

Optimisation of the JoJo Tanks Manufacturing Model

Thabiso Ndebele

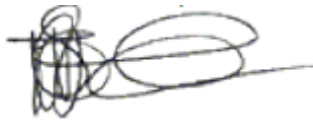
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**A consultancy report submitted to the Faculty of Commerce, Law and
Management, University of the Witwatersrand, in partial fulfilment of the
requirements for the degree of Master of Business Administration**

Johannesburg, 2018

DECLARATION

I, Thabiso Ndebele, declare that this consultancy report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.



Thabiso Ndebele

Signed at Alan Manor, Johannesburg on the 17th day of January 2018

DEDICATION

I dedicate this research to my late mother, Thabisile Ndebele, who lost her battle to scleroderma in November 2015. You are missed dearly!

To my wife, Sibongile Ndebele, who has been my rock for the last twenty months of the MBA – thank you! Without your support, I would still be busy with the introduction. I also hope that this work inspires little Minenhle, who was born on the 27th of February 2017, to always do her best in whatever she does!

ACKNOWLEDGEMENTS

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To my supervisor Mike Mundy, your far-reaching experience provided me with guidance I needed to think differently. You kept pointing me in a direction of discovery – I enjoyed the journey.

To the Wits Business School, thank you for providing students with dynamic and business-oriented research options and to Prof Anthony Stacy - thank you for your time and patience to answer those random questions.

To Dane Potgieter, thank you for being the unofficial sounding board – a super genius yet to do his MBA!

SUPPLEMENTARY INFORMATION

Supervisor: Mike Mundy

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Supplementary files: Overall Equipment Effectiveness Analysis

EXCO Presentation – 22 September 2017

Factory Manager Template

[†] Including Executive Summary, References, etc.

***Note:** Provision of supplementary information is limited due to the nature of work conducted and agreement on the Non-Disclosure Agreement. As such, key information may have been excluded in the report if it was deemed to offer competitive advantage to industry players who may read this report which may be publicly available.

EXECUTIVE SUMMARY

Through this exercise, JoJo Tanks management wanted to understand the opportunities for improving efficiency in the manufacturing of their products. With over 35 ovens across the country, the optimisation of the manufacturing model was important in what is becoming a highly competitive roto-moulding industry. Furthermore, what was key for Executive Management was the ability to optimise the use of existing ovens and the ability to increase production in response to market demand.

Three Operations Management theories were applied in the assignment i.e. Lean Thinking, Lean Manufacturing and the Theory of Constraints as well as the concept of Overall Equipment Effectiveness (OEE) was utilised to understand the effectiveness of each oven. Each of the oven's production data was analysed to determine the OEE which was comprised of; throughput of the oven (categorised by size), the utilisation rate as well as the overall factory's quality rate. The key conclusions from the analyses were (1) the manufacturing model was constrained by the limited number of oven moulds and as such, this led to (2) overproduction of non-stock items (in a bid to increase oven utilisation) and (3) this led to high inventory holdings and at times, affected (and stalled) production as there was no space to store products from the manufacturing line and (4) led to use of overtime to respond to customer demands (both in terms of product and within SLA timelines).

The analyses also indicated that, ovens which focused on two or less products had higher throughputs. A closer inspection indicated that factories with a low number of ovens, had to manufacture a wide range of products and lost out on efficiencies irrespective of the oven size category. Furthermore, JoJo Tanks production pattern was cyclic, that is; the company has predictable peak and off peak period in which manufacturing modes could be adjusted however; the troughs were used to catch up to the production cycle.

Financial analysis presented to JoJo Tanks Management indicated that some ovens required a high number of units to break even due to pricing and cost to manufacture. This was linked to the size of the product and as expected, the large products were profitable.

A five step upgrade path to address the above challenges is proposed:

1. Increase the number of stock product moulds in order not to 'choke' the operating model – this would provide opportunities to manufacture the right product at the right time;
2. Standardise cycle times and that would enable factory managers to optimise outputs / targets;
3. Reduce inventory holdings and operate on a 24/5 model. This would in turn provide the company with the ability to surge if sales / customer demands are high;
4. Centralise coordination of manufacturing and delivery based on customer location (vs. customer's preferences) and based on capacity in a specific factory; and lastly
5. Optimisation of factory location based on Steps 1 – 4 above.

The major impact of the above recommendations would be on the net pay the employees would receive, as the company would run less overtime schedules due to proper planning.

Keywords: Lean Manufacturing; Takt Time; Overall Equipment Effectiveness (OEE)

ABBREVIATIONS

Abbreviation	Definition
AM	Agile Methodology
BCG	Boston Consulting Group
BDP	Best Demonstrated Practice
CEO	Chief Executive Officer
FCFs	Free Cash Flows
JIT	Just In Time
LLDPE	Linear Low-Density Polyethylene
LM	Lean Manufacturing
PM	Project Manager
OEE	Overall Equipment Effectiveness
OM	Operations Management
SCM	Supply Chain Management
ToC	Theory of Constraints
TQM	Total Quality Management

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1 INTRODUCTION

JoJo Tanks is a South African roto-moulding company that utilises linear low-density polyethylene (LLDPE) for liquid storage applications for water storage, animal habitation, and other sewerage storage products, as shown in Figure 1 below. The company was established over 40 years ago by Johannes Joubert (hence JoJo Tanks), to address the need for water storage in communities without easy access to water.



Figure 1: Illustration of JoJo Tanks products, JoJo Tanks Brochure (2017)

Roto moulding is a process melting plastic powder that has been put inside a metal mould and baked in a hot environment. The rotation of the mould would ensure the melted plastic is distributed evenly and after a certain period, this mould would be taken out of an oven and cooled down - a process illustrated in figure 2.

These plastic moulds were seen as a solution to the problem at the time but the idea turned into a profitable and successful business for JoJo Tanks. As far back as 1998, the application of roto moulding was on the rise due to its simplicity and scalability and ability to create complex shapes relatively simple, as outlined by Liu *et al* (1998).

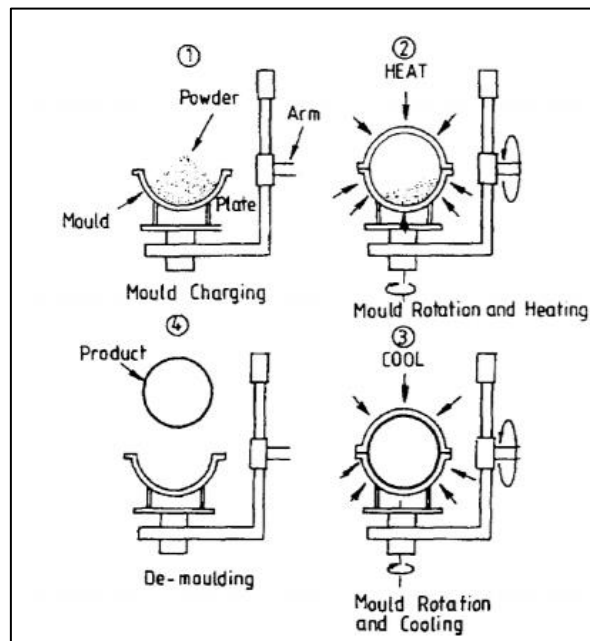


Figure 2: Roto moulding process (simplified) Crawford (1996).

The company grew over the years and currently JoJo Tanks has two polymer processing plants (in Groblersdal (Limpopo) and Camperdown (KwaZulu Natal)), which convert plastic bits from SASOL into fine powder that is distributed to all seven manufacturing factories across the country as shown in Figure 3 below. JoJo Tanks also has a factory in Zimbabwe however; the study excludes analysis of this plant.

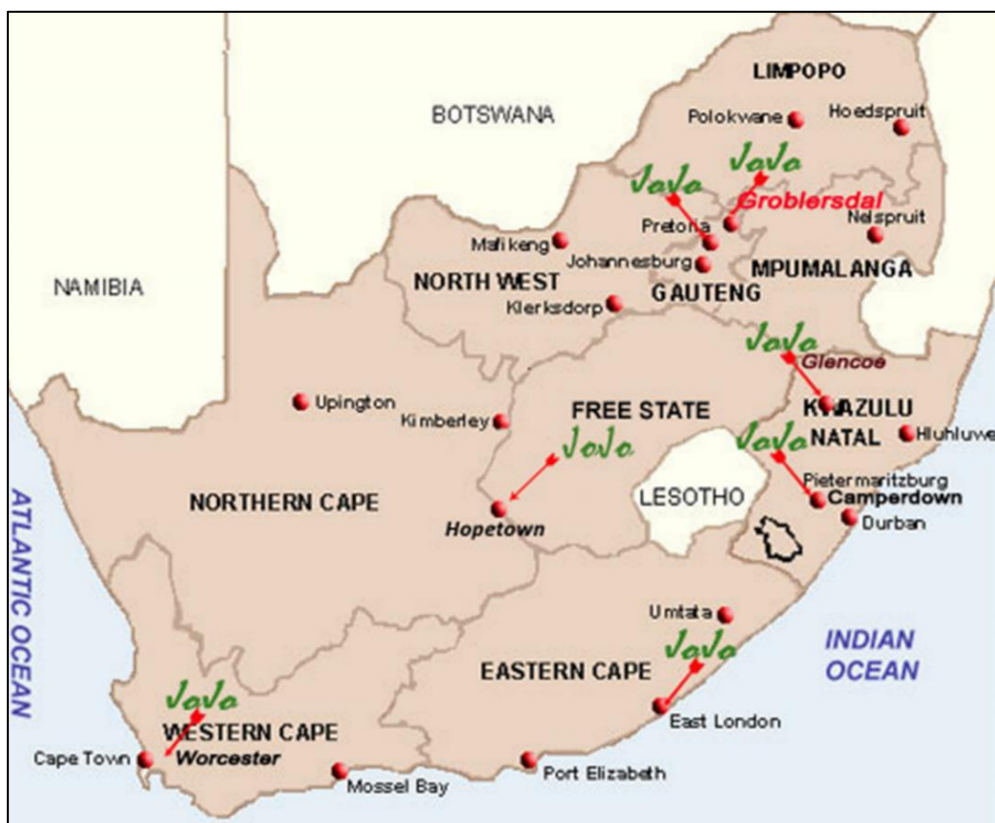


Figure 3: Location of JoJo Tanks Factories as of Jan 2017

1.1 Purpose of the study

A company is created to add value to a product and/or service in exchange for profit. That is, if a potential customer sees value in the product and/or service, they are likely to purchase it – hence the concept of ‘value for money’.

Furthermore, companies are created and/or investors buy into a company that can illustrate the ability to enhance value, i.e. create a product(s) that customers will see value in them. Investors put up capital to start a business or invest in the acquisition of assets to generate shareholder value. This shareholder value can be increased in multiple ways including; increase in profit, net worth of shares through ‘sweating of the assets’ and/or the reduction in operating costs.

In the case of JoJo Tanks, shareholders instructed management to increase their shareholder value and one of the key focus areas for this consulting assignment is to identify pockets of efficiency that can be achieved and thus lower operating costs, ‘sweat the assets’ and increase profitability.

1.2 Context of the study

The company supplies the market with over 100 different products in various colours, strengths and configurations. Each factory has a number of ovens and moulds for a variation of products. The moulds are inter-changeably utilised in a plant and henceforth, there are various combinations – i.e. an oven can accommodate a number of product moulds. Furthermore, the company has a number of ovens across the country that use various types of fuel viz. coal, paraffin and/or electricity.

In a bid to increase its shareholder value, the company has undertaken to review its operations and logistics divisions. The key objectives are to understand where efficiencies could be gained by lowering operating costs and have flexibility in pricing to remain competitive and retain market share dominance.

