups that are the primary culture carriers from the organisation entirely. These groups are then replaced with new members who are willing to learn and adopt the new assumptions. This process requires the removal of large numbers of people who have been with the organisation for time spans which prevent them from changing their ways. It is usually considered for organisations facing bankruptcy or under “turnaround processes”.

Cameron (2004) proposes a different *seven step process* for implementing cultural change, based on the work of at least five other authors on the subject. It is reported by Cameron (2004) that the steps of the process serve to “initiate change to individual and organisational processes, conversations, language, symbols, and values, none of which by itself ensures that culture change will occur, but in combination they create a great deal of momentum toward fundamental culture change in organisations”.

When comparing to the *levels of culture* reported by Schein (1990) the changes initiated would be in the *Artefact* and *Value* level of culture, supporting the point made regarding the uncertainty that cultural change will occur, since this would require change at the level of *Assumptions.* Nonetheless, Cameron (2004) states that the process will instil movement toward the desired culture. The seven steps are as follow (Cameron, 2004):

1. Clarifying meaning: The initial step is to define outcomes or objectives of the process, as well as the meaning of cultural change. Changing from one culture type to another does not mean that all other culture types should be removed or overlooked. The emphasis should rather shift to the characteristics of the culture that’s desired. It should be known that the correct and necessary cultural elements already in play need not change.

2. Identifying stories: Cameron (2004) states that culture is best communicated through stories, and the second step of the process focusses on this. Stories and examples of the positive benefits that the organisation will realise if the new cultural elements are adopted needs to be made known throughout the organisation. The stories should be real and relatable so that the individuals are given a sense of what it would be like with the future culture in place. The stories can take the form of examples of best practices, peak performance, and aspirational levels of achievement. In relating to the examples team members feel motivated about the

change, are clear about what is to be accomplished by the change and they can identify with the core values being illustrated.

3. Determining strategic initiatives: These initiatives are the actions that need to be implemented to facilitate culture change. The initiatives dictate which activities need to stop and which need to start. Identifying what is to be started is a way to help the organisation think of strategic initiatives that have not been previously pursued. This serves as a focusing step ensuring that resources are not wasted on activities that do not add value to the organisation. Examples of such strategic initiatives include rolling out a leadership and employee development program, employee rewards that encourage ownership, allocating funds to R&D and the creation of innovation drives.

4. Identifying small wins: This step in the cultural change process supports the success factors reported for the implementation of Lean. The objective is to identify an element that is relatively simple to change, implement the change and publically communicate the success throughout the organisation. The process can then be iterated. Publicising the wins is important in this process, and often omitted or carried out incorrectly (Cameron, 2004). By achieving and communicating small wins, resistance to change is decreased and momentum is developed.

5. Create metrics, measures and milestones: Measuring the progress of the change is necessary and this step deals with creation and deployment of such measures and key indicators. This is especially important with regard to cultural change as the concept of culture itself is difficult to quantify, and is therefore not measured at all in some change programs. The process should only select a few meaningful measures, each having actions and responsible persons assigned to address deviations. These metrics can be in the form of deadlines for implementation of change elements, or analysis of data collected through monthly interviews. This ensures that accountability for the process becomes that of the larger organisation.

6. Communication and symbols: To further reduce resistance and ensure commitment to the change process, effective communication needs to be carried out. The need for change, as well as the benefits that can be obtained from the cultural shift has to be communicated. This step is common to the seven step process prescribed by Schein (1990).

Cameron (2004) states that people explain “why” a certain course of action is to be carried out to people they care about or hold in high esteem, whereas “what” needs to be done is communicated to those less cared for or held in low esteem. Explaining the “why” behind the process thus assists in reducing resistance, as a sense of caring and respect is generated.

The “old” cultural aspects should not be overly criticised in these communications, as the target audience are the people who actually lived in that culture and may take it personally, or see it as an attack on their efforts to date. Positive spins and emphasis on the good aspects of the “old” culture should be used as far as possible.

Communication also prevents employees from creating and spreading of potentially damaging rumours, due to their own uncertainties and insecurities.

Symbols are the visible reinforcements of the changing culture. It could take the form of new logos or slogans, team charters etc. these symbols allow visualisation of the changing culture as well as a rallying point for team members.

7. Leadership development: The role of leadership in the success of change initiatives has been seen throughout this study and further incorporated in this cultural change process. The emphasis made by Cameron (2004) is on using leaders to drive the implementation process by assigning accountability for various change processes (such as the communication and strategic initiatives) to them.

To sustain cultural change, future leaders need to be identified and developed. When selecting leadership candidates, strict screening should be carried to ensure a "cultural fit" and that the strengths of the individual are relevant in the current and future cultures. Leaders can be developed through developmental assignments, mentoring and identification of leadership candidates.

- **Measuring Organisational Culture:**

One method for the analysis of organisational culture is the use of a Competing Values Framework (CVF) (Cameron, 2004). The framework is used to profile the dominant cultural elements of the organisation. This analysis is used to identify where the organisational culture is at the present time, so that measures can be put in place to move toward the desired cultural elements.

The framework utilises two dimensions to divide the cultural elements. The first dimension differentiates between a focus on flexibility and dynamism on one side, and focus on stability and control on the other.

The second dimension differentiates between a focus on an internal orientation; integration; and unity, from a focus on an external orientation; differentiation; and rivalry.

Organisations may find success by adopting cultural aspects associated with these two dimensions on a case-by-case basis. Some may find that being dynamic and adaptable is beneficial as opposed to being stable and predictable.

The two dimensions are represented as four quadrants with competing values on opposite sides. Figure 2.2-12 illustrates an example of the Competing Values Framework, reproduced from Helfrich *et al.* (2007):

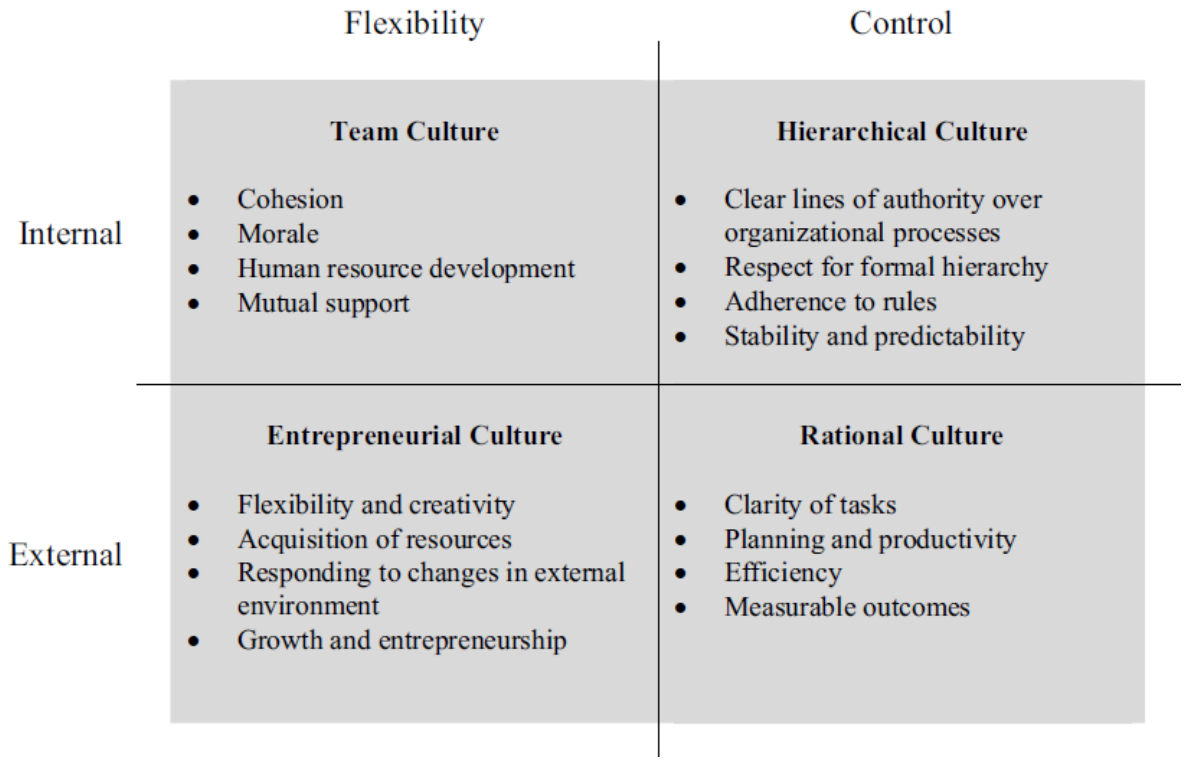

Figure 2.2-12 Competing Values Framework, reproduced from Helfrich *et al.* (2007)

The four quadrants represent four culture types. Authors label these groupings differently, with essentially the same characteristics attached to each. The cultural types shown in figure 2.2-13 (reported by Helfrich *et al.*, 2007) are listed with the group titles and characteristics reported by (Cameron, 2004) shown in parenthesis and described alongside:

- Team Culture (Clan Culture):

This culture type is characterised by a friendly, “family like” work environment. Leaders are mentors, coaches and parent figures. Levels of commitment, loyalty and morale are high. Teamwork, consensus and participation are encouraged.

- Hierarchical Culture (Hierarchy Culture):

The workplace is formal and structured. Workflow is governed by procedures and processes. Emphasis is on coordination, organisation and efficiency. Long term goals are stability and predictability. Rules hold the organisation together.

- Rational Culture (Market Culture):

The culture is one that is results driven. The leadership develops a challenging working environment which strives to meet ambitious goals and targets. Success factors include increased market share, market penetration and increased share prices.

- Entrepreneurial Culture (Adhocracy Culture):

  The workplace exhibiting this culture is creative, innovative and risk oriented. The organisation's long term emphasis is on rapid growth and acquiring new resources. Success means producing unique and original products and services.

The current organisational culture can be accurately represented using the CVF (Cameron, 2004). The profiling of the values, beliefs and assumptions of the organisation are facilitated through data collection methods such as the Organisational Culture Assessment Instrument (OCAI) as per the example created by Cameron (2004) and found in Appendix A. The future or desired cultural profile is also created using the OCAI, as per the description given in Appendix A.

- **Leadership Role in OE:**

Strong and sincere leadership commitment and involvement have appeared as a critical successful factor in the literature, not only for the implementation of the improvement initiative's tools and systems, but also for the development of the necessary organisational culture for OE.

The top management of the organisation have to accept and understand the new philosophy and culture before attempting an improvement initiative (Liker, 2004).

Three questions which top managers should ask before embarking on a Lean transformation journey are (according to Liker, 2004):

1. "Are top executives who run the company committed to a long-term vision of adding value to customers and society in general?

2. Are top executives who run the company committed to developing and involving employees and partners?

3. Will there be continuity in top leadership's philosophy?"

If the leader answers "no" to any of these questions, the recommendation is to implement a few improvement tools such as Lean and TOC, achieve some short-term monetary gains and move to a different profession, as these gains would not be long-lived and sustainable (Liker, 2004).