1.2.1 Industry Competitors

JoJo Tanks operates in a market which has other 2-3 major players viz. Eco Tanks, Rototanks and KRM. The major players are all part of the Association of Rotational Moulders of Southern Africa (ARMSA), which produce a variety of plastic products. Based on engagements with the Managing Director of JoJo Tanks, the company is

deemed to have the strongest brand in the water storage industry, with the largest market share (over 50%¹) based on stock orders, inventory space with major retailers as well as the fact it has been operating the longest in South Africa.

1.2.2 Market Share

Whilst market share is often a good indicator on how successful a company may be in a specific market; it has to be stated that market share should not be viewed in isolation because:

- Lack of efficiency in producing the significant product volumes may lower its returns and profitability;
- The company may not be making significant cost contributions per unit product; and/or
- The market share could be for a product that is slowly becoming obsolete.

1.2.3 Increasing shareholder value

The key objectives of any business is to increase shareholder value, either by profit or the net worth of the company shares Hart and Milstein (2003). The key attributes that shareholder value is composed of are:

- Sales - in terms of the revenue generated from the volume of units sold at a specific selling price;
- Earnings – usually the after-tax income generated from sales ; and
- Free Cash Flows (FCFs) – cash available for additional investment, as paid out to investors / shareholders as dividends.

There are various ways one can achieve that objective and the two primary variables are namely”

- To decrease the cost of producing a product and/or service, or
- Increase the revenue generated through its sales, either increasing the volume of units produced or its selling price.

Figure 4 provides a synopsis on key variables that are generic and applicable to a number of applications / organisations.

¹ The non-disclosure agreement does not permit providing exact figures on pricing, volumes, market share and production figures.

The complexity in addressing the challenge of increasing shareholder value is that; the variables are internally and externally linked. An example of such is how by decreasing the price of the product may attract more customers and increase the market share however; if the efficiencies of producing the product are not looked into, this may have an overall negative outcome to the profitability and henceforth, the shareholder value. Increasing shareholder value can also be investigated by looking into the internal efficiencies the company can achieve, be in a position to offer a lower selling price and henceforth increase market value and volume throughput.

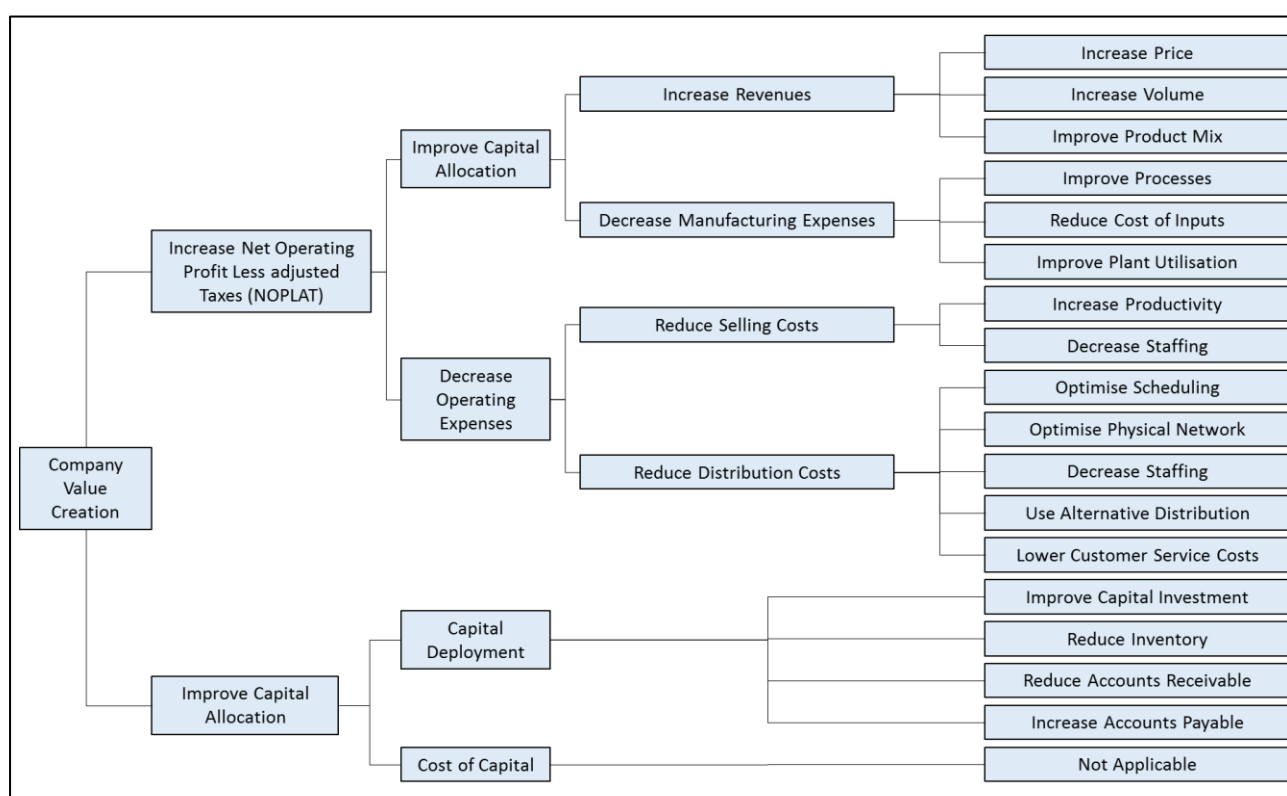


Figure 4: Key operational and financial variables that can be considered to look into increasing shareholder value – adapted from Domont (2014)

1.3 Problem Statement

1.3.1 Efficient Oven Utilisation

The business has in the past, optimised its functions and production on a ‘trial and error’ basis, and whereby best manufacturing practices (BDPs) within the companies were not recorded and shared within the business. This culture (i.e. ‘the way we do things around here’) was evident when in one factory, where instead of installing a standard water cooler, a ‘hydration station’ was created by cutting/punching out

holes on an electric deep freezer, one for the water inlet pipe and the other for the outlet tap. The argument was – ‘we make it work!’.

Furthermore, the company’s ovens and moulds used to manufacture various products were designed in such a way that various moulds can be utilised interchangeably and as such, the same oven – e.g. a 2 500l tank mould can be baked in a 5 000l oven, and so would be the case for the 5 000l, 2 200l and a 1 000l tank. Figure 5 below provides a schematic of such a process.

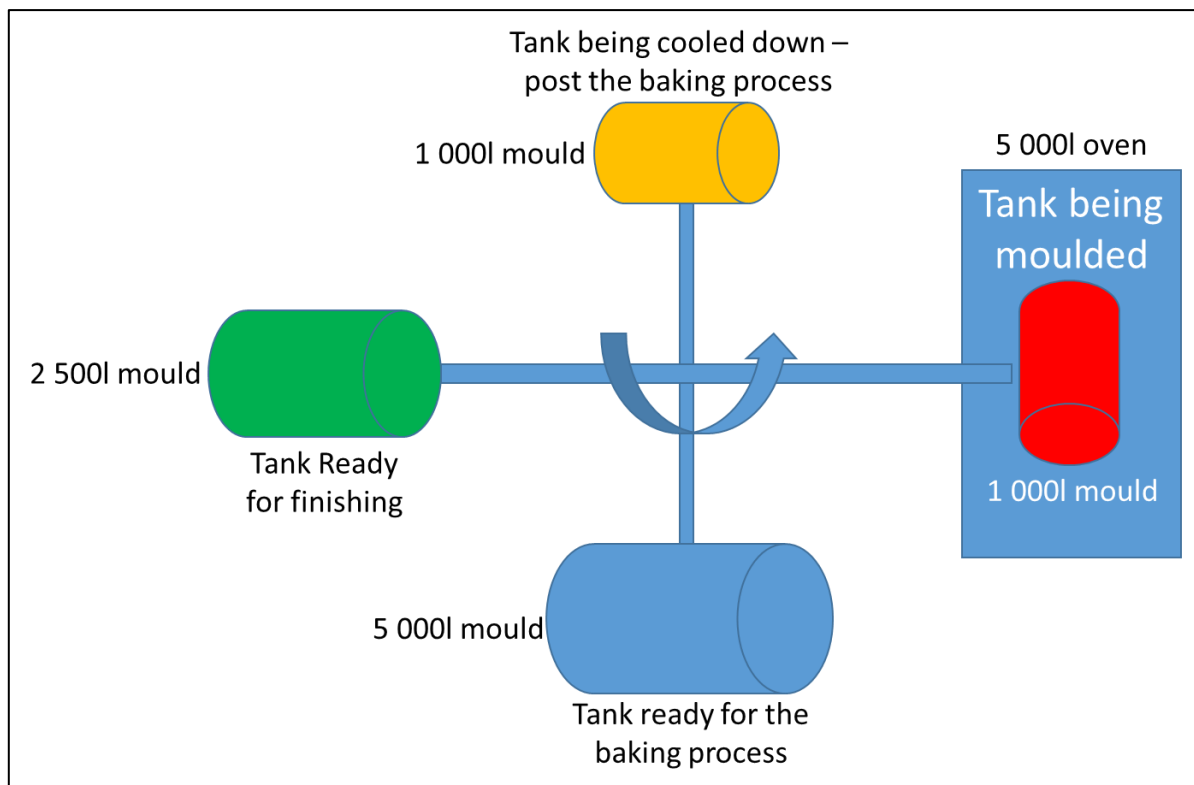


Figure 5: A typical oven with various mould sizes, reconstructed from factory observation

From observations, areas to optimise the process were identified however to date, there was no scientific or business analysis conducted by management. It was on ‘gut feel’ that the company could do better. Furthermore, the mixing and matching ovens and moulds meant that, any scientific analysis or processed mass calculations could be skewed. In addition, due to the mixing and matching, the optimum scheduling and production practices were yet to be identified (as shown in Figure 6).

Other complications linked to managing costs were that, the logistics model is in-sourced and each plant ‘pays’ for insourcing material and distribution of the finished goods. It meant that a factory was operating semi-independently. Henceforth, it would be possible to have a factory offering a product cheaper and yet it is slightly further away from the client vs. another factory (intra-factory competition).

Lastly, a customer can order a tank directly from the factory and it is dependent on a smart and 'street-smart' individual to advise the client of a nearby factory or to check and possibly transfer the order to the nearest factory (if they have capacity).