The leadership traits that Liker observed through his study of the "Toyota Way" are illustrated in figure 2.2-13:

Figure 2.2-13: Toyota leadership traits, courtesy of Liker (2004)

Liker (2004), reports that Toyota's leadership style, which encompasses all four of the styles shown in figure 2.2-13, is one of their success factors in terms of organisational performance. The use of the four styles is dependent on the situation at hand, with the primary style being one which creates a *learning organisation*.

He went on to summarise some of the common leadership traits of Toyota's leaders:

- A focus on the long term purpose of the organisation
- Visually live by the philosophy of the company and never allow deviation.
- Worked their way up from lower ranks whilst continuing to go to the shop floor to observe the value adding work.
- Focus on the positive aspects of problem solving by considering every new issue as a process to learn and increase knowledge.

2.2.7 Continuous Improvement

Continuous Improvement (CI) is a central concept that is present in production and quality improvement methods (Choi, 1995) such as Deming's Plan-Do-Check-Act (PDCA), Six Sigma, Lean and TPS.

The OE definitions, models and tools reported in this study incorporate CI or similar iterative concepts as well. The CI process is one in which small incremental changes or improvements are carried out ceaselessly, such that there is an eventual cumulative (beneficial) effect (Choi, 1995).

Choi (1995) stated that CI requires a transformation of the organisation to one which exhibits the following characteristics:

- A Process oriented work culture: One which focuses on improving the work processes which lead to the final product instead of the final product itself (traits of results oriented culture)

- Workers' creativity is valued: The intellectual ability of the workers is of high value, since the ideas for change are likely to be put forward by experienced workers, familiar with the processes and operations.

- Discipline-driven changes are carried out: Incremental changes are carried out through a plan-do-check-act cycle. The data and knowledge derived in the "check" phase is used for improving the next improvement iteration. Choi (1995) reports the importance of the data analysis and subsequent actions to the success of CI programs. Disciplined workers thus drive the process by utilising past information to guide future actions.

- Incremental continuous changes are carried out: Employees search for smaller step changes, rather than large scale projects. The changes occur very slowly, but constantly, accumulating into organisational gains. The small changes also mean low risk and costs associated with the change. Large scale capital investment is avoided.

Liker (2004) describes the need for standardisation and stabilisation of work processes to provide a foundation for CI. Improvements carried out before stabilisation leads to further variation. Furthermore, best practices developed from CI changes are standardised throughout the organisation (once the benefits have been verified). In this way the standards themselves are also optimised over time.

CI in Japanese manufacturing is referred to as *kaizen* meaning "change for the better" (Liker, 2004). In contrast to that reported by Choi (1995), kaizen can refer to large scale and incremental changes. According to Liker, the larger changes are focused on more by the western companies, and are the focus when teaching kaizen in the west.

Another Japanese cultural concept which is supportive of CI is known as *hansei* or continuous reflection (Liker, 2004). Reflection is carried out after key project milestones to identify and correct shortcomings of the project. The process is one of constructive criticism, which is sometimes misinterpreted as negativity in the west. Hansei is synonymous with the "check" step in PDCA, a key behaviour of the "discipline driven change" culture described by Choi (1995)

CI thus requires a cultural change, since it requires specific behaviours and assumptions (such as hansei) from the workforce for it to be carried out successfully. The processes for culture and organisational change described in section 2.2.6 can be utilised for this purpose.

2.3 Case Study Literature

2.3.1 The Organisation

Sasol Polymers is a company forming part of the Sasol Chemical Industries division. Its primary focus is the production and sale of polymers, derived from feedstock hydrocarbons from its Coal-To-Liquid technology. Its South African operations facilities are in Mpumalanga and the Free State.

Chlor-Vinyls is a business unit within Sasol Polymers, and has been chosen as the subject of the case study. It has four major production facilities, each using different technology licensors. Plant sections had been run as independent facilities historically with restructuring into the current form taking place around 2008, the same year that it began the implementation of an OE program. The study will be limited to the Vinyls and Chlor-Alkali value-chain within the business.

2.3.2 The Organisational Structure

The summarised organisational structure and lines of reporting on the operations side is shown in Figure 2.3-1. The organisation utilizes a form of the Hays naming convention for its job levels. Seniority increases with decreasing numerical level (e.g. Directors would fall under level 2). Table 2.3-1 shows the job levels used by Sasol as well as a generalised indication of management seniority at corresponding levels.

Sasol adopts a form of the "Leadership Pipeline model" created by Steve Drotter and colleagues (Charan *et al.*, 2010). The company makes provisions for specialisation in the pipeline model so that progression to higher job levels can be attained without making a "turn" from managing oneself to managing others, a fact to be noted when referring to Table 2.3-1.

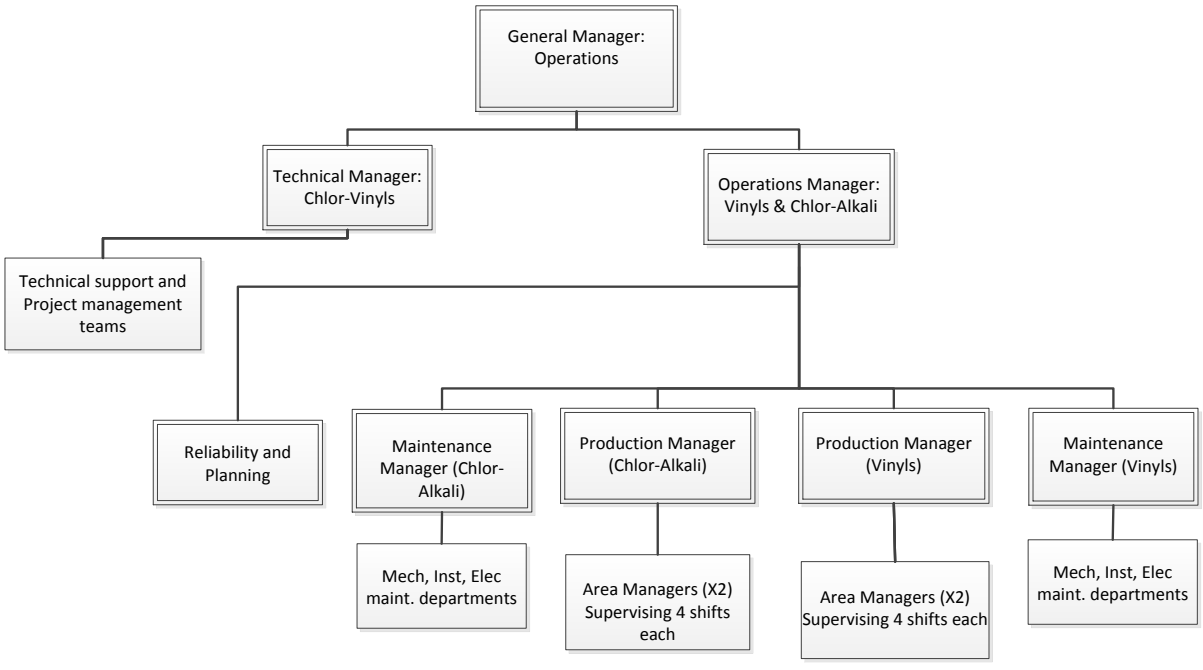

Figure 2.3-1: Summarised organisational structure (from unpublished Sasol data).

Management classification	Job Level
Top	02
	2B
	03
Middle	04
	5A
	5B
Lower	6A
	06
	07
	08
	09
	10
	11
	12

Table 2.3-1: Job level vs. general management classifications, adapted from (Govender, 2010)

The organisational chart found in Figure 2.3-1 serves as the scope of the research work described further in Chapter 3 of this study.

2.3.3 The case study OE model:

The Sasol OE model was developed for the organisation to realise the potential improvements in operating performance that such a program could deliver, amidst global petrochemical market pressures (Sasol Limited, 2011).

The vision statement for the program is:

“As a key enabler of the Sasol vision, Operations Excellence (OE) is a journey to deliver sustainable business performance supported by excellent business practices enabled by excellent leaders” - (Sasol Limited, 2011)

The company created an operations management system, known as the Operations Excellence Management System (OEMS), which serves as a high level guide and framework for the implementation of the initiative. The OEMS is thus the management system which provides the means for realising the OE vision.

- **Description of the OEMS**

The OEMS is divided into six sections, as described by Sasol Limited (2011):

a) OE Principles of Operation:

The OE model describes a set of guiding principles. This is an approach supported in the Shingo Model, although there is less emphasis on “living by these principles” seen in the Sasol OEMS. The essence of the Shingo Model is that it bases all of the organisations actions on the *guiding principles*, whereas the Sasol OEMS states the essence of the OE program is to “facilitate One Sasol Way whereby people use expected *practices* to deliver targeted performance”. The Sasol Model is practices based, and is more comparable to the Chevron and DuPont models in this regard. The principles themselves are:

- We challenge the way we do things at present
- We empower teams to deliver results, not to do “interesting stuff”
- We focus on solving problems, not implementing solutions
- We share knowledge to help colleagues succeed
- We learn by doing
- We meet minimum standards and aspire to excellence
- We keep things simple and practical

b) Leadership Accountability:

This element of the model is also in line with that used by Chevron and further emphasises the role of leadership in achieving organisational improvements, stated in section 2.2.6. The OEMS also states that the success of the OE program is dependent on committed leaders who live by and demonstrate the values in order to achieve business goals. Leaders establish a vision and set objectives that enable and challenge the organisation to continually drive performance improvement.

The leadership are accountable for the following:

- OE ownership and engagement

Leaders must be role models for OE. Commitment of time and resource must be shown to the improvement process. They take ownership of the results and outcomes of OE activities.

Leaders mentor and coach to develop their people. They remove barriers to OE. They create meaning and engagement within the work force so that all employees contribute to business success.

- OE alignment

Leaders understand and communicate the OE vision and objectives. They develop challenging objectives and metrics aligned with the business goals. These are cascaded in a meaningful way as performance targets for teams and individuals at all levels throughout operations.

Leaders prioritise OE plans to deliver the best business results. They ensure that resources are in place and their roles and responsibilities are clear and aligned. Leaders personally ensure the implementation of the OEMS to establish processes and practices that realise and improve performance towards the OE expectations.

- Leadership guide

Leaders should consistently challenge themselves to ensure the correct implementation and sustainability of OE through self-evaluation and by asking questions on their role in OE.

c) Improvement approach:

The improvement process is outlined in this section of the OEMS. The process requires the current practices to be addressed such that they meet those of the OE model. The details of the proposed OE implementation phases and resources required for the process are outlined here.

d) OE Expectations:

These “Expectations” are the desired operations processes which are prescribed under the OE model. There are a total of nine core processes which are implemented by the **local leadership** of the organisation through the development of practices and programs.

It is the leaders’ responsibility to ensure that the practices and programs meet the OE expectations, further emphasising leadership accountability. The incorporation of OE expectations is common with the Chevron model as well.