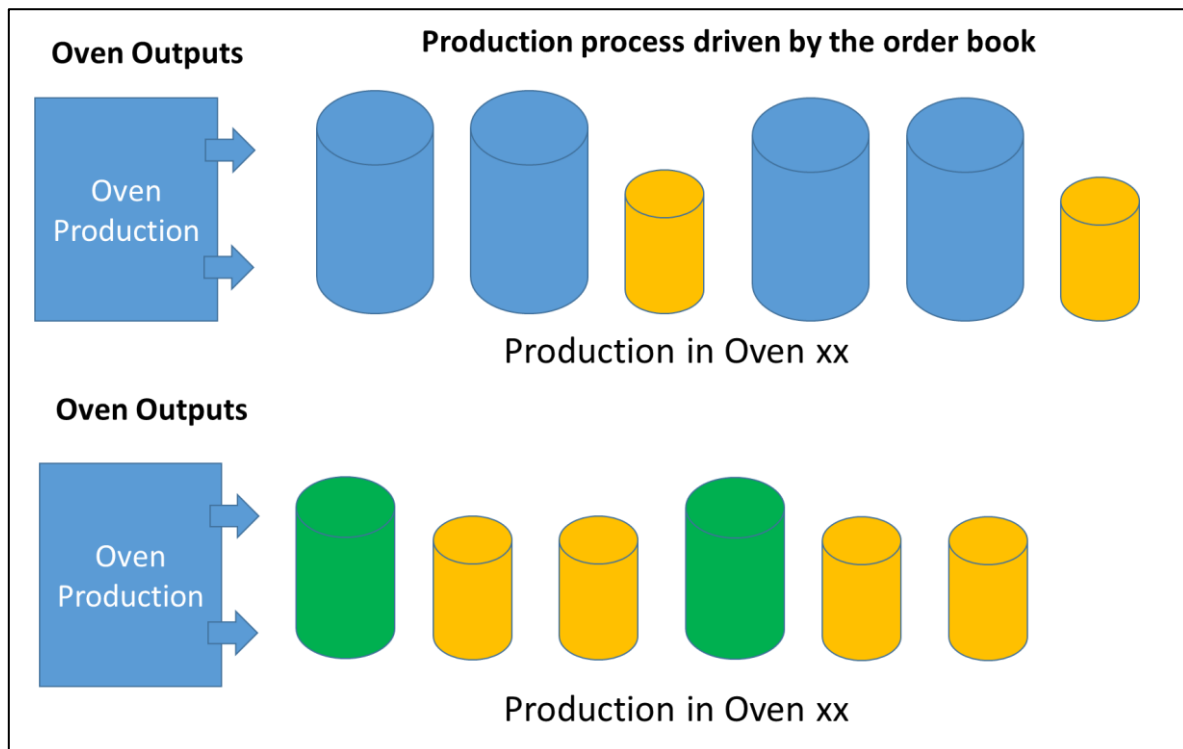


Figure 6: A production output driven by stock demand from customers

1.3.2 Variation of production of goods

The company produces over a 100 different products in various locations in South Africa. Due to the lack of understanding the true production costs per product as well as the pricing structure (which includes transport), the company felt it was beginning to lose the competitive edge as competitors were offering similar products for cheaper (and produce these tanks in a green colour as well). Engagement with National Sales Manager indicated that JoJo Tanks' prices were the benchmark for the market and as such, it was becoming difficult to 'beat your own price'. The objective to understand the true cost of the product per location was important, so that products can be marketed and priced accordingly.

The demand for various products is witnessed in the production of tanks whereby, the schedules are not aligned and as such, it is possible to utilise the various size ovens producing products of different sizes. That led to increased energy costs, noting that majority of the ovens utilise paraffin as a source of energy.

1.3.3 Variation in workload

Whilst it is generally acknowledged that the demand for a product varies throughout the year, the lack of understanding this pattern can escalate operational costs for JoJo Tanks. This is due to the fact that during peak times, the company runs 24 hour shifts (either 3 shifts for 8 hours or 2 shifts for 12 hours), for five to seven days which may lead to employee exhaustion and increased production costs (i.e. the overtime labour rate is above the normal wage rate).

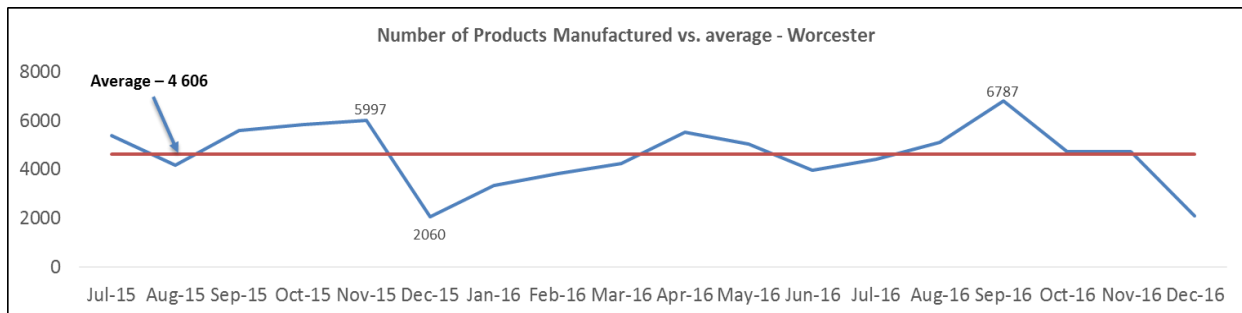


Figure 7: Analysis of product manufacturing (completed to understand scope of work)

The pattern illustrated in Figure 7 for one of the plants (Worcester) was analysed for all factories (and summarised in Figure 8). The production patterns have proven to be similar across most plants however; Groblersdal seems to be the most stable and efficient plant (at face value).



Figure 8: Variation in the production of products for all factories [July 2015 - December 2016]²

Key trends shown were:

² The analysis was conducted during the project scoping phase hence the timelines were extended to include July – Dec 2015

- The peak production period before December (considered to be the 'hobbyist period' when environmentalists have time to configure their homes for water harvesting); and
- Adverts by retailers (around April) increased the demand for tanks.

Other factors were related to the weather (e.g. Western Cape drought) which drove demand beyond expectations.

1.4 Significance of the Consulting Assignment

This consulting assignment will benefit the JoJo Tanks management by:

- Better understanding the true manufacturing costs per product, per oven and per factory;
- Understanding the Overall Equipment Effectiveness (OEE) for each oven;
- Identify opportunities to increase or reduce prices based on location, competition prices and operating asset efficiency and limits; and
- The review of the transport logistics – the company has outsourced that to an independent consultant however, the co-development of a cost to serve model will be factored into the project.

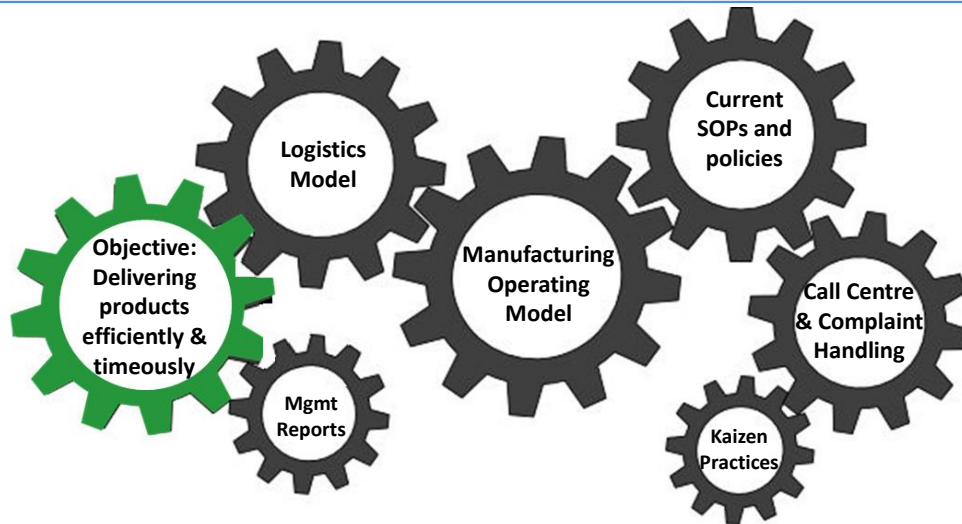
1.5 Delimitations of the Consulting Assignment

The value chain of JoJo Tanks includes several focus areas *viz.* logistics, call centre, Standard Operating Procedures etc. These are represented in figure 9 below:

The scope of the work excludes:

- The analysis will focus on company's factories based in South Africa;
 - Operations in Zimbabwe will benefit as the operating procedures will be standardised post the project
- The review of the Call Centre and ordering process;
 - The management of sales and complaints have been excluded to manage scope

Phase II of the project will focus on the key components of the supply chain model & relationships between the 'cogs'



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JoJo Tanks

Figure 9: Key components in the production and delivery of a JoJo Tank

- Data analysis will be from 01 July 2016 to 28 February 2017;
 - This was based on available data and reflection on sales patterns recently (viz. Western Cape drought)
- Data extraction will be executed by JoJo Tanks employees, and such work will be acknowledged.
 - This will be primary data sourced from systems, log sheets (employee, fuel and production sheets)

1.6 Assumptions

The following assumptions have been made for this consulting assignment and these are:

- The company's strategy will not be amended prior to the conclusion of the study;
- The management and the project sponsor will keep the scope of the consulting assignment reasonably unchanged, noting the potential small gains that can be discovered during the consulting assignment (scope creep); and
- The data integrity will not be compromised in an attempt to influence the study
 - The data triangulation will be conducted to ensure consistency and reliability

1.7 Chapter 1 Summary

The project aims to address the challenges noted by the Executive of JoJo Tanks. The project's uniqueness lies in the fact that, it seeks to push the boundaries of a well-known technological application and market knowledge to retain profitability and market share. Furthermore, it aims to investigate and identify best manufacturing practices and logistics practices within JoJo Tanks through:

- Analysis of production information as well as operational costs (incl Break Even analysis as shown in Figure 10 below);

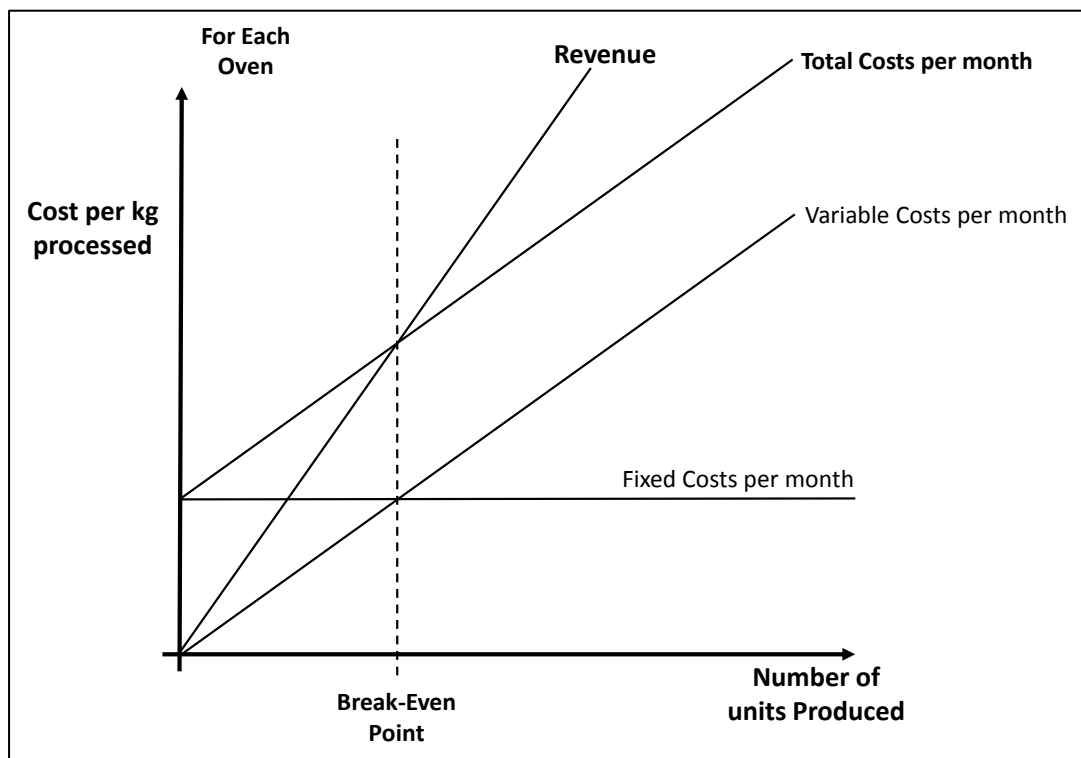


Figure 10: Discussion notes during scope development

- Pushing the boundaries of a well-known technology and market knowledge to retain profitability and market share;
- Overall effective use of operating assets; and
- Replicate the best practices throughout the company.