The nine core processes and their accompanying sub-elements are summarised in Table 2.3-2, adapted from the Sasol OEMS, Sasol Limited (2011). Appendix B shows the interconnection between these nine processes.

PROCESS MODEL SUMMARY

Core Process	Element	Definition
1. LEAD OPERATIONS PERFORMANCE	Set operations direction	• **The translation of business strategies and customer needs into operational goals and targets. Deliverables, goals and expectations are clear with defined roles, responsibilities and accountabilities.**
	Manage operations risk	• **All risks are identified, analysed and mitigated to acceptable levels.**
	Enable operations	• **The business sets the necessary management processes and support structures to deliver business goals. Leaders embed an appropriate operations culture, climate and set of behaviours that are in line with values-driven leadership.**
	Align operations direction with execution	• **Operational goals and long-term plans are cascaded through effective two-way communication in the organisation in such a way that appropriate improvement initiatives, actions and measures are understood and agreed at all levels to deliver the business goals.**
2. PLAN OPERATIONS	Develop ops plan and budget	• **An iterative negotiated process to develop safe, reliable and achievable operations plans that create alignment between operations function, suppliers and customers to achieve the business goals.** • **The operations budget includes people, people development, production volumes, operating cost, capital budgets and inventory, and all inputs into this budget should be current, realistic and available.**
	Short-term ops plan	• **It is a process that links and co-ordinates the budgets and high level plans to short-term operations across the value chain. The plan is agreed with all stakeholders and matches the current operations capabilities and critical resources, focusing attention on opportunities and on resolving likely risks and threats.**
	Develop weekly and daily ops plans and schedule	• **Short-term plans are converted into weekly and daily plans and schedules. The schedules are updated daily, using data from all functional disciplines, and approved and locked weekly for current and forecast conditions.**
3. RUN OPERATION AND FACILITIES	Manage ops resources	• **Managing operations resources enables operations using effective processes, so that stakeholder satisfaction is achieved with respect to people, products, process materials, assets, waste and pollutants.**
	Operate and maintain assets	• **Appropriate business systems, work processes, policies, standards and procedures are applied so that motivated and engaged people deliver the operations plan in a safe and effective manner, minimising risk.**
	Monitor operations	• **Processes that monitor performance against the operations plan, to ensure that plans are delivered e.g. KPIs, inspections, product and service level agreements, service provider performance contracts, scorecards, targets and budgets. Deviations are identified in a timely manner and communicated to relevant people.**
	Manage incidents and deviations	• **Processes are in place to effectively manage all operational incidents and deviations so that control is safely re-established and reported. Although prevention is the first priority, plans are made to effectively respond to all emergencies, incidents and deviations.**
4. PROTECT AND SUSTAIN THE AGREED BASELINES	Analyse impact of incidents/ deviations and potential deviations	• **Processes to effectively analyse the impact and causes of deviations, incidents and predicted future events that influence the baseline so that the appropriate action can be initiated and learnings shared.**
	Determine remedial action	• **Processes to effectively determine actions to eliminate or mitigate the impact of identified or potential incidents and deviations.**

	5. ANALYSE AND REVIEW	Interpret operations capability and performance	• **A process that uses hard and experiential data and information from internal and external sources to analyse, review and interpret performance against capability and objectives.**
		Identify improvement opportunity	• **A process that identifies and captures all opportunities to improve the capability or performance of the people, processes and technologies.**
		Prioritise operations activities	• **The process ensures that the resources available add the most business value and that planning is effectively integrated.**
		Revise baselines	• **The process to regularly revise baselines so that operations have current information to make effective, informed decisions and plans. Revised baselines and their impacts are documented and communicated to all stakeholders**
	6. EVALUATE TECHNICAL CAPABILITY OF OPERATIONS	Determine operations envelope	• **A process to assess whether operations have the technical ability and capacity to achieve planned operation performance and growth targets in a sustainable, responsible, reliable, efficient and safe way.** • **Define and continuously improve the integrity of integrated operations envelopes for all operations facilities from fundamental knowledge and actual operating experience. Operations envelopes describe installed assets, including plants, value chains, utilities and support systems**
		Assess technical capability	• **Processes exist to assess and verify the actual technical capability of operations in relation to the people, processes and technologies employed.**
	7. IMPROVE OPERATIONS	Develop alternative solutions	• **A process to find, evaluate and rank opportunities and solutions. The process confirms and further develops the identified opportunities and solutions as described in the opportunity definition document.**
		Develop and test the selected solutions	• **A process to further refine and develop solutions so that they can be approved for implementation. This includes all relevant management of change and documentation required as well as the execution plan and benefit tracking methodology.**
		Implement improvement solutions	• **Processes in place to implement solutions, including all aspects of change management, put the solutions into operation and complete the handover process.**
	8. MOBILISE OPERATIONS KNOWLEDGE	Capture operations learning and experience	• **This process identifies knowledgeable people and networks. It captures valuable operational information from internal and external sources. Information is collected in an appropriate knowledge enabling infrastructure in such a way that it is easily entered, logically grouped, indexed and securely stored so that it can be transformed into actionable knowledge.**
		Transform information to operations knowledge	• **Processes are in place to facilitate the debate of ideas and views where people actively create new actionable knowledge for themselves and the organisation. This is achieved by filtering, linking and transforming information captured in documents and gained from knowledgeable people.**
		Maintain operations knowledge	• **Maintaining operations knowledge ensures that there is a process, and accountability, to administer knowledge enabling infrastructure and operations information.**
		Package operations knowledge	• **The packaging process places the relevant knowledge into a format which is easy to access, use and understand for specific knowledge user groups. The packaging makes the knowledge accessible to enable effective knowledge transfer.**
		Transfer operations knowledge	• **Transferring operations knowledge involves the movement of useful operations knowledge to the intended recipients, in an appropriate package, to the specific user, in time at the point of use for individual, team and organisational development. This enables enhanced decision-making and organisational learning.**

	9. MOBILISE PEOPLE CAPABILITY	Plan operations people capability	• **Based on the outcome of set operations direction and the people policies, a comprehensive people planning system is in place that determines the skills requirements for current and future operations people requirements.**
		Source capability according to plan	• **Deliver to operations the appropriate people for current and future needs who best fit the position and person profiles. The recruitment process sources potential candidates both internally and externally in line with the position requirements.**
		Develop operations people to their full potential	• **Operations people are developed through a process that focuses on individual development and also delivers team integration and the organisational skills requirements.**
		Monitor demonstrated competence	• **All training and development is measured by a process where competence is demonstrated and assessed.**

Table 2.3-2: The OE Expectation's Core Processes, adapted from Sasol Limited (2011).

The first three of the core processes is centred on the corporate strategy alignment and operations planning. The need for this process is justified in section 2.2.3 of the study.

The 4th-7th processes focus on operations analysis and improvements. The OE models discussed in section 2.2 utilise methods such as Lean and Six Sigma for this purpose. The elements under process number seven show similarities to Six Sigma's DMAIC approach.

The 8th and 9th processes cover knowledge management and people development, common traits with the OE literature.

As seen in Appendix B, the system is inter-dependent and iterative, which brings in the Continuous Improvement aspect of the model.

e) OE metrics

These metrics are used to analyse and monitor the operations performance and can be thought of as the key performance indicators. It also provides a method to analyse the effectiveness of the OE program.

Examples of operations metrics are:

- Overall Equipment Effectiveness (OEE)
- Process performance index (Ppk) and process performance (Pp)
- Working capital as % sales
- Adherence to operations plan % (ATOP)
- Unplanned maintenance as a % of total maintenance
- Maintenance schedule compliance %
- Maintenance spend as % of replacement value

f) OE Practices Assessment

The assessment tool is a word model used to analyse the maturity of the business units with regard to the adherence to the nine core processes. This analysis is used to identify gaps between the current practices and those required to meet the OE expectations. Four maturity levels exist for each of the core processes, namely poor, mediocre, good and excellent. Each of these levels describes in words the practices that the business unit in question possibly adopts at the time.

In conclusion, the study of the OE and Case study literature provided insight into the various approaches to OE, as well as the success factors and barriers to successful implementation of such programs. This information is used in the development of the experimental method, which is described in Chapter 3 which follows.

3. EXPERIMENTAL DESIGN

3.1 Introduction

The details of the design and deployment of the research experiment is described in this chapter. These details include the chosen experimental methods and the details and rationale behind the design of the data collection process. The experimental work was created with the intent to resolve the high level research aim. To recap, the research aim as stated in Chapter 1 is as follows:

"The high level aim of the research was to critically review the implementation of OE at Sasol Chlor-Vinyls and identify the inhibiting factors to its successful implementation."

3.2 Experimental Method

There are two popular methods employed for data collection in research, namely qualitative and quantitative methods (Creswell, 2009). The qualitative method is described as "a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell, 2009). This form of data collection utilises open-ended questioning and interviews, observation etc., with the results being open to interpretation by the researcher. Inquiry of this nature creates a holistic view of the problem being studied, with a broad picture developed around the meaning of the views held by the research subjects.

Quantitative methods on the other hand "require the use of standardised instruments so that the varying perspectives and experiences of people can fit a limited number of predetermined response categories, to which numbers are assigned" (Naidoo, 2010). The instrument used can take the form of a survey, designed to provide numerical descriptions of trends, opinions and characteristics of a population, based on a sample population (Creswell, 2009).

A third method used less frequently is a combination or "Mixed Method" which combines the benefits of the two "standard" methods (Creswell, 2009). It combines the numerical analysis of data from a large sample population with the less "rigid" subjective information gained in qualitative inquiry, improving the understanding of the research problem.

This research was carried using a predominantly quantitative form of inquiry. The data collection instrument took the form of a specially designed survey questionnaire (discussed further in section 3.3). The motivation for the selection of this method is the relative speed at which data can be obtained and a low cost of execution (Naidoo, 2010), a benefit considering that the implementation of OE had to be investigated throughout many geographic locations and work groups.

With the goal of the research being the identification of barriers to successful implementation of OE, as much insight into the thoughts and opinions of the employees needed to be obtained. Therefore a qualitative section was added to the questionnaire allowing for research into these social and behavioural characteristics of the workforce. Employees were given an opportunity to give their views on open

ended questions relating to operations, continuous improvement etc. This inclusion allows the research to be categorised as a **combined** or **mixed approach**.

3.3 Survey Design

The primary research instrument utilised was a data collection survey/questionnaire, a version of which is found in Appendix C. This version is used for illustrative purposes only, showing the scores for each response and the constructs under investigation. It should be noted that the scores and constructs were hidden in the survey sent out to respondents.

The survey has been developed specifically for the study and is based on information obtained during the literature study (Chapter 2).

- **Introductory Section:**

The opening sheet of the questionnaire contains introductory information such as:

  - A basic description of the research being carried out
  - The aims of the survey
  - The benefit of the research as a means to encourage honest response
  - Instructions on how to fill in the survey

- **Quantitative Section:**

The quantitative section of the questionnaire was created to investigate two aspects related to the implementation of the OE system deployed at the case study organisation:

- Investigation of the degree to which the organisation's culture, behaviour and systems matches that defined for OE programs. The OE characteristics are as per the OE and Case study literature in Chapter 2
- Investigation of the presence (or lack thereof) of the critical success factors described for improvement initiatives, reported in Chapter 2, section 2.2.

A set of dimensions or constructs had to be defined to facilitate numerical analysis of the data obtained during the abovementioned investigations. These were created using the literature study information and are as follows:

1) Training in OE methods
2) Leadership Accountability
3) Facilitation of continuous operations improvements
4) Developing an Empowered and Competent workforce
5) Alignment between business strategy and operations

The survey questions have been created to study each of these five dimensions, which form the five variables under investigation in the study. Statements reflecting the characteristics of the five dimensions are made in the context of the case study organisation. Respondents are required to rate the applicability of the statements (and hence the implementation of the dimensions) using a continuous Likert type

scale (Malhotra, 2006). The scale's five response levels range from "Strongly Disagree" to "Strongly Agree". It also incorporates a "Neutral" selection at the middle of the scale.

Based on the survey instrument guidelines reported in Malhotra (2006), the language used in the questions were kept free of technical terms and jargon, keeping in mind the knowledge and skills of the respondents at lower competency levels. Special care was taken to ensure that questions were not ambiguous, double barrelled, biased, leading or open-ended. Effort was also put into keeping the survey short, encouraging participation and reducing non-response error (Naidoo, 2010).

Questions relating to the five dimensions were grouped together, maintaining focus on that particular topic (Naidoo, 2010). The order of the questions and dimensions were also considered. Malhotra (2006) suggests using questions perceived to require more thought than others, as well as questions of a more personal nature later on in the survey. "Simple" questions are used at the start of the questionnaire, thus building trust and commitment to the exercise before entering into "difficult" questions. Declaration of anonymity and a background to the research was given in the introductory instructions to encourage response and confidence as well.

Balancing of questions that can be worded either positively or negatively (dual statements) was carried out as far as possible, with the scoring scale reversed for each direction of questioning. This is a further recommendation made by Malhotra (2006), said to reduce bias.

- **Qualitative Section:**

This section of the survey was kept short, and is used primarily as a source of additional information and opinion regarding operations culture and behaviours. The questions were open ended and provide the respondent with an anonymous platform to voice opinion of a general nature and allows insight into the context in which the survey was answered.

- **Biographic Information:**

Biographic information was requested and deemed necessary due to the complex subdivision of the operations teams between the various plants in the value chain, the operations disciplines, as well as the various seniority/job levels (refer to figures 2.3-1 and 2.3-2). The data was used to investigate if cultural and behavioural trends could be seen between the various plants and seniority levels.

3.4 Survey Validity

Naidoo (2010) defines validity as "achieving confidence that what is set out to be measured is actually measured and not something else". To test the content and face validity of the test instrument, the draft version of the survey was sent to a test group at the case study organisation for comment. The survey was in an illustrative format as per Appendix C, so that the testers could evaluate the validity of the

questions and scoring in accordance with the five dimensions/constructs. The test group included members with differing degrees of exposure to the OE system and included senior and middle management, as well as individuals in non-management positions. In addition, the survey was sent to an independent Statistical Consultant for review. Comments received were incorporated before distribution to the study population.

To increase the validity of the questionnaire, reference was made to pre-existing questionnaires examining similar OE constructs as those defined for this study. The reference material includes the Sasol OE Practices Assessment (Sasol Limited, 2011), the Oliver Wight ABCD Checklist for OE (Ozumba, 2010) and The Shingo Prize Model for OE Assessment Guidelines (The Shingo Prize for Operational Excellence Ltd., 2012).

3.5 Study Population

The sample population selected for the research study consists of the Production, Maintenance, Technical Development, and Reliability teams of the Chlor-Alkali and Vinyls divisions of the Chlor-Vinyls business (refer to figure 2.3-1 for an organogram). The number of personnel within these groups totals approximately 332 individuals, the majority of which (63%) are Production personnel. The details of the actual participation rate are discussed in Chapter 4.

3.6 Data Collection and Analysis

The questionnaire was distributed electronically to the study population via a Microsoft Excel 2010 workbook. The workbook was designed to summarise the scores from responses and submit the survey automatically. This enabled ease of collection and data collating, which was beneficial considering the large target group.

Statistical software (OpenStat) was utilised to assist with the analysis of the quantitative data. The tests conducted included standard deviation, mean, p-value, d-value and Cronbach's alpha.

The experimental work described in this chapter was utilised to realise the research aim and objectives of the study. The analysis and interpretation of the experimental results are reported in Chapter 4.

4. PRESENTATION AND DISCUSSION OF RESULTS

4.1 Introduction

The research data obtained from the survey participants was analysed, with the results presented in this chapter. The measurement of each of the constructs is used to investigate the implementation of OE at the case study organisation, using the information reported in the literature study as a reference. The interpretation, discussion and verification of the experimental results are presented here.
The quantitative results are presented first and in further detail, considering it is the "primary" research method. An interpretation of the qualitative responses follows.

Recommendations and conclusions stemming from these results can then be proposed to resolve the research objectives.

4.2 Participation Rate

The total number of survey replies received was 57, broken down into the following demographics:

	Number of Survey Replies	Percentage of Total Sample set
Management	18	32%
Non-Management	39	68%
Production Discipline	15	26%
Maintenance Discipline	15	26%
Development Discipline	20	35%
Reliability Discipline	6	11%
Vinyls Area	27	47%
Chlor-Alkali Area	15	26%
Chlor-Vinyls Area	15	26%

Table 4.2-1: Survey participation rate according to demographics

4.3 Analysis of Results

The questionnaire scores range from 1 to 5 with the following interpretation regarding the aspect being tested:

1= "Strongly Negative"
2= "Negative"
3= "Neutral"
4= "Positive"
5= "Strongly Positive"

4.3.1 Overall Mean Data:

The mean scores for each of the questions in the survey are shown in Figure 4.3-1.The mean values are presented in a bar chart above and below the "Neutral" mean

value of 3. This was done to ease the identification of questions scoring positively, negatively or neutrally. The data presented is for the entire sample population.

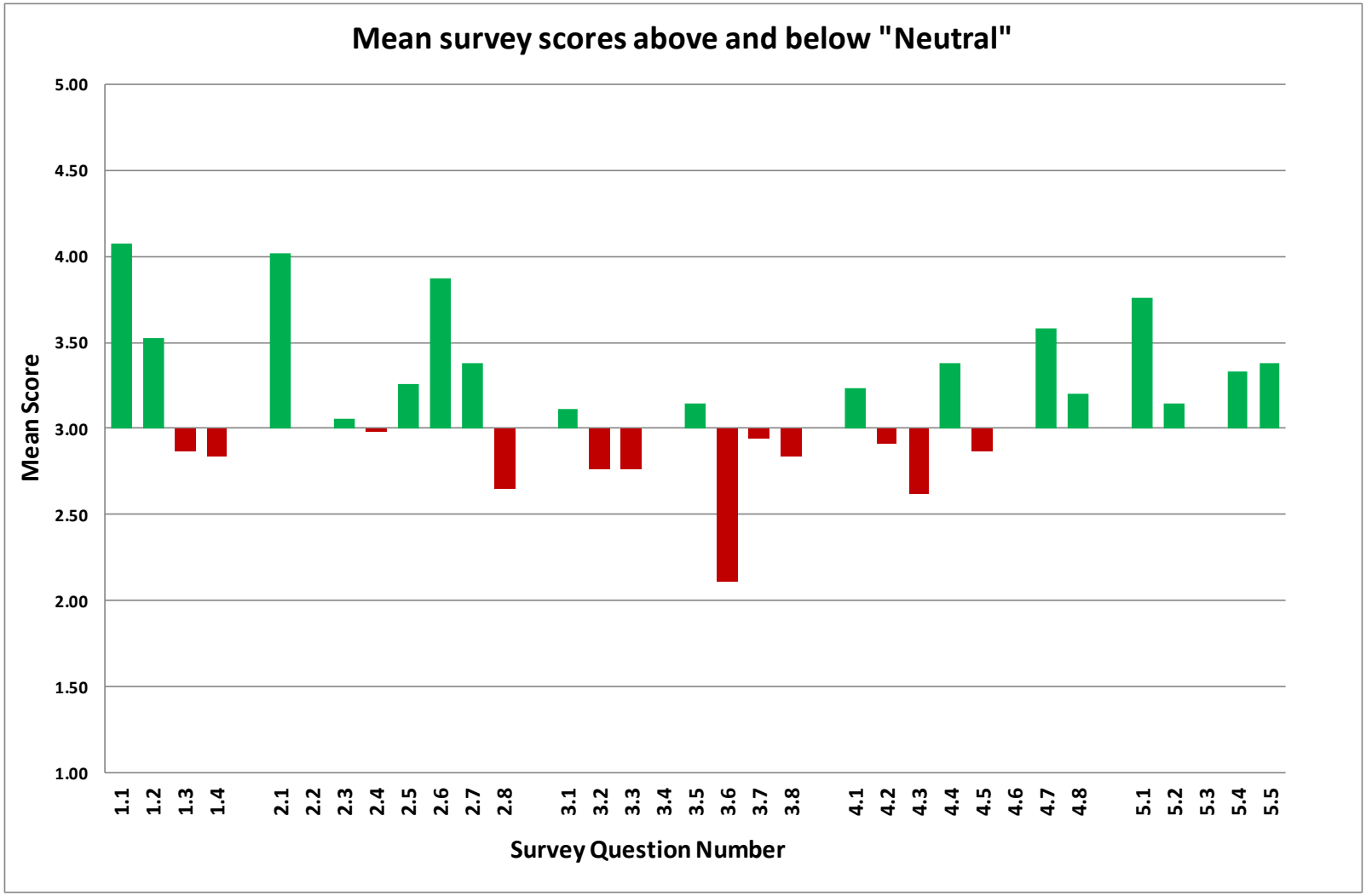

Figure 4.3-1: Mean survey scores per question

The negatively scoring questions are summarised below in descending order (i.e. more “negative” to less) in Table 4.3-1 below with the calculated mean and standard deviation. All of the negatively scored questions are shown, as these represent the potential implementation shortcomings.