Post engagement and agreement with JoJo Tanks' Managing Director (MD), who was the project sponsor and manager, the focus was deemed to be on the highlighted areas in Figure 11 below.

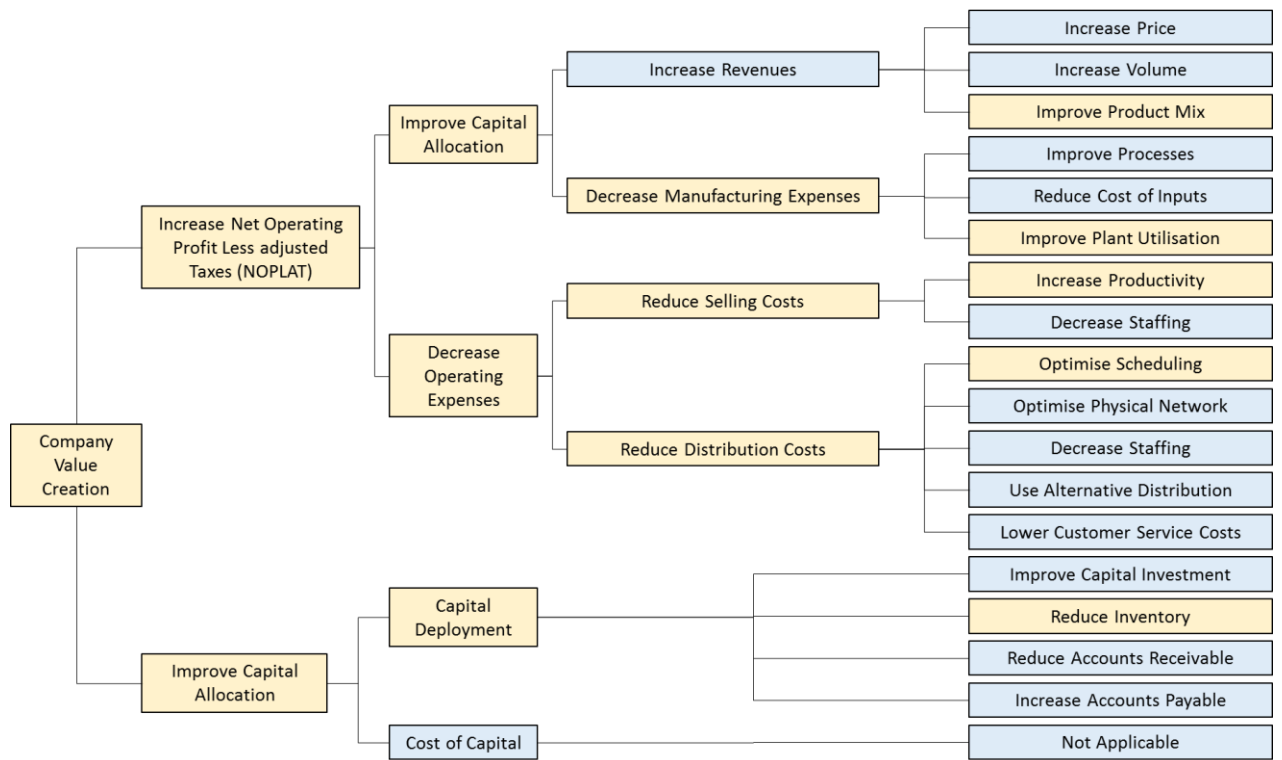


Figure 11: Highlighted are key focus areas for the project – adapted from Domont (2014)

2 Literature Review

2.1 Key Operational Management methodologies

Various process improvements and operations management (OM) methodologies have been developed over the past five decades. These have included Lean Manufacturing (LM), Six Sigma (6σ), Total Quality Management (TQM), Just-In-Time (JIT) and more recently, strategic Supply Chain Management (SCM), Agile Methodology (AM) as well as Lean Thinking. These methodologies have focused strictly on producing a specific product in the most efficient manner by removing waste from the process. Gupta and Boyd (2006) expressed that these methodologies focused on improving manufacturing performance and various case studies have been published to indicate such improvements.

Each of these methodologies has been applied to various industries, mainly in manufacturing. The success of Toyota and other Japanese companies has been attributed to LM as discussed by Hines *et al.* (2004). The key fundamentals of Lean Manufacturing which focus on eliminating waste (or *muda*) are:

- *Transport – unnecessary movement of goods (not required at a particular point in time);*
- *Inventory – storage of finished goods which have associated ‘management’ costs (e.g. security, movement, insurance);*
- *Motion – additional movement by employees or goods during processing;*
- *Waiting (time) – time wasted waiting for the next production cycle;*
- *Overproduction – which leads to additional movement of goods into the inventory;*
- *Over-processing – which results from poor manufacturing processes; and*
- *Defects – which require re-working and inspection as well as right off.*

These principles have been applied successfully in the automotive industry however; Hines *et al* (2004) also highlighted significant short comings of LM including amongst others:

- *Lack of human integration and/or human aspects*

The LM production systems are viewed through the Marxist lens as being exploitative and dehumanising.

- *Insufficient strategic perspective;*

Hines *et al.* (2004) argued that companies employing such management methodologies did not consider the benefits of other tools or operations management frameworks, view was further supported by Hines *et al* (2002).

The above operational management methodologies have ensured that companies retain their competitiveness in various industries (as shown in Table 1 below), with a primary view to respond to the clients' needs. Meredith *et al.* (1994) provides an indication on these needs which may be stand alone or a combination of (high) quality, delivery times and/or price Meredith *et al.* (1994). Table 1 below provides a synopsis of the various types of customer needs for some of the well-known companies.

Example	Critical attributes	Supporting attributes
Peerless	Rapid response, customization	Image, quality, price
Toyota	Rapid response, semi-customization	Convenience
Dover	Rapid response, semi-customization	
Pilton	Rapid response, customization	Price
Benetton	Rapid response, product design	
US2	Customization, rapid response, price	
Black & Decker	Quality, price, semi-customization	
Makita	Price, quality	

Table 1: Key customer needs that companies need to react at Meredith et al. (1994)

The introduction of the Theory of Constraints (ToC) by Goldrat in 1980s introduced a different view of how manufacturing should be. The methodology focused on throughput versus the perfection of producing a product (Moore and Scheinkopf (1998), Simatupang *et al.* (2004)). The focus of the methodology was to identify constraint(s) that prevent the system from achieving higher levels of performance. The fundamental difference with this approach is that, improving efficiencies were known to yield 15% to 25%.

2.2 Application of the Theory of Constraints

The ToC has been applied in numerous quantitative and qualitative applications. Simatupang *et al* (2004) applied the ToC in a quantitative environment for Supply

Chain optimisation, Teaching Leadership and Single Machine Scheduling application respectively. Ehie and Sheu (2005) applied the ToC and existing operations management theories (e.g. Six Sigma (6 σ)) to improve factory efficiencies Ehie and Sheu (2005). Figure 12 below provides a comparison between ToC and Six Sigma.

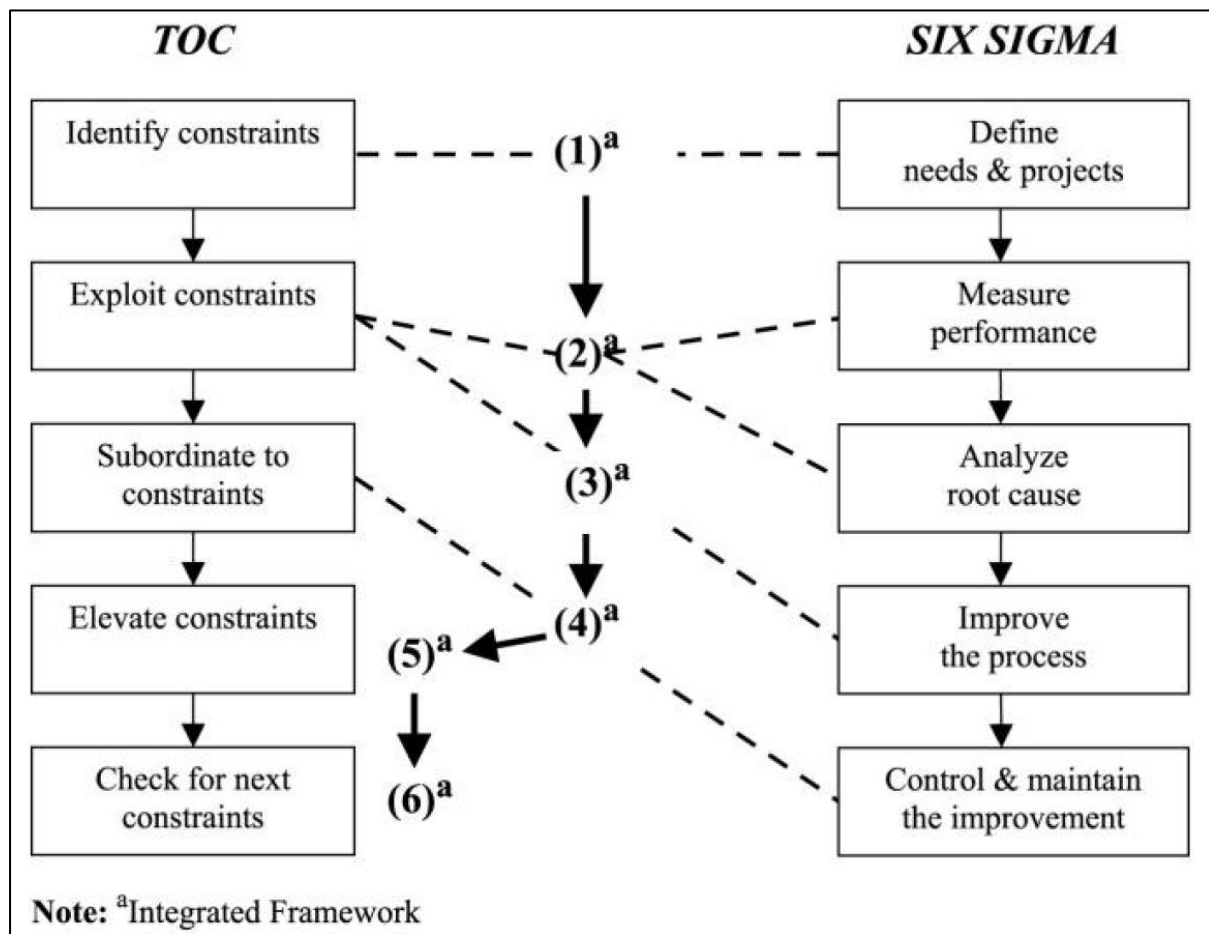


Figure 12: Contrast between ToC and Six Sigma (Operations Management Theory), Ehie and Sheu (2005)

The theory revolves around the notion that systems have a constraint – an inhibitor that causes the system to slow down and not function optimally / to its maximum potential. The ToC uses a methodical methodology which consists five steps (Goldratt and Cox, 1992):

- I. Identify the system's constraint(s).
- II. Decide how to exploit the system's constraint(s).
- III. Subordinate everything else to the above decision.
- IV. Elevate the system's constraint(s).
- V. If a constraint has been broken, go back to step 1. Do not allow inertia to cause a system's constraint.

2.3 Lean Thinking

Womack and Jones (2015) outline a key fundamentals of Lean Manufacturing which should be explored in detail in order to improve production. Authors propose that a lean way of thinking permits an organisation to “specify value, line up value creating actions in the best sequence, conduct these activities without interruption whenever someone requests them, and perform them more and more effectively”. This type of thinking is best summarised by figure 13 below. Further exploration of this concept outline the key aspect relevant to JoJo Tanks – creating value. The authors define the concept of value as “capability provided to customer at the right time at an appropriate price, as defined in each case by the customer” - Womack and Jones (2015).