	Question:	Mean Score	Standard Deviation
3.6	The underlying principles/philosophies of the organisation changes from leader to leader	**2.11**	**0.98**
4.3	We are allowed to make informed decisions regarding our work without having to get approvals	**2.62**	**1.09**
2.8	Standards and procedures are updated regularly, maintaining a source of "best practices"	**2.65**	**1.15**
3.2	Management have communicated the benefits seen from OE to me.	**2.76**	**1.04**
3.3	There is no clear communication from leadership regarding OE. For e.g. info of the process going forward, impact on me and my work methods etc.	**2.76**	**1.13**
1.4	I am unaware of the *Operations Excellence Management System* (OEMS)	**2.84**	**1.17**
3.8	Senior Leadership visits operations directly in order to reinforce Operations Excellence performance and discuss its effectiveness.	**2.84**	**0.97**
1.3	The business has visibly trained and developed OE specialists to facilitate the programme	**2.87**	**1.06**
4.5	Lessons learnt and best practices are shared amongst individuals at all levels	**2.87**	**1.22**
4.2	People are keen to share knowledge within the organisation, even across disciplines and teams	**2.91**	**1.18**
3.7	Management focuses on the positive aspects of problem solving by considering every new issue as a process to learn and increase knowledge.	**2.95**	**1.13**
2.4	Management allocates the resources and attention needed for the implementation of improvement ideas.	**2.98**	**0.92**

Table 4.3-1: Negatively scored questions

Three out of the top five negatively scored questions were from the “Leadership Accountability” construct.

In terms of positive results, the top six positively scored questions are shown in Table 4.3-2 along with the mean and standard deviation:

	Question:	Mean Score	Standard Deviation
2.6	There is no need to change anything- "If it isn't broken, don't fix it"	**3.87**	**1.13**
5.1	Effort has been made to clarify the organisations vision and strategy to our team	**3.76**	**0.89**
4.7	Training is encouraged through formal education courses and on the job coaching	**3.58**	**0.91**
2.7	Problem areas are addressed through the use of scientific improvement methods such as "Plan, Do, Check, Act" and RCA (Root Cause Analysis).	**3.38**	**1.00**
4.4	I don't feel a sense of belonging or ownership toward the organisation	**3.38**	**0.98**
5.5	Performance measures are used to identify deviations from the plans and solutions are implemented to bring it back on track.	**3.38**	**0.92**

Table 4.3-2: Top six positively scored questions

The constructs appearing in the top six scoring questions are balanced between "Facilitation of Continuous Operations Improvements", "Developing an Empowered and Competent Workforce" and "Alignment between business strategy and operations".

4.3.2 Results According to Constructs:

Mean scores were calculated for each of the five constructs defined in Chapter 3. The construct means were analysed for the entire sample population or "Total Sample Set", as well as per the various demographic divisions that can be made within the sample population.

The means scores and corresponding standard deviation per construct for the total sample population is shown in Figure 4.3-2 below:

Figure 4.3-2: Mean scores per construct for the entire sample set

From Figure 4.3-2, it can be seen that a single construct scores negatively (with a mean score less than 3), namely “Leadership Accountability”. In addition, the positively scoring constructs have mean values close to the “neutral”, with the highest value being 3.34 achieved for “Training in OE methods”.

The construct analysis was extended to demographic groups within the organisation to investigate hypothetical differences between groups.

The mean construct scores for those participants in management and non-management positions is shown in Figure 4.3-3, together with the total sample set means for comparative purposes:

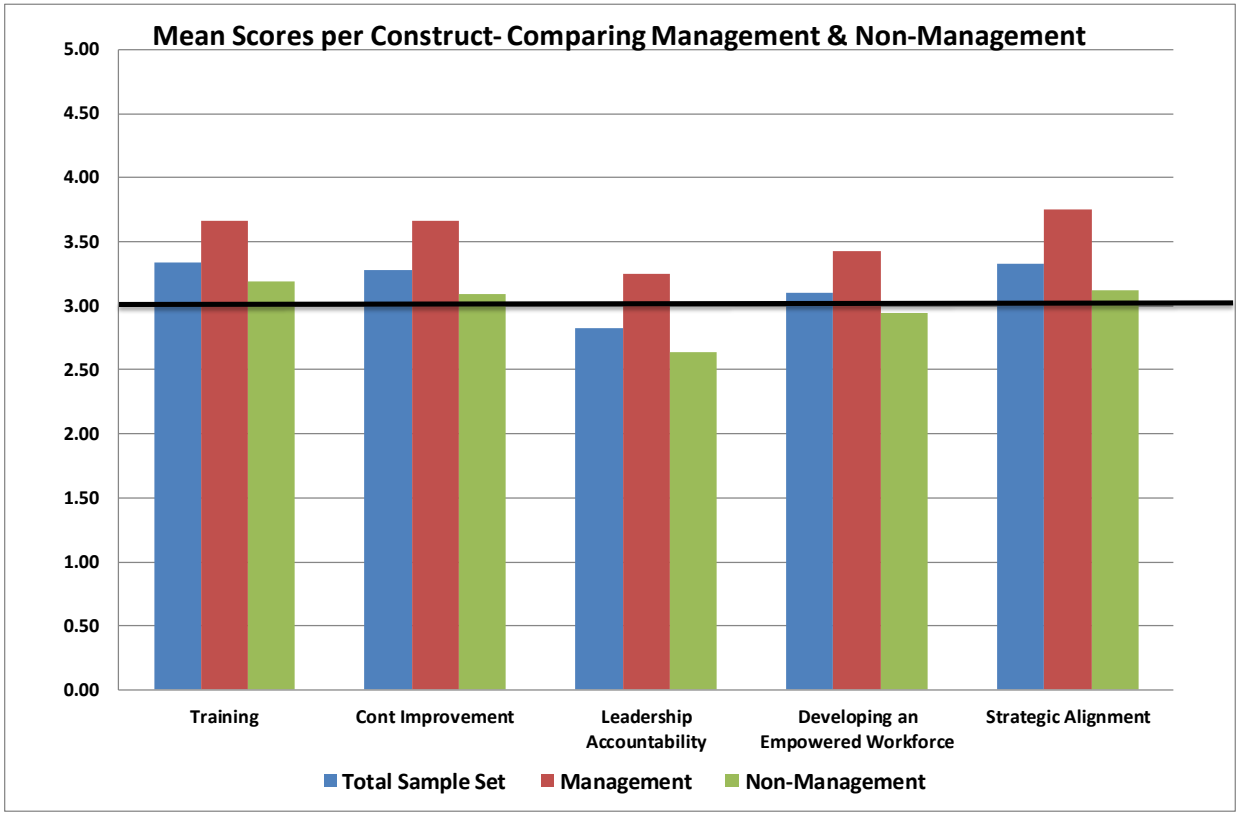

Figure 4.3-3 Mean scores per construct for management, non-management and total sample population

There is an apparent difference between the mean values seen for the management and non-management groups, with managers scoring the constructs higher than those in non-management positions.

Non-managers scored two constructs negatively on average (“Leadership Accountability” and “Developing an Empowered and Competent workforce”) with the other three constructs close to neutral (max value of 3.19 for “Training”). Management on the other hand scored all constructs positively on average, with a maximum mean of 3.76 for “Strategic Alignment”.

The second demographic investigated was the operations disciplines at the organisation. The disciplines fall into four categories; Production, Maintenance, Development, and Reliability and Planning. The construct means for each of these groups is shown in Figure 4.3-4:

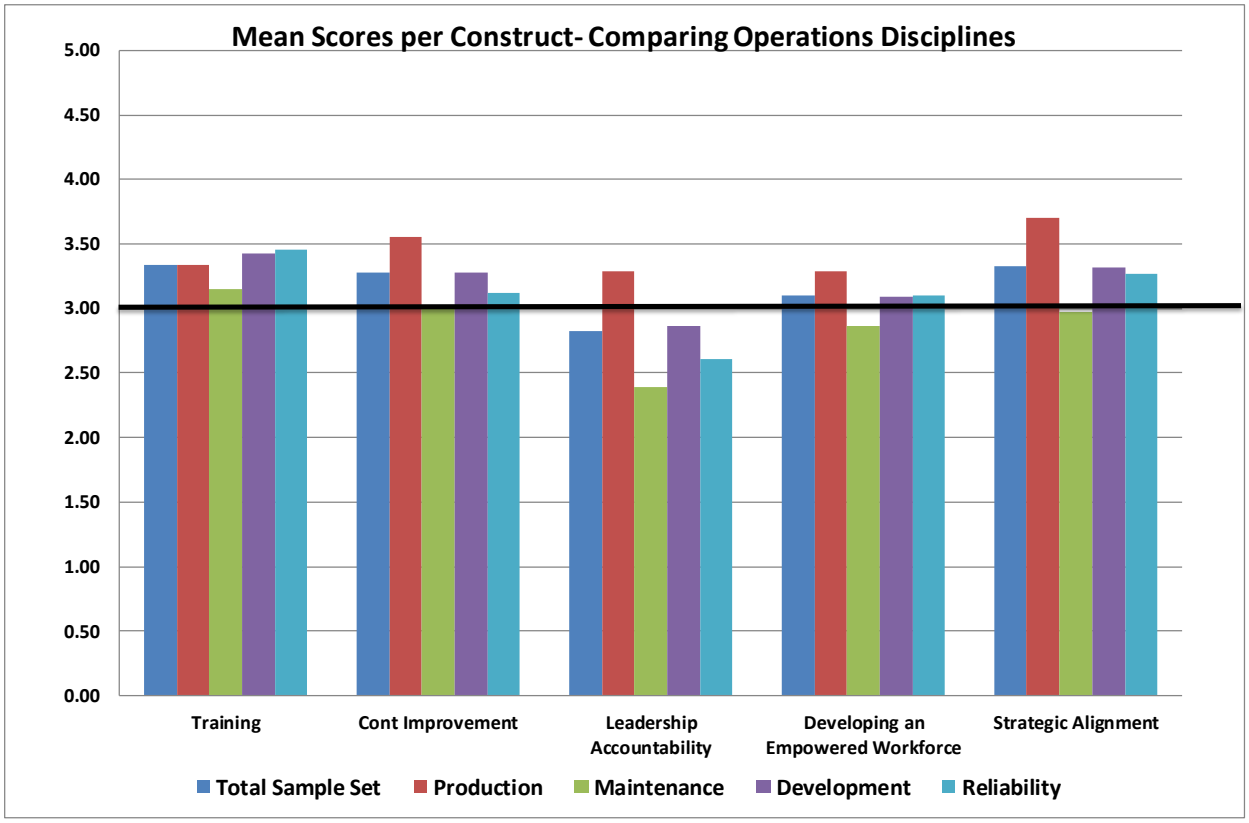

Figure 4.3-4: Mean scores per construct for the various operations disciplines, and the total sample population.

Analysis of the mean data indicates a difference between Production personnel and those from the maintenance discipline. Production scored positively in all of the constructs, whilst Maintenance scored negatively in all constructs but one ("Training"). The lowest construct mean was "Leadership Accountability".