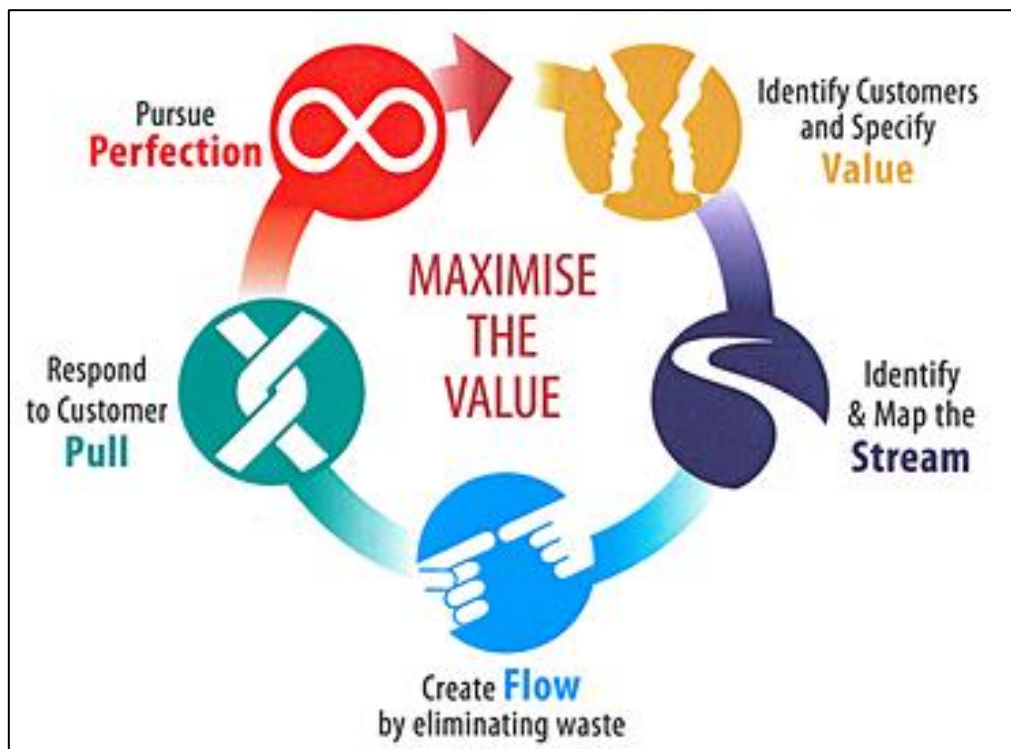


Figure 13: Adapted figure from Womack and Jones (2010) – ZeeshaN (2017)

Lean thinking principles address most of the challenges identified in Section 1 above. With over a 100 product variations produced across the country, JoJo Tanks’ product development was led by what customers have suggested. Most of these are not purchased in large volumes compared to traditional water tanks. This is deemed to be first step that is, the identification of customers and the specific value the product has. The second step outlined by ZeeshaN (2017) is value stream, the ability to remove waste from the processing of the value-add product. This strongly

resonates with proposals by Ehie and Sheu (2005), Simatupang *et al* (2004) and Matthews *et al* (2017) – whereby constraints in optimally producing a product are identified and reduced (if not eliminated).

The third step in lean thinking “Creating Flow”, aims to eliminate waste from a flow perspective whereby; value is created by tightly aligning sequential steps together that will enable a smooth flow in manufacturing and delivering a product to the customer. The fourth step “Responding to customer pull” focuses on the need not to over-produce and let production be led by the customer demand. This type of thinking finds expression and linkage to the elimination of waste as discussed by Hines *et al.* (2004) as well as using the concept of buffering as introduced by Goldratt (1992) and further explored by Moussa *et al* (2016).

The fifth step outlined in the lean thinking framework is the pursuit of perfection that is, continuously identifying and removing waste in manufacturing the product. This type of application finds linkage to 6 σ , TQM and the elimination of a constraint as applied by the ToC.

2.4 Amalgamation of various methodologies relevant to the problem statement

Various operations management theories have been developed over the past decade and in most cases, successfully implemented. These theories have a single common element – to ensure a product is delivered to a customer within no defects, on time and at a minimal cost (to the company). As such, three key categories that Goraya (2017) identified are:

- Manufacturing Productivity Improvement Techniques which may include amongst others:
 - Just in Time philosophy
 - Lean Manufacturing
 - Theory of Constraints (ToC)
- Quality Improvement Practices
 - 6 σ methodology
 - TQM
 - Benchmarking
- Organisational Improvement Practices

- Kaizen (strongly linked to Step 5 in Lean Thinking)
- Supply Chain Management (SCM)

Goraya (2017) further argues that companies can ‘compete’ on one or more of the three dimensions and furthermore, he proposed a framework encapsulates customers’ needs as shown in figure 14 below.

COST- C	DELIVERY- D
C1- Competitive pricing C2- Premium pricing C3- Reduction in Mfg. Cost C4- Lower operating expense C5- Low inventory	D1- Dependable D2- More frequent D3- Order fill rate D4- Accuracy D5- Timeliness
QUALITY- Q	FLEXIBILITY- F
Q1- Product quality conformance Q2- Product performance Q3- Enhanced customer satisfaction Q4- Value to customer Q5- Freedom from Defects	F1- Product variety F2- Product innovation F3- Lot size variation F4- Throughput time variation F5- Flexible Human Resource

Figure 14: Dimensions of competitiveness Goraya (2017)

The amalgamation of these theories is best summarised by ZeeshaN (2017) as shown in figure 15 however; the application of various theories for the study will be limited to the following operations management theories.

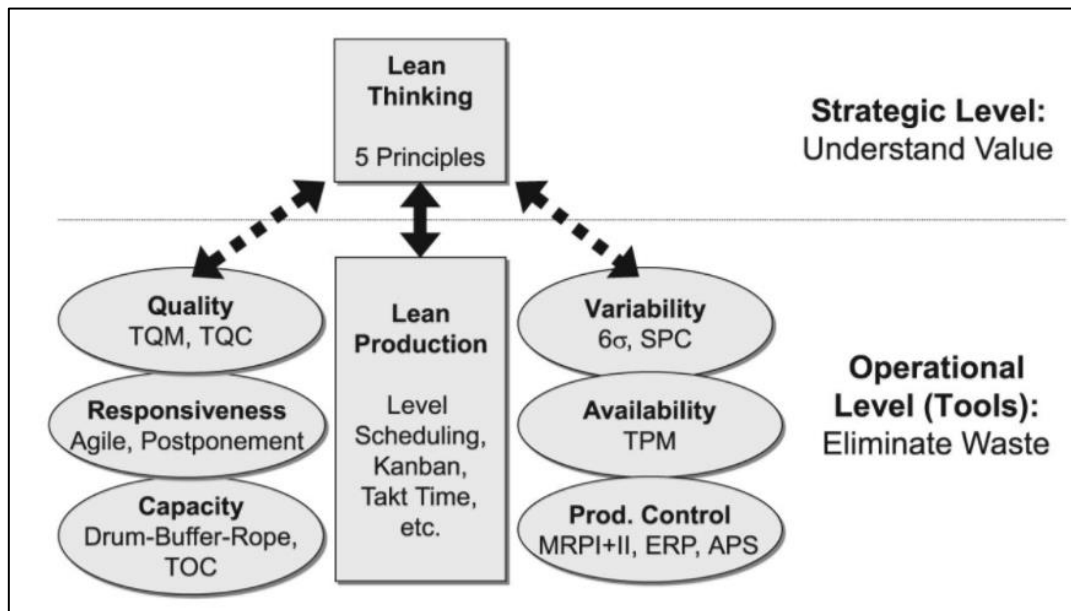


Figure 15: Integration of operations management theories Zeeshan (2017)

The relevant theories which will be considered for the consulting assignment are the following:

Current Challenges	Lean Thinking	ToC	SCM	Lean Manufacturing / Production
Variation in workload		√		√
Optimisation of the product portfolio	√		√	√
Inventory and Production Control	√			
Eliminating production wastes	√			

Table 2: Summary of the applicable theories to the consulting assignment

2.5 Chapter 2 Summary

The above OM theories were used as follows:

- Lean Thinking provided the insight to produce what the customer deems to be valuable;
- Lean Manufacturing provided insight to produce what is required in an efficient manner (i.e. reduce muda / 7 types of wastes)

- Theory of constraints provided the insight on removing major constraints in the processing value chain to maximise production and profitability.

As such, the above-mentioned theories reshaped the project during engagements with the JoJo Tanks management team.

3 Methodology

The analyses was split into two to:

- Better understand the production costs in detail per product, per oven and per factory; as well as
- Evaluate oven performance through the definition of the Overall Equipment Effectiveness (OEE).

Aligned to the objectives of the exercise, the focus strongly on:

1. Do we produce what we need, at the right time?
2. What is the cost of production for each tank and knowing that, are we flexible enough to price our products competitively?

The combination of the two products was anticipated to yield insight into production mix and how it can be optimised in response to sales. Furthermore, the analyses was to ensure the manufacturing and/or oven performance was coupled with profitability of the company.

3.1 Data collection and analysis

3.1.1 *Primary Data Collection*

This consulting assignment will focus on quantitative analysis of primary data from JoJo Tanks' systems. The information will be furnished by JoJo Tanks employees and the information will include the following (based on observations from the factory tour and project scoping)

- Product name (kg)
- Polymer Price (R/kg)
- Heat Energy Cons (litres/unit)
- Cooking Time (min)
- Cycle Time (min)
- Finishing Costs Mat (R/unit)
- Finishing Costs Labour (R/unit)
- Oven Operator Labour Costs Normal (R/hr)
- Direct Electrical Cons (kW)
- Electricity Costs (R/kW)

- Nominal Transport Costs (R/kg)

The operational / manufacturing analysis will include interviews with management to validate results or analysis in a semi-structure manner (i.e. inquiries will be based on the analysis however; the discussion will be grouped by category – e.g. HR elements on sick leave, roster / shift planning).

The other source of information which was key to the OEE analysis was:

- The production in the last 6 – 8 months, per oven, per product, per month (Available data);
- Rejects / Class B production (class B products are deemed to be good enough to be sold 'at cost')

3.1.2 Financial Analysis

Similar to the operations data, the financial information will be sourced from JoJo Tanks employees and/or management and these have been the identified variables based on the project scoping engagement:

- Factory Fixed Cash Cost Analysis
- Production & Maintenance and Support
- Admin Team
- Loading Teams
- Security and Cleaning
- Rental
- Rates & Taxes
- Base Electricity Costs
- Water
- Telephone and Communication Costs
- Machine Costs
- Other Costs

3.1.3 Break Even Analysis based on Factory Fixed Costs

The break even analysis was aimed at understanding each oven's contribution to the overall profit or loss to JoJo Tanks. The analysis was used to develop a Cost to Serve (CTS) model for Senior Management to determine pricing.

The methodology was based on:

- Production in the oven;
- Cycle time of the product
- Weight of the product;
- Cost of producing the product
 - Fuel Costs
 - Transport Costs
 - Labour Costs
 - Material

Figure 16 provides a synopsis of Oven 1 in Orania, whereby the oven (10 000l) was mainly used to manufacture 5 000l tanks.

Medium Product - 5000lt Vert	Per Unit		Per kg	
Selling Price - Netto	R	3 556	R	47.41
Less nominal tpt cost	R	460	R	6.13
Less TVC	R	1 630	R	21.74
Variable Margin	R	1 466	R	19.55
BE Point		3 585	R	268 884
Capacity per Month		743		55 722.86
Profit Cont at full Capacity	R	1 002 463	R	1 002 463

Figure 16: BE Analysis - Orania, Oven 1

3.2 Overall Equipment Effectiveness (OEE)

The primary objectives of this analysis was to investigate the performance of each oven. The commonly used definition for OEE is:

$$\text{Availability} \times \text{Performance Rate} \times \text{Quality Rate}$$

Whereby:

- **Availability** looks at the hours the oven is available (and not available due to maintenance, adjustments, machine idle time etc.)
- **Quality Rate** – the amount of plastic (in case of JoJo Tanks) that is not rejected due to poor product quality.

- **Performance Rate** takes into account the throughput (how well is the machine running when it runs);

The project seeks to investigate the current JoJo Tanks manufacturing model and business practices with a view to determining opportunities for improvement and a sensible and practical upgrade path. The project aims to identify best practices within and outside the company through the analysis of raw production data. This extensive study will focus on the manufacturing of different produces from raw material, to the cost of conversion (labour, energy, fixed costs) and lastly, on inventory control for finished goods.

The definition was however amended for JoJo Tanks due to the following reasons:

- Non-continuous process – ovens could be stopped at any time depending on the situation (e.g. overstock)
- Availability not recorded however, shift records provide utilisation which is a good proxy for availability. Henceforth, the absolute value of the OEEs would be a relative comparative measure and would be used as a peg on the ground to improve performance.

JoJo Tanks has over 35 ovens in 7 factories, across South Africa. During the analysis, all but the following ovens were paraffin powered:

- Orania
 - Coal powered ovens (both 10 000l ovens)
- Pretoria
 - One coal powered oven 2 500l and another converted post the study data period
- East London
 - One electric oven (less than 1 000l capacity)
- Worcester
 - One electric oven (with capacity between 1 000l and 2 500l)

The operations across the country were as per the order book and shifts could vary from a single 8-hour shift, to two 12-hour shifts and worst case, three 8-hour shifts which operate over the weekend.

As such, the OEE analysis focussed on a 24/7 shift system due to the limitation of the information (i.e. if the machine operated only two 8-hour shifts, there would be no information to support such a decision – perhaps the machine was offline due to maintenance. In cases where the length and reason for the breakdown was provided, the adjustments were.

3.3 Generic Consulting Methodologies

The value of management consulting has been recognised across various industries to being in a neutral opinion and among other reasons, to bring in expert knowledge within and outside of a particular industry. Furthermore, Gummerson (2000) argues that case study research was becoming more important and accepted as a scientific tool for management research – especially for cases which look into decision making, implementation and process change Gummerson (2000). Kubr (2002) outlines ten reasons why consulting assistance would be provided to management and table 3 below indicates the applicable reasons for this project.

Provision of consulting assistance to Management	Applicable to JoJo Tanks?	Comments
Provision of expert opinion	Yes	The student who will undertake the research has been in the management consulting field for over five years, in the optimisation of business processes. Annexure A outlines his consulting knowledge.
Performing diagnostic work	Yes	The project entails analysing the production data in a bid to establish efficiency levels
Developing action proposals	Yes	The assignment seeks to formulate solutions that management will consider for implementation, taking into account the time required to implement and yield results as well as the capital spent.

Table 3: Key reasons for providing management consulting assistance to management Kubr (2002)

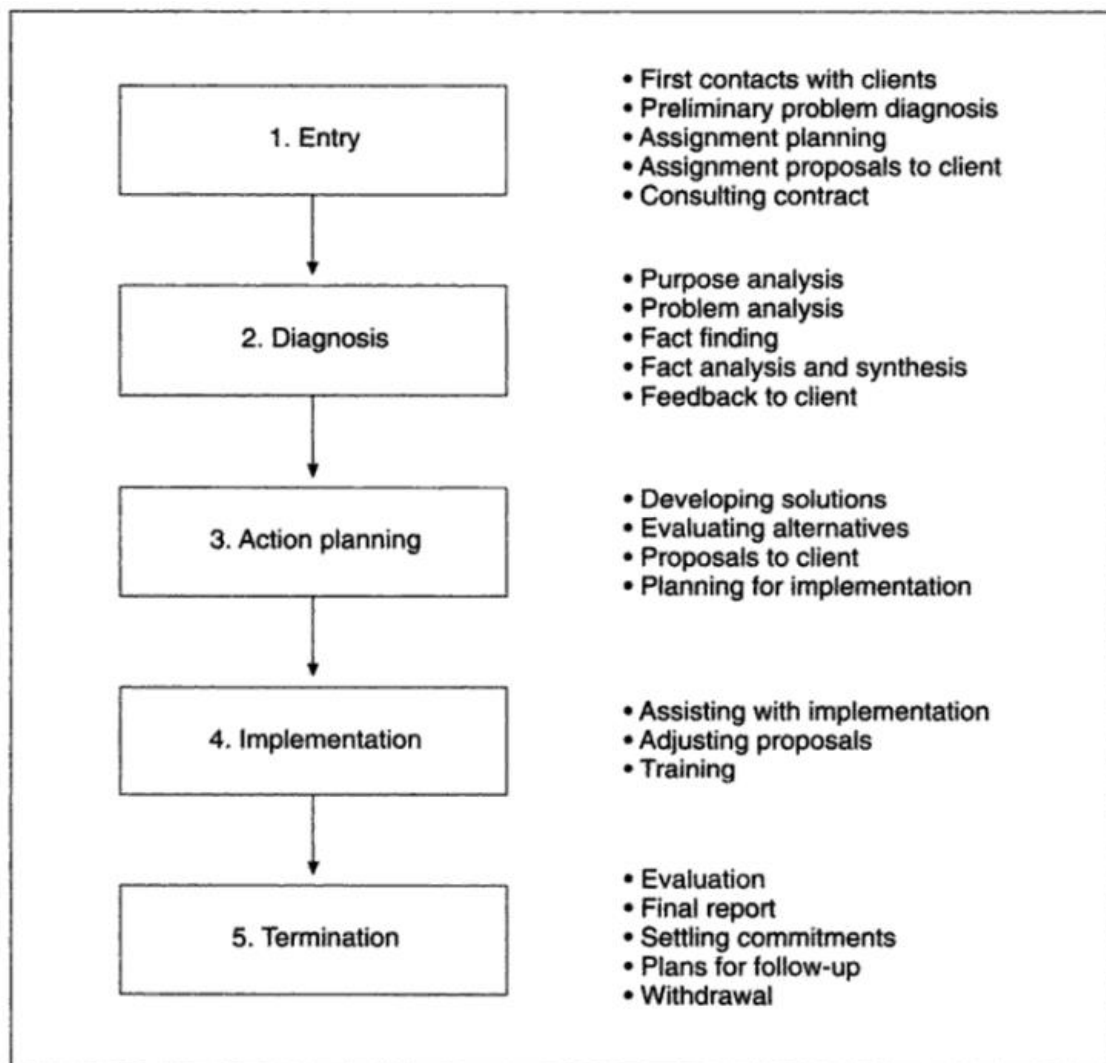


Figure 17: Generic Management Consulting process (Kubr (2002))

Other key reasons to engagement or acquire management consulting services (and not applicable for this project) are:

- Development of systems and methods
- Provision of information
- Provision of specialist resources
- Establishing business contacts
- Planning and managing organisational changes
- Training and development of staff
- Counselling and coaching

3.4 Selection of the top consulting companies

Well known consulting firms have their 'own' consulting methodologies. The objective of this research was look into existing methodologies and identify good practises which are applicable to this project. In the analysis and review of these methodologies, two different 'consulting' frameworks where identified namely:

- The common management framework
 - How management consulting methodologies are different or similar to one another
- The well-known frameworks that are associated with specific consulting companies (e.g. the dog, cash cow, star and unknown categorisation by BCG).
 - The objective with this framework is to define and understand the value each product has on JoJo Tanks' customers and to the firm itself. Engagement with management (during the project scoping phase) indicate that some products may not be worthwhile for the firm.

As such, the consulting methodologies from McKinsey and Bain and Company were explored, whilst the BCG portfolio framework was investigated and considered from a company product portfolio perspective.

3.4.1 Consulting Methodology

3.4.1.1 McKinsey

McKinsey utilises a similar methodology whereby, the emphasis is in scoping the problem, prioritising key issues, analysing and providing recommendations. Dunford (2000) looked into various consulting methodologies and outlined McKinsey's approach to problem solving is based on the key principles outlined in Figure 18 below.

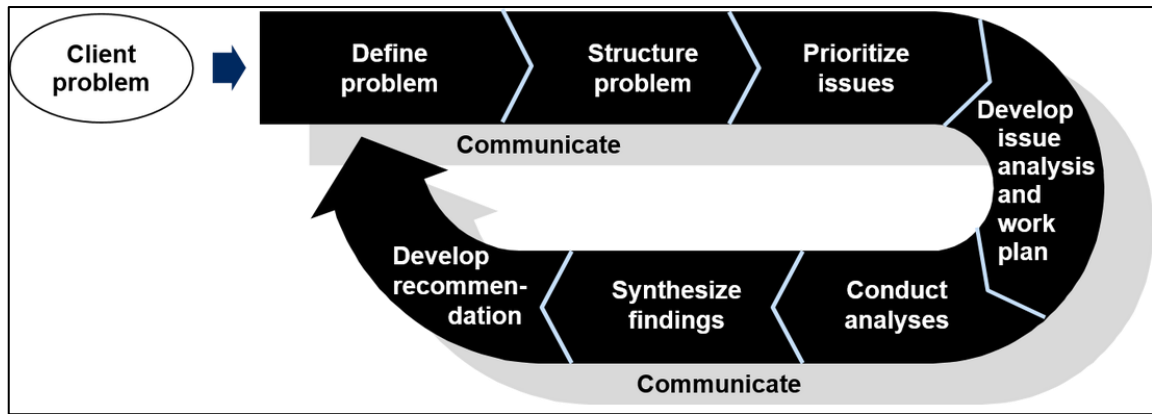


Figure 18: McKinsey Consulting methodology framework

In both the generic and the McKinsey approach, a significant amount of effort is taken in scoping the problem in a bid to identify the biggest ‘constraint’ and hence address it or come with solutions to eliminate it.

3.4.1.2 Bain and Co.

Figure 11 below provides an outlined approach to solving problems at Bain and Co. The difference in this approach is that, the methodology answers the question first (more of a hypothesis) and analysis the information to verify the ‘answer’. This approach is suitable for cases in which the Chief Executive Officer (CEO) has given an indication of where problems could be emanating from, and more importantly – for consultants to generate solutions to the hypothesis.