The analysis was also carried out on the various working areas within the organisation. The demographic analysis divides the data into groups according to three divisions of the organisation with personnel working at Chlor Alkali, Vinyls or both (Chlor-Vinyls as a whole). The data is presented in Figure 4.3-5:

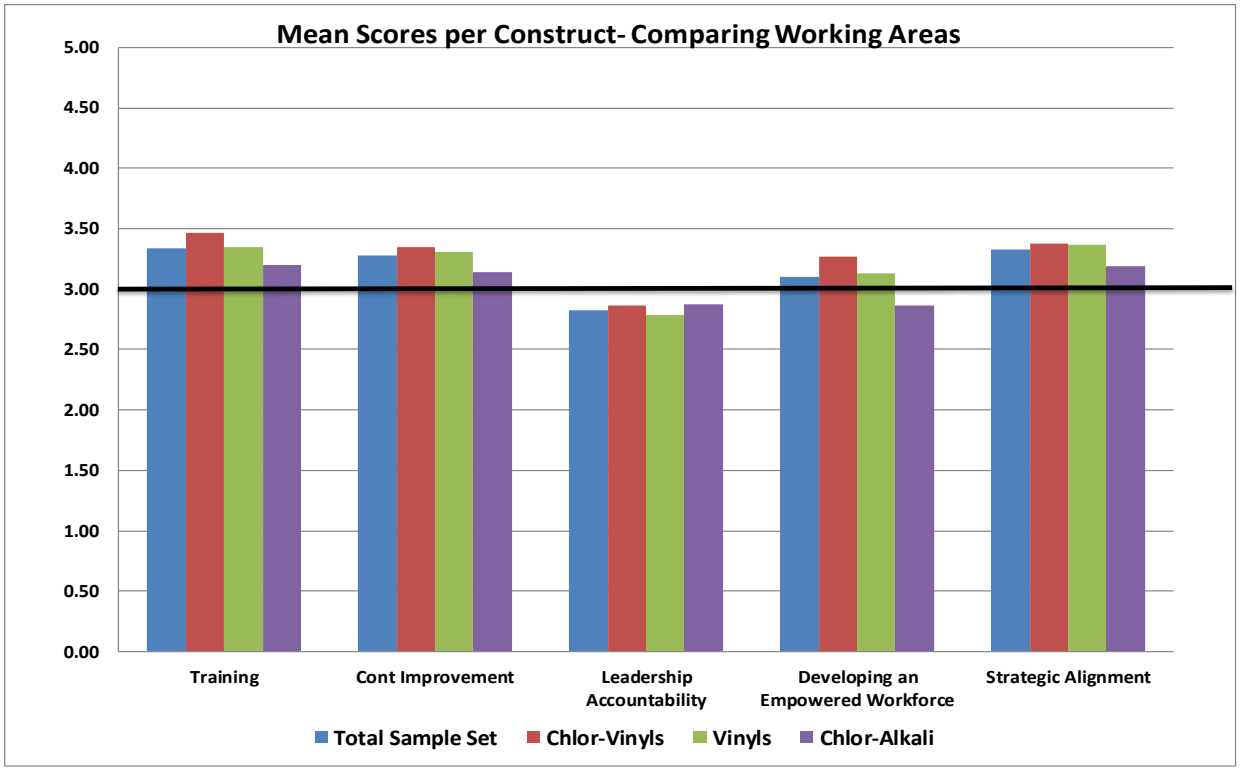

Figure 4.3-5: Mean scores per construct for the three working area divisions, and the total sample population.

No apparent trend is seen regarding differences between the various working groups and the total sample set.

The final demographic analysed examines trends between seniority levels. The data is divided into two categories, those in more senior positions (Level 6A and senior) and those in less senior positions (Level 6 and less senior). Figure 4.3-6 presents the mean data.

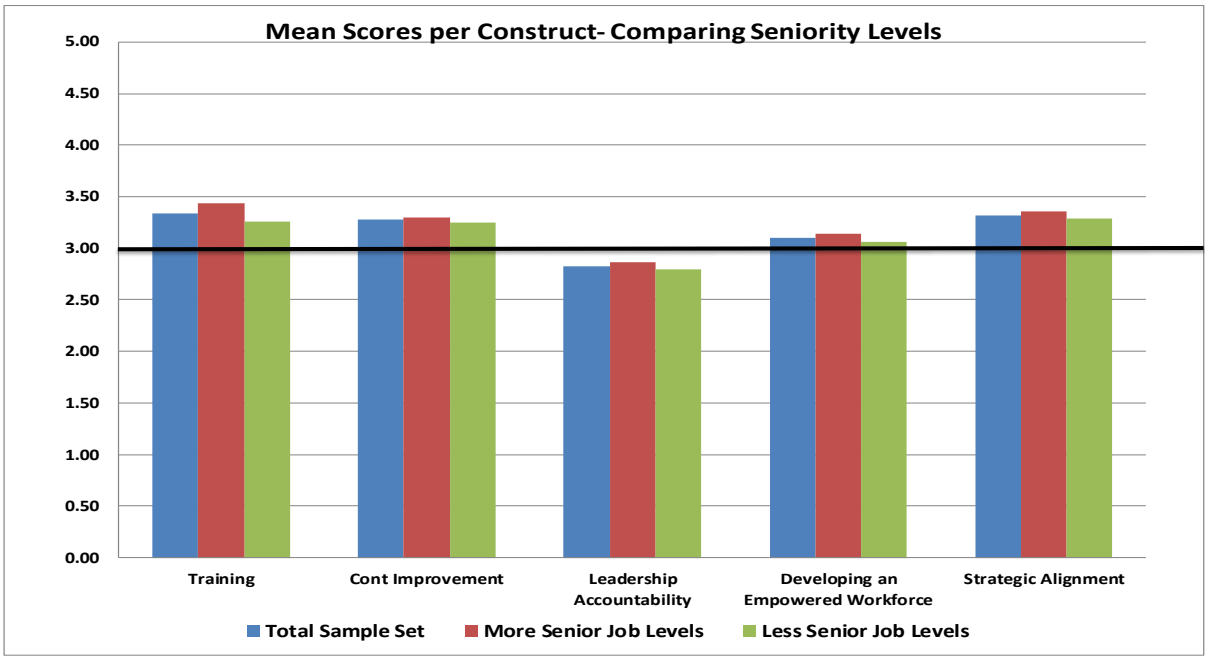

Figure 4.3-6: Mean scores per construct for the different seniority groups.

As seen with the working areas demographic, there is no apparent difference between the two seniority groupings, or the total sample set.

4.3.3 Results of the Qualitative Investigation:

The analysis and interpretation of the qualitative data was carried out by summarising the responses received and categorising them according to the five constructs (although only four of the constructs featured). The comments are listed according to the relevant construct below:

Training:

- Information sessions were held at time of roll out, but were poorly attended and received.
- Detailed training into the principles of the system was not carried out.
- Principles of the program are not reiterated continuously.
- Operations personnel had no training at all in some areas.
- Training was not carried out at the "shop floor level"
- One employee felt that the system was much more involved at Sasol Mining

Facilitation of continuous operations improvement:

- An improvement culture is not present within the workforce. A negative attitude toward improvements and change is seen.
- Improvements are not the given the resources required.
- Senior personnel are reluctant to make improvements unless it comes from them.
- Working "silos" exists
- Reflection is not carried out- "Plan" and "Do" steps but not "Check" or "Act"
- A lack of team work exists across disciplines and within.
- Improvement ideas from the "Shop Floor" level are not appreciated or considered by those at higher levels. Input is not requested from lower levels.

Leadership Accountability:

- There is a lack of communication from leadership downward
- Leadership does not guide the organisation in one common direction.
- Leadership is not seen to live by the values and principles of the organisation
- Different approaches are used by each manager
- Commitment to the initiative is not seen. This is seen in the availability of funds for improvements
- OE started with a great deal of enthusiasm but the drive has fallen away

Developing an Empowered and Competent workforce:

- Decision making takes a long time and through complicated systems
- Management tries to achieve results through fear and not people development
- Knowledge is not shared freely between groups
- There is a lack of standard operating methods.

4.4 Discussion and Interpretation:

The experimental work was carried out with the aim of investigating the implementation of an OE system at the case study organisation. The results analysis carried out above allows for this investigation to be carried with an interpretation carried out in this section.

When looking at the overall results, it is seen that none of the questions, which were designed to test successful implementation of the system, scored very positively (i.e. 4 or greater). Twelve questions scored less than the neutral value. This result is in line with the initial observations made, namely that there exists a misalignment between the OE implementation goals and the apparent culture and behaviours of the organisation.

The analysis of the data according to constructs showed that the lowest scoring dimension overall was “Leadership Accountability”. As discussed in Chapter 2, the role of leadership is critical to the overall success of management systems such as OE. Leadership’s role in developing the desired *culture* for improvement initiatives was also stated. The perceived low level of leadership accountability seen from the experimental data could thus have a bearing on the low scores obtained for other constructs as well.

The qualitative responses provide some further information on the specific leadership traits which were deemed to be lacking. The qualitative data is however from a small portion of the total population and therefore does not reflect the views of the entire organisation. It nevertheless gives an indication of the leadership improvement areas (refer to section 4.3.3 for the statements).

The construct analysis was also carried out according to the demographic groupings participating in the study to identify apparent differences in implementation success between the demographic groups. In figure 4.3-3 it appears that those in management positions scored all constructs more positively than those in non-management positions. Possible reasons for this could be that there is more involvement and information available at a management level.

The dimensions scoring negatively for non-management were “Leadership Accountability” and “Developing an Empowered and Competent workforce”. Those in management positions however scored all dimensions positively. Management could thus have a more optimistic view with regard to their own accountability regarding the change initiative, as well the development and empowering of their subordinates.

The analysis of the operations disciplines showed an apparent difference between the construct mean scores obtained for Production and Maintenance disciplines, with Production teams scoring positively in all constructs and Maintenance scoring negatively in all but one. The maintenance discipline plays an important role in the OE system, as they play a key role in asset reliability, efficiency and quality, all of which are requirements of the Operations Excellence models discussed in Chapter 2 (DuPont, Chevron etc.). Poor implementation of OE processes, principles and philosophies in this area of operations will thus make it difficult for the goals of the program to be realised.

Demographics which did not show any apparent trend in the construct means were the working areas (or plant areas) and seniority levels. The working areas under consideration have independent operating teams, sharing management at a senior level only. This result shows that the program role out was carried out with similar effectiveness throughout the business. The behaviour and culture of the organisation is thus similar at a global level. Changes to these behavioural characteristics would have to be driven by leadership from the senior levels downwards, according to the cultural change methods outlined in the literature study.

Considering that managers tend to be of a higher seniority or job level, it may appear peculiar that there is a small difference between results according to seniority levels, since a trend was seen for the management demographic. This can be explained by the fact that some "high level" personnel are in non-management positions and vice versa (46% of respondents were "level 6A and more senior" and 32% of respondents were in management positions). This result thus strengthens the hypothesis that there exists a trend for the management demographic since it removes the possibility that the trend seen for management is actually seniority based.

4.5 Verification of Results:

Two forms of verification were utilised, comparing the data to that expected from the literature study (as was done in the discussion above), as well as through the use of statistical analysis. For the verification of results through statistics, the OpenStat statistical software package was utilised.