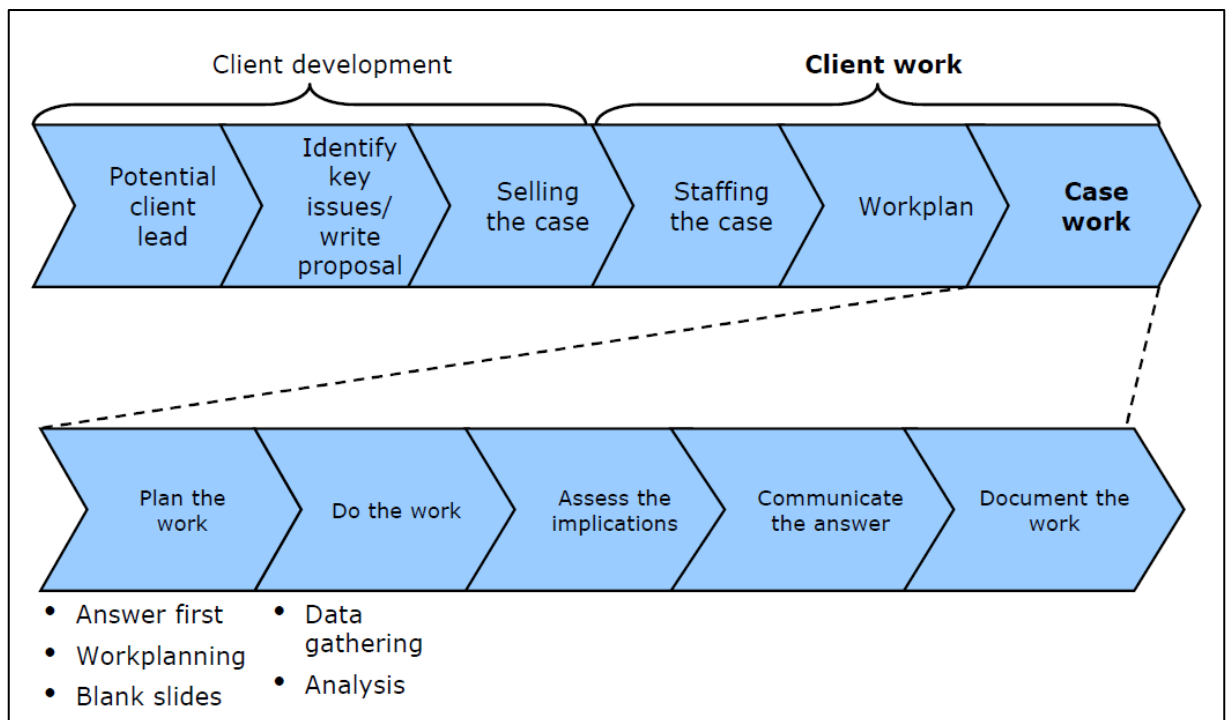


Figure 19: The way we work at Bain and Company (2007)

3.4.2 Product Portfolio - Boston Consulting Group

The second element that this consulting methodology research identified was the use of the BCG portfolio matrix framework (also known as the growth-share matrix) as shown in Figure 20 below. Developed by Bruce Henderson in the 1970s, the framework aims to identify a group of products that fall into four categories based on the revenue they generate and the cost of production.

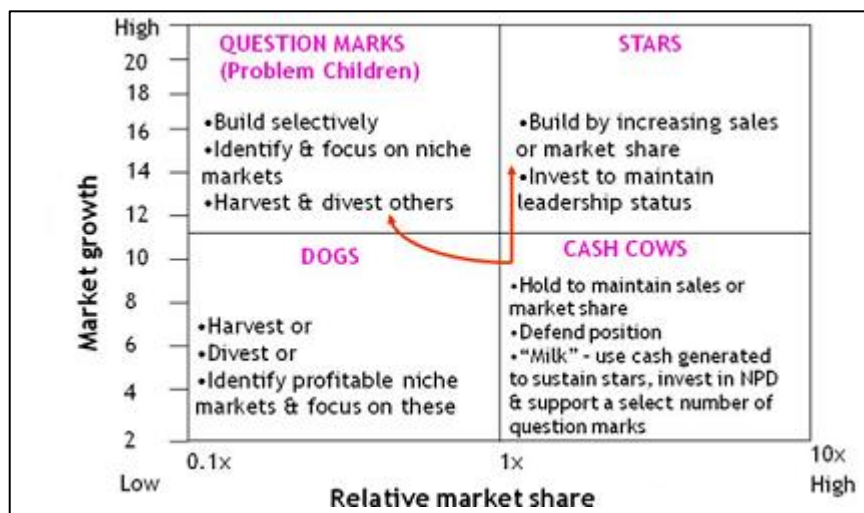


Figure 20: BCG Product Portfolio Matrix (Younis, 2016)

The relevance of the framework is that, there are products which JoJo Tanks produces that are cash cows (main stream products in specific locations), whilst other exact products are stars for different locations (due to logistical costs). Engagement with management during project scoping provided insights whereby, the 'gut-feel' was that not all products offered by JoJo Tanks were profitable – based on the volume, location and/or time required to manufacture

3.5 Project Governance

The work performed was reported on every 2-3 weeks through a PowerPoint presentation as well as supporting Excel sheets. Annexure 1 provides examples of such reports to the JoJo Tanks Project Team. These sessions were used as feedback (in addition to supervisor insight) on where to tackle key problems.

Engagements during the project with other relevant resources within JoJo Tanks were during office hours, as they were not available before 07:00 and after 17:00.

4 Data Analysis and Presentation of Results

As discussed in Section 3 above, Section 4 presents the outcome of the data analysis on both the financial (BE analysis) and manufacturing analysis (OEE).

4.1 OEE Analysis

The OEE analysis is made up of three components, viz. utilisation, performance (represented through throughput (kg/h)), and quality rate – all expressed in percentage (%).

4.1.1 Utilisation of Ovens

Based on the methodology set out in Section 3.3, the hours the oven operated for between July 2016 and Feb 2017 were analysed. The information revealed that on average, the ovens at JoJo Tanks worked 14.5 hours per 24 hour shift.

Main Product / Oven Size	Groblersdal	Pretoria	Glencoe	Orania	Camperdown	Worcester	East London	Grand Total
210l							5.5	5.5
500l	18.8				4.5	7.6	3.3	8.5
750l	15.2							15.2
1 000l						9.0		9.0
2 500l	16.7	17.8				12.6	15.0	15.8
5 000l	19.1	16.6	16.2		14.8	13.4		16.7
6000l	17.9							17.9
10 000l	18.4	16.7	17.0	15.6	13.1	11.1	10.9	14.8
20 000l	7.3							7.3
Grand Total	17.3	16.9	16.6	15.6	12.8	10.7	10.1	14.5

Table 4: Oven Utilisation between July 2016 and Feb 2017 (Average hours per 24 hour shift)

The ovens were utilised heavily towards the pre-Festive season months and one of the key reasons was that, hobbyists usually have time December to work on their projects as well as rural dwellers who buy a water tank when they are paid additional income in December. Other sales drivers are specials that hardware stores run prior and during the Festive season.

Shift information has always been captured but to date, JOJO TANKS had never conducted a study on how it utilises its ovens. Henceforth, the breakdown hours for each of the ovens was not available.

4.1.1.1 Groblersdal

The fact the biggest factory (i.e. largest number of ovens and the manufacturing headquarters) had the highest average utilisation per oven. The 20 000l oven was expected to have a lower (if not the lowest) utilisation rate due to the limited number of products it produces efficiently. “The Beast” as it is known, produces 20 000l tanks, a variety of 10 000 - 15 000l as well as heavy septic tanks operated mainly on a 24/5 shift unless if there was a significant order. Despite the number of ovens that provides Groblersdal with the ability to surge, there are underlying reasons why Groblersdal have on average, have the highest utilisation rate.

4.1.1.2 Pretoria

The next factory with high utilisation rate is the Pretoria factory. The utilisation of the 2 500l oven is mainly to produce two of the top 10 products for the company viz. 2 200l and 2 500l tanks. Its proximity to urban markets also meant other production lines are not far off from the internal benchmark figure of 17.8 hours.

4.1.1.3 Glencoe

The two oven factory’s utilisation (more specifically the 10 000l oven) is driven by the fact that there 10 000l oven can accommodate more mould types – a common practice for the smaller factories with a smaller number of ovens. Its utilisation however was affected by the limited number of factory operators.

4.1.1.4 Orania

Table 3 above does not reveal that the similar sized ovens are utilised differently, where one oven is dedicated to produce up to 5 000l ovens whilst the other one produces 5 000l to 10 000l tanks. However; the notable comments from the maintenance and shift sheets are that, Monday mornings are dedicated to ‘maintenance’ however; coal-based combustion requires a higher than normal clean up rate.

4.1.1.5 Camperdown

Camperdown's average is lowered significantly by the use (or lack thereof) of the small (Carousel) ovens, which is linked to the demand. At 4.5 hours per day, the utilisation of the small oven is significantly lower than Groblersdal's same capacity oven.

4.1.1.6 Worcester

Whilst the utilisation rate of the smaller ovens was expected, the utilisation of the bigger ovens was lower than expected. One observation was that, Worcester would operate 24 hours but not over weekends vs. other factories.

4.1.1.7 East London

Similar to Worcester, the East London's smaller ovens' utilisation rate was significantly reduced compared to other factories. A combination of limited or no weekend runs (even during peak periods), employee absenteeism and production stops due to overproduction – as shown in Figure 21, are contributory factors to the low utilisation rate.

Shift 1	Shift 2	Shift 3	Comments
8	8		16 SHORT STAFED
8	3		11 OVEN STOPPED, NO SPACE FOR TANKS
8	9		17 OVEN STOPPED, NO SPACE FOR TANKS
8	8		16 SHORT STAFED
8	4	4	16 PAY WEEKEND

Figure 21: Comments from Excel Oven Hour Schedules

4.1.1.8 Utilisation Summary

Table 4 below provides a summary of the utilisation rate for each oven for the duration of the study. Whilst it is noted that whilst Groblersdal has the highest utilisation rate, and that Camperdown, Worcester and East London's rate might be lowered by the use (or thereof) of carousels – it is important to highlight that 2 500l, 5 000l and 10 000l ovens are the most utilised throughout the company and efficient and maintenance should be high in the operations manager priority list.

Another set of analysis performed was the use of ovens (average and statistical deviation), in order to assess how long we use and shut down each of these ovens. Whilst it may be argued that East London's and Worcester's ovens will have higher deviations due to no weekend work, the table provides an (obvious) indication that most of Groblersdal and Pretoria's ovens are utilised consistently. There are opportunities to introduce preventative maintenance schedules for bigger ovens vs. waiting for something to go wrong (as shown in Figure 22 below).

SKOF 1	SKOF 2	SKOF 3	URE	KOMMENTAAR
0	0	0	0	payweekend
0	0	0	0	payweekend
0	0	0	0	payweekend
8	8	8	24	gearbox reggemaak

Figure 22: Example of reasons provided to stop production (bar the lack of downtime)

The information discussed above matched the data set that was used during the scoping phase (i.e. Figures 7 and 8 above), indicating heavy oven utilisation in specific months of the year, as analysed and shown in Figure 23 below.