An analysis was performed to establish the reliability of the survey responses in testing the intended construct. This was done by carrying out a test of the internal consistency of the response data with regard to the construct being tested. The Cronbach's Alpha coefficient was evaluated for this purpose. The results can be considered reliable if the Cronbach's Alpha coefficient is greater than a value of 0.7 (Govender, 2010). The results for the five constructs examined are found in Table 4.5-1 below:

Construct	Mean	Std. Deviation	Cronbach's α
Training	3.34	0.75	0.700
Cont Improvement	3.27	0.62	0.750
Leadership Accountability	2.83	0.73	0.848
Developing an Empowered Workforce	3.10	0.68	0.804
Strategic Alignment	3.32	0.72	0.784

Table 4.5-1: Cronbach's Alpha Coefficients for the five constructs

It can be seen that all of the constructs attained a Cronbach's Alpha coefficient of 0.7 or higher, showing an acceptable reliability (Govender, 2010).

Statistical analysis was then undertaken to verify the apparent differences reported for the constructs according to demographics. The Student's t-test was used for the purpose of determining statistical significance, outcomes of which are the p-value and d-value. According to Govender (2010), a p-value less than 0.05 indicates a significant difference, however for large sample sets, the d-value should also be evaluated to determine practical significance (or the magnitude of the effect observed).

The interpretation of the d-value is given by Govender (2010) as follows:

d-value	Interpretation
> 0.8	Large effect
0.5 to 0.8	Medium effect
0.2 to 0.5	Small effect

Table 4.5-2: d-value Interpretation, courtesy of Govender (2010)

The significance t-test results for the analysis of constructs according to demographics is summarised in Table 4.5-3 below. Statistically significant results are highlighted in the table. It can be seen that the apparent differences mentioned in the discussion in section 4.4 have been statistically verified as significant (and vice versa).

Significance of Demographic Differences:					
	Training	Cont. Improvement	Leadership Accountability	Developing an Empowered Workforce	Strategic Alignment
Production vs Maintenance:					
p-value	0.6031	**0.0465**	**0.0031**	0.139	**0.0103**
d-value	0.18	**0.52**	**0.89**	0.42	**0.74**
Production vs Development:					
p-value	0.7238	0.1708	0.0595	0.3872	0.0877
d-value	0.1	0.27	0.42	0.2	0.39
Chlor Alkali vs Vinyls:					
p-value	0.6284	0.4608	0.7053	0.2756	0.4756
d-value	0.14	0.17	0.1	0.26	0.18
Chlor Vinyls vs Vinyls:					
p-value	0.4794	0.8091	0.6614	0.4602	1
d-value	0.13	0.04	0.09	0.14	0
More Senior Job level vs Less Senior:					
p-value	0.3865	0.7583	0.7169	0.6618	0.7144
d-value	0.17	0.05	0.07	0.08	0.07
Management vs Non-Management:					
p-value	**0.0241**	**0.0003**	**0.0024**	**0.0115**	**0.0027**
d-value	0.48	**0.58**	**0.61**	0.49	**0.64**

Table 4.5-3: Statistical significance testing of demographic data

The verified results analysed and discussed in this chapter allowed for successful investigation of the research problem defined in the objectives of this research. The conclusions and recommendations that were drawn from the research work undertaken with regard to the research aim and objectives are presented in Chapter 5 of this report.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The research data discussed and presented in the previous chapter, as well as the literature study in Chapter 2 are brought together in the formulation of conclusions and recommendations to address the implementation shortcomings. These concluding statements and recommendations are reported in this chapter.

5.2 Conclusions:

The utilisation of advanced operations management methods such as Operations Excellence has become popular since the 1970s. Sasol Ltd. implemented such a program, however an observation of the operating culture showed apparent implementation shortcomings with regard to OE requirements. The research reported in this dissertation was undertaken to investigate these shortcomings. Research objectives were defined to carry out the investigation. The conclusions drawn with regard to these objectives follow.

5.2.1 Research Objectives:

The research aim was defined according to the research need described above, namely *to critically review the implementation of OE programs, identify barriers to successful implementation and to recommend corrective actions.*

The research aim was achieved by fulfilling the following Specific Objectives:

- Specific Objective 1: Investigate OE models and similar programs created and implemented in other organisations to enable critical evaluation of the case study system

The investigation and critical review of OE programs implemented globally as well as at the case study organisation was carried out in the literature study.

The examination of the literature provided a foundation for the experimental work carried out at the case study. It allowed for the creation of the five critical dimensions or constructs utilised in the experimental work.

- Specific Objective 2: Study the culture and operations processes of the Chlor-Vinyls business and compare to the OE implementation requirements identified in literature

The quantitative section of the study showed that all of the five constructs did not score highly, with all mean values below “4”, indicating that the culture and operating processes of the organisation are not fulfilling the requirements for OE at present. Further evidence for this is seen from the qualitative remarks collected in Chapter 4.

- Specific Objective 3: Critically review the implementation of OE with reference to the case study.

The evaluation of the OE implementation at the case study organisation was carried out in the discussion of the experimental results. The lowest scoring dimension identified in the review was found to be “Leadership Accountability”, a dimension which strongly influences the success of improvement initiatives, according to literature.

The evaluation also identified a statistically significant difference between the views of management and non-management, and Production and Maintenance disciplines.

Qualitative data indicated that although training was carried out initially, this was not seen as sufficient with certain individuals receiving no training at all. The data also indicated that operations improvements did not go through a reflection process required for continuous improvement. A lack of standardisation and people development was also noted in the comments.

The realisation of the specific objectives allowed for the recommendations reported in section 5.3 to the drafted, ensuring that the corrective measures required as part of the research aim is completed successfully.

5.3 Recommendations:

The recommendations from the research as a whole are as follows:

- Ensure that the leadership team is sufficiently trained and knowledgeable in the tenants of the OE system. The principles of the system have to be well understood and demonstrated by the leadership team. Through leading by example and continuous reinforcement, the desired culture can be imbedded.

- Commitment to the change initiative must be present. Personnel may need to be changed so that the required commitment and capability is present. The personnel must fit the requirements of the system. Selective recruiting, mentoring, development projects, promotions and restructuring can be used to achieve this.

- The principles of the organisation should not change drastically from one leader to another. This is so that the culture can be developed over time, instead of being uprooted when leadership changes. Leadership should not pursue different/conflicting change initiatives in parallel.

- Training should be compulsory for all operations personnel, especially those entering the organisation. Refresher training may be required periodically so that it is not seen as something which began with enthusiasm but soon fell away.

- Investigation should be carried out into the apparent differences seen between those in management and non-management positions, as well as

Production and Maintenance personnel. These differences may be addressed by the training and communication improvements recommended above.

- Standardisation of work methods should be carried out, along with improvements in knowledge management and transfer. This is required for the facilitation of people development.

- Additional emphasis and discipline regarding continuous improvement is required, especially the last step of the PDCA cycle, Review or Reflection (Hansei).

- Determine if the organisation is in a reactive operating culture in which “fire fighting” prevents operating change from occurring. Re-evaluate the amount of resources and skill required to move away from this state.

5.4 Limitations and Future Work:

The experimental work was designed to analyse the overall organisation in a very limited period of time (approximately 6 months). The analysis was thus carried out at a high level. This time limitation meant that the specific reasons for the OE dimensions measuring poorly could not be investigated in further detail as part of this research. This also meant that the recommendations made are not at a low enough level for corrective measures to be immediately implemented. There is thus further scope for investigative work to be carried out going forward.

5.5 Concluding Thoughts:

Research into improvement initiatives as well as investigation into their successful implementation showed the significant effort that is required in adopting such systems. The creation of an improvement model and its subsequent introduction into the organisation is only the first step. It is up to the personnel in the organisation to “live by” the philosophy and principles of the system. This cultural shift requires strong motivation and demonstration by the leaders of the organisation. It thus requires the right people with sufficient energy to drive operations improvement methods continuously until it becomes the new norm.

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APPENDIX A: THE ORGANISATIONAL CULTURE ASSESSMENT INSTRUMENT

"

1. DOMINANT CHARACTERISTICS

A. The organization is a very special place. It is like an extended family. People seem to share a lot of themselves.
B. The organization is a very dynamic and entrepreneurial place. People are willing to stick their necks out and take risks.
C. The organization is very production oriented. A major concern is with getting the job done. People are very competitive and achievement oriented.
D. The organization is a very formalized and structured place. Bureaucratic procedures generally govern what people do.

2. ORGANISATIONAL LEADERS

A. The leaders of the organization are generally considered to be mentors, facilitators, or parent figures.
B. The leaders of the organization are generally considered to be entrepreneurs, innovators, or risk takers.
C. The leaders of the organization are generally considered to be hard-drivers, producers, or competitors.
D. The leaders of the organization are generally considered to be coordinators, organizers, or efficiency experts.

3. MANAGEMENT OF EMPLOYEES

A. The management style in the organization is characterized by teamwork, consensus and participation.
B. The management style in the organization is characterized by individual risk-taking, innovation, flexibility, and uniqueness.
C. The management style in the organization is characterized by hard-driving competitiveness, goal directedness, and achievement.
D. The management style in the organization is characterized by careful monitoring of performance, longevity in position, and predictability.

4. ORGANISATION GLUE

A. The glue that holds the organization together is loyalty and mutual trust. Commitment to this organization runs high.
B. The glue that holds the organization together is orientation toward innovation and development. There is an emphasis on being on the cutting edge.
C. The glue that holds the organization together is the emphasis on production and goal accomplishment. Marketplace aggressiveness is a common theme.
D. The glue that holds the organization together is formal rules and policies. Maintaining a smooth running organization is important.

5. STRATEGIC EMPHASES

A. The organization emphasizes human development. High trust, openness and participation persist.
B. The organization emphasizes acquiring new resources and meeting new challenges. Trying new things and prospecting for new opportunities are valued.
C. The organization emphasizes competitive actions and achievement. Measurement targets and objectives are dominant.
D. The organization emphasizes permanence and stability. Efficient, smooth operations are important.

6. CRITERIA OF SUCCESS

A. The organization defines success on the basis of development of human resources, teamwork, and concern for people.
B. The organization defines success on the basis of having the most unique or the newest products. It is a product leader and innovator.
C. The organization defines success on the basis of market penetration and market share. Competitive market leadership is key.
D. The organization defines success on the basis of efficiency. Dependable delivery, smooth scheduling, and low cost production are critical. ‘’

Some guideline as to how the OCAI is deployed is reported by (Cameron, 2004)**:**

“In the OCAI, organization members are provided with a set of scenarios that describe certain fundamental cultural aspects of organizations. Individuals rate their own organization’s similarity to those scenarios by dividing 100 points among four different scenarios, each descriptive of a quadrant in the competing values framework. Six dimensions are rated: (1) the dominant characteristics of the organization, (2) the leadership style that permeates the organization, (3) the organisational glue or bonding mechanisms that hold the organization together, (4) the strategic emphases that define what areas of emphasis drive the organization’s strategy, (5) the criteria of success that determine how victory is defined and what gets rewarded and celebrated, and (6) the management of employees or the style that characterizes how employees are treated and what the working environment is like. In combination these content dimensions reflect fundamental cultural values and implicit assumptions about the way the organization functions. They reflect “how things are” in the organization. This list of six content dimensions is not comprehensive, of course, but it has proven in past research to provide an adequate picture of the type of culture that exists in an organization (see Cameron & Quinn, 1999). By having organization members respond to questions about these dimensions, the underlying organisational culture can be uncovered…

An important caveat is that it may make little sense to try to describe the culture of the overall Ford Motor Company, for example, in as much as it is simply too large, heterogeneous, and complex an organization. Consequently, individuals are directed to target a specific organisational unit as they respond to the questions on the OCAI. Respondents usually are individuals in the organization who have a perspective of the relevant organization’s overall culture, who will be engaged in implementing change initiatives, and whose acceptance is necessary for ensuring a successful culture change effort. These individuals assess the current culture of their organization.

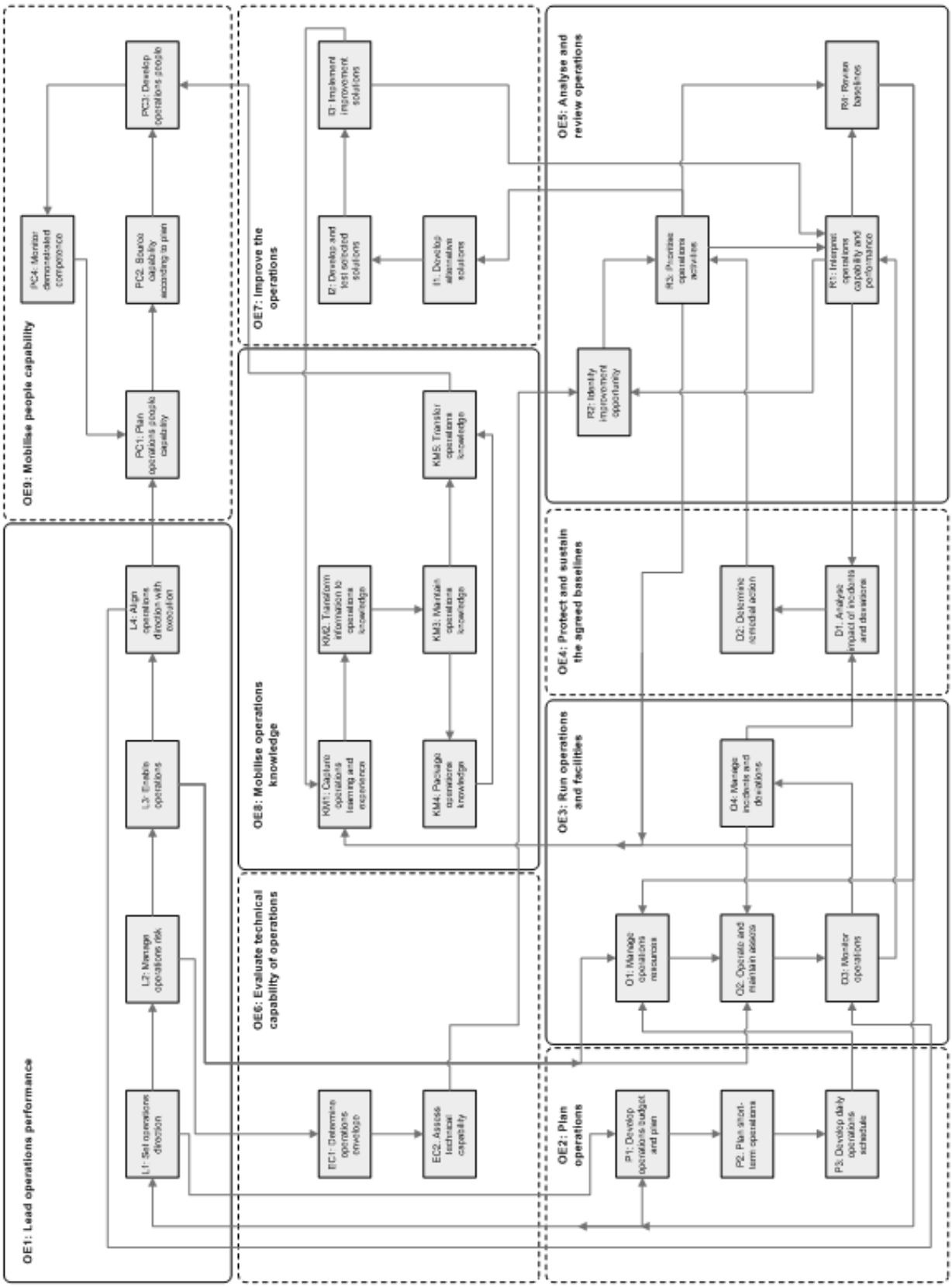
Using individual scores on the instrument, respondents participate in a discussion to generate a consensual view of the current organisational culture (not an average view), with everyone having input into the consensus profiling process. Considering the potentially disparate perspectives of individual raters is a rich and enlightening part of culture assessment since it uncovers multiple perspectives that may go unnoticed otherwise.”

“This discussion builds understanding, opens lines of communication, and reveals elements of the organization’s culture that a single individual or task force may miss.

Following this consensus building discussion focused on the current culture, this same group of respondents completes the OCAI a second time. This time they rate the OCAI items in response to this question: If your organization is to flourish, to achieve dramatic success, and to accomplish its highest aspirations in, say, five years, what kind of culture will be required?

After individual culture scores are produced a second time, a consensus building process occurs again in which a preferred future culture profile is developed by the respondent group. The current and the preferred future culture profiles can then be compared to determine the extent to which a culture change process is required. In a large majority of organizations, some culture change is desired as indicated by a difference in the culture profiles resulting from the two consensus building discussions.”

APPENDIX B: OE EXPECTATIONS- INTERCONNECTION BETWEEN THE CORE PROCESSES



APPENDIX C: RESEARCH QUESTIONNAIRE

Operations Excellence Survey

Dear Respondent,

Thank you for taking the time to complete this survey!

The data submitted shall be used in a review of the Operations Excellence programme implemented at Chlor-Vinyls.

The identification of the implementation shortcomings through the survey will allow recommendations to be made in order to achieve the desired outcomes of the programme.

The information gathered here can thus be used to change the way things are done at present, to the benefit of all stakeholders.

Instructions:

1. Enable macros by clicking on the **"Enable Content"** button highlighted above the formula bar. This allows the survey to be submitted.
2. The survey itself is on the next sheet. Click on the "Begin Survey" button below to go there.
3. The responses in the first section are made by clicking on the option best reflecting your opinion, as per the scale
4. Answers to the open ended question can then be made.
5. Complete the Demographic Information. This is used purely for analysis, for example it may appear that certain groups approach things differently than others.
6. Submit your results by clicking the "Submit Survey" button on the top right of the sheet

Begin Survey

	1) Training in OE methods	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.1	I am aware of the *Operations Excellence* (OE) Programme at Sasol	1	2	3	4	5
1.2	The *Operations Excellence Principles* have been communicated to me	1	2	3	4	5
1.3	The business has visibly trained and developed OE specialists to facilitate the programme	1	2	3	4	5
1.4	I am unaware of the *Operations Excellence Management System* (OEMS)	5	4	3	2	1

	2) Facilitation of continuous operations improvements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2.1	My working group usually seeks improvements in the work that we do	1	2	3	4	5
2.2	Management does not appreciate and respect the ideas and input of the workforce.	5	4	3	2	1
2.3	The effects of operational changes are analysed and reflected on after implementation to enable further improvement.	1	2	3	4	5
2.4	Management allocates the resources and attention needed for the implementation of improvement ideas.	1	2	3	4	5
2.5	Data is used in a continuous process of identifying improvement areas within operations	1	2	3	4	5
2.6	There is no need to change anything- "If it isn't broken, don't fix it"	5	4	3	2	1
2.7	Problem areas are addressed through the use of scientific improvement methods such as "Plan, Do, Check, Act" and RCA (Root Cause Analysis).	1	2	3	4	5
2.8	Standards and procedures are updated regularly, maintaining a source of "best practices"	1	2	3	4	5

	3) Leadership Accountability	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
3.1	Leadership demonstrates a long term commitment to operational change/improvement through their actions at all levels	1	2	3	4	5
3.2	Management have communicated the benefits seen from OE to me.	1	2	3	4	5
3.3	There is no clear communication from leadership regarding OE. For e.g. info of the process going forward, impact on me and my work methods etc.	5	4	3	2	1
3.4	Leadership demonstrates and lives the company's values	1	2	3	4	5
3.5	Management makes resources (time, money, knowledge and people) available for the implementation of improvement initiatives	1	2	3	4	5
3.6	The underlying principles/philosophies of the organisation changes from leader to leader	5	4	3	2	1
3.7	Management focuses on the positive aspects of problem solving by considering every new issue as a process to learn and increase knowledge.	1	2	3	4	5
3.8	Senior Leadership visits operations directly in order to reinforce Operations Excellence performance and discuss its effectiveness.	1	2	3	4	5

	4) Developing an Empowered and Competent workforce	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
4.1	The organisation is committed to developing me in line with my career aspirations and potential	1	2	3	4	5
4.2	People are keen to share knowledge within the organisation, even across disciplines and teams	1	2	3	4	5
4.3	We are allowed to make informed decisions regarding our work without having to get approvals	1	2	3	4	5
4.4	I don’t feel a sense of belonging or ownership toward the organisation	5	4	3	2	1
4.5	Lessons learnt and best practices are shared amongst individuals at all levels	1	2	3	4	5
4.6	Senior team members and managers withhold their knowledge and experience	5	4	3	2	1
4.7	Training is encouraged through formal education courses and on the job coaching	1	2	3	4	5
4.8	Standards and procedures are simply documented and easily accessible	1	2	3	4	5

	5) Alignment between business strategy and operations	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
5.1	Effort has been made to clarify the organisations vision and strategy to our team	1	2	3	4	5
5.2	Operations Excellence has been shown to fit within the company's strategy	1	2	3	4	5
5.3	Operations plans and strategies are seldom reviewed or adhered to	5	4	3	2	1
5.4	Customer requirements and Supplier capabilities are considered in the planning process	1	2	3	4	5
5.5	Performance measures are used to identify deviations from the plans and solutions are implemented to bring it back on track.	1	2	3	4	5

Q1	In your opinion, has there been sufficient information and communication made available regarding OE and its goals?	
Q2	What are the main barriers to operations improvements noticed from your experience?	
Q3	Are there any general comments regarding operations practices (positive or negative)?	

	Biographical Information:	(Please select from the options listed below)
B1	You currently work at:	
B2	Your current job level is :	
B3	Your operations related discipline:	
B4	Are you in a leadership/management/supervisory position?:	