Factory	Oven	Fuel Type	Oven Size	Main Product(s)	Oven Hours											
					July	August	September	October	November	December	January	February				
Glencoe	1000lt R/R	Paraffin	10 000l	5 000l Vert	519	498	510	583	652	472	445	449				
Glencoe	5 000 R/R	Paraffin	5 000l	2 200l Vert	486	300	639	659	660	379	411	392				
Orania	10 000l (coal)	Coal	10 000l	5 000l Vert	528	528	472	628	608	232	424	464				
Orania	10 000l (coal)	Coal	10 000l	5 000l Vert	484	520	470	552	584	240	400	456				
Camperdown	1000lt R/R	Paraffin	10 000l	5 000l Vert	528	440	488	288	532	220	296	392				
Camperdown	5 000 R/R	Paraffin	5 000l	2 200l Vert	520	440	616	568	652	312	336	424				
Camperdown	5 000 R/R	Paraffin	5 000l	2 500l Vert	384	400	568	536	644	276	240	393				
Camperdown	5 000 R/R	Paraffin	5 000l	5 000l Vert	520	376	496	528	612	292	280	452				
Camperdown	5 000 R/R	Paraffin	5 000l	2 200l Vert	424	464	592	528	608	256	336	352				
Camperdown	Carousel	Paraffin	500l	500l	160	136	128	168	160	96	112	128				
Camperdown	Rond om Tallie	N/a		Moth balled												
East London	Carousel - Paraffin	Paraffin	210l	VIP200	112	152	104	88	160	24	16	138				
East London	2500lt Elec - Oven A	Electric	2 500l	2 500l Vert	464	456	464	480	552	312	360	528				
East London	2500lt Elec - Oven B	Electric	2 500l	2 500l Vert	480	464	512	512	576	288	360	504				
East London	10000 LT Oven C	Paraffin	10 000l	5 000 Vert	448	472	440	400	474	288	354	498				
East London	10000 LT Oven D	Paraffin	10 000l	5 000 Vert	60	232	208	152	440	224	312	298				
East London	Carousel - Electrical	Electric	500l	PIT PEDESTAL	168	200	216	280	136	40	120	176				
Pretoria	10000lt R/R	Paraffin	10 000l	5 000l Vert	448	424	636	651	671	344	320	296				
Pretoria	2500lt Coal Oven	Coal	2 500l	2 500l Vert	472	595	657	716	657	367	343	319				
Pretoria	5000lt Converted Oven	Paraffin	5 000l	5 000l Vert	472	303	617	713	642	193	170	154				
Pretoria	5000lt R/R	Paraffin	5 000l	2 200l Vert	456	586	692	717	648	368	344	320				
Worcester	Carousel - Oven 1	Paraffin	500l	V/Set	160	144	320	276	340	112	228	236				
Worcester	1000lt R/R Elec - Oven 2	Electric	1 000l	1000 VW	325	408	336	184	220	240	220	228				
Worcester	2500lt R/R - Oven 3	Paraffin	2 500l	2 500l Vert	381	440	440	264	512	328	368	384				
Worcester	10000lt R/R - Oven 4	Paraffin	10 000l	10 000l Vert	373	456	448	296	264	288	260	276				
Worcester	5000lt R/R - Oven 5	Paraffin	5 000l	5 000l Vert	469	456	448	320	472	352	348	372				
Groblersdal	Carousel - Oven #1	Paraffin	260l	260l	544	532	656	608	608	396	632	700				
Groblersdal	2500lt R/R	Paraffin	2 500l	2 500l Vert	648	612	684	696	708	440	612	568				
Groblersdal	5000lt R/R	Paraffin	5 000l	5 000l Vert	616	624	660	640	712	404	652	568				
Groblersdal	10000lt R/R	Paraffin	10 000l	10 000l Vert	516	624	656	504	612	416	608	632				

Figure 23: Summary of Oven Utilisation by month for all ovens

Factory	Average	Standard Deviation	Standard Deviation (%)
Groblersdal	20.2	7.56	37%
Groblersdal	20.1	7.87	39%
Groblersdal	20.1	7.94	40%
Groblersdal	20.1	7.73	39%
Groblersdal	19.7	7.96	40%
Groblersdal	19.7	8.10	41%
Groblersdal	18.8	8.24	44%
Groblersdal	18.5	8.42	46%
Groblersdal	18.3	8.26	45%
Groblersdal	17.9	8.72	49%
Pretoria	17.8	9.88	56%
Pretoria	17.7	9.99	56%
Glencoe	17.0	10.36	61%
Pretoria	16.7	10.29	62%
Glencoe	16.2	10.10	63%
Orania	16.0	10.31	64%
Camperdown	15.9	10.35	65%
Groblersdal	15.9	9.07	57%
Pretoria	15.5	10.73	69%
Orania	15.3	10.71	70%
Groblersdal	15.2	10.33	68%
East London	15.2	10.64	70%
East London	14.9	10.31	69%
Camperdown	14.7	10.44	71%
Camperdown	14.6	10.49	72%
Camperdown	14.2	10.81	76%
East London	13.9	10.23	74%
Worcester	13.4	10.78	81%
Camperdown	13.1	10.49	80%
Worcester	12.6	10.56	84%
Worcester	11.1	10.07	90%
Groblersdal	9.9	11.27	114%
Worcester	9.0	8.38	93%
East London	7.9	8.47	107%
Worcester	7.6	7.56	99%
Groblersdal	7.3	7.42	102%
East London	5.5	5.03	92%
Camperdown	4.5	4.02	90%
East London	3.3	3.99	122%

Table 5: Average utilisation rate (hours) and standard deviation analysis

4.1.2 Performance

The second attribute to the OEE is the performance of the oven, i.e. if the oven is being utilised (as discussed above), how well it is being utilised? The analysis was broken into oven size categories:

- Carousels (500l)
- 1 000l;
- 2 500l; (which produced the top selling 2 200l and 2 500l)
- 5 000l (which could accommodate 2 200l; 2 500l and 5 000l moulds)
- 10 000l (which can accommodate the above-mentioned volumes)
- 20 000l (Which mainly manufactures 15 000 – 20 000l tanks, as well septic tanks)

The weight throughput was analysed for each product and the oven hours (from utilisation) were used to normalise the performance – that is, derive a kilogram/hour rate per oven size to establish good and best demonstrated practices (BDPs) within the company. The emphasis on ‘within the company’ is that, the company has a competitive advantage in its ability to set up machines and develop production technology in-house.

Table 5 below provides a synopsis of BDPs per oven size. The normalisation ensured that throughput was linked to the time the oven was operating.

Factory	Oven Size	Throughput Rate (kg/h)							
		July	Aug	Sep	Oct	Nov	Dec	Jan	Feb
East London	210l	7.2	6.9	7.5	7.5	4.8	6.0	6.0	7.3
Pretoria	10 000l	140.6	129.7	128.5	127.4	113.9	119.4	143.5	98.5
Worcester	500l	13.3	14.8	6.1	7.5	11.4	25.6	12.5	18.3
Worcester	1 000l	14.8	6.2	4.9	31.1	9.2	15.9	15.7	12.3
Groblersdal	5 000l	94.8	78.7	102.3	85.7	107.8	108.2	79.9	59.0
Groblersdal	750l	19.2	24.9	19.0	22.0	31.7	28.5	23.6	3.8
Groblersdal	2 500l	No	No	No	0.0	73.7	69.2	61.3	24.3
Groblersdal	6000l	80.2	70.8	61.9	67.1	59.6	54.4	62.7	52.6
Groblersdal	20 000l	83.7	98.5	62.8	79.1	106.8	86.1	0.0	24.4

Table 6: Performance Measures (Throughput between July 2016 and Feb 2017)

Whilst it was expected that big ovens would yield higher throughput values, the variation of normalised figures was an indicator that production was affected by other variables, besides utilisation and maintenance.

Factory	Oven Size	Average Throughput per month (kg/h)	Actual BDP for oven size (kg/h)	Theoretical throughput per hour (kg/h)	Standard Deviation - expressed as std/avg
East London	210l	6.6	7.3	No Cycle Times	14%
Pretoria	10 000l	125.2	143.5	167	11%
Worcester	500l	13.7	25.6	20	42%
Worcester	1 000l	13.8	31.1	40	56%
Groblersdal	5 000l	89.5	108.2	167	18%
Groblersdal	750l	21.6	31.7	45	36%
Groblersdal	2 500l	45.7	73.7	83	63%
Groblersdal	6000l	63.7	80.2	164.38	13%
Groblersdal	20 000l	67.7	106.8	309.28	51%

Table 7: Average throughput vs. BDP of the best ovens

The key finding in the throughput analysis was the variance in performance for the same oven, as discussed below.

4.1.2.1 210l Oven

The only electric oven in the portfolio (located in East London) – this oven is utilised to manufacture small items e.g. tank lids, which complete the product. The oven however is used to produce new and non-main stream products (e.g. owl houses), which the uptake has been very slow. Nonetheless, its average throughput is 10% away from its BDP.

4.1.2.2 500l – 1 000l Ovens

Table 7 provides the performance summary of the sub-750l ovens. The BDP for this oven category was influenced by the heavier (than usual) production during December (as a special order). Opportunities to improve small oven production are limited to product sales (i.e. specific products are heavier than others). Notably, the sole 1 000l oven is a slightly lower throughput vs. 750l due to the product mix.

Factory	Oven Size	Throughput Rate (kg/h)								Average Throughput per month (kg/h)	Actual BDP for oven size (kg/h)
		July	Aug	Sep	Oct	Nov	Dec	Jan	Feb		
Camperdown	500l	5.6	6.8	9.3	7.2	5.7	5.1	5.6	4.6	6.2	25.6
East London	500l	9.1	9.5	9.5	7.5	10.5	7.2	10.1	12.3	9.5	25.6
Worcester	500l	13.3	14.8	6.1	7.5	11.4	25.6	12.5	18.3	13.7	25.6
Worcester	1 000l	14.8	6.2	4.9	31.1	9.2	15.9	15.7	12.3	13.8	31.1
Groblersdal	500l	9.9	6.7	8.0	6.6	9.8	6.6	6.2	5.0	7.4	25.6
Groblersdal	750l	19.2	24.9	19.0	22.0	31.7	28.5	23.6	3.8	21.6	31.7

Table 8: Performance of the sub 1 000l ovens - July 2016 to Feb 2017

4.1.2.3 Sub 2 500l ovens

These are the ovens which are expected to perform exceptionally well due to the fact that 40% of the revenue is generated from 2 200l and 2 500l tanks.

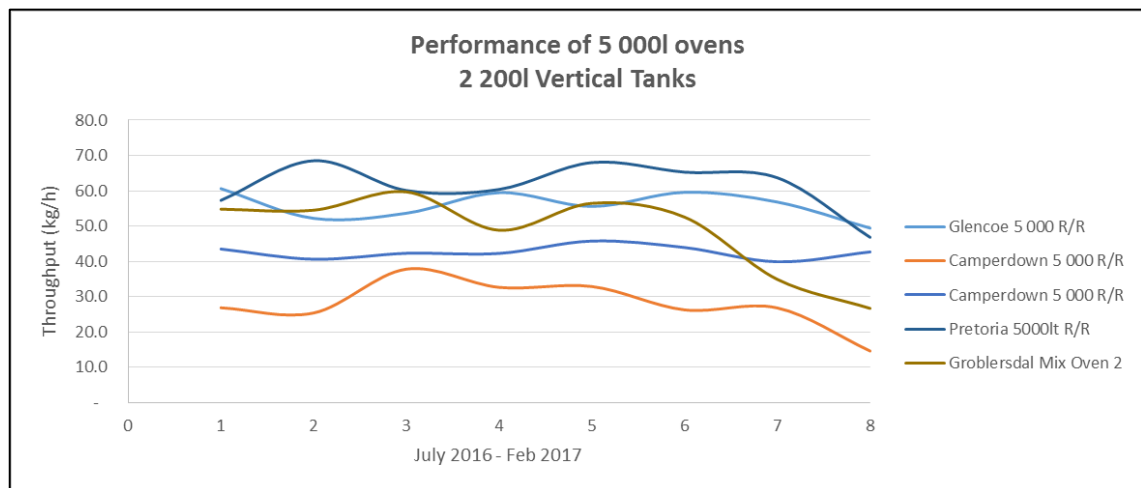


Figure 24: Performance of the 2 500l oven manufacturing 2 200l tanks

Table 8 indicates that the newly installed 2 500l oven in Groblersdal was able to establish the BDP immediately post installation – an indication that employees and the machinery can be improved. In its second month, the oven still managed to produce at a rate of 69.2 kg/h however, the average monthly output is relatively low vs. the BDP.

Factory	Oven Size	Throughput Rate (kg/h)								Average Throughput per month (kg/h)	Actual BDP for oven size (kg/h)
		July	Aug	Sep	Oct	Nov	Dec	Jan	Feb		
East London	2 500l	42.9	40.9	45.7	43.9	42.4	41.6	42.7	40.6	42.6	73.7
East London	2 500l	51.0	51.4	53.9	49.7	43.4	44.2	47.1	46.9	48.5	73.7
Pretoria	2 500l	24.3	27.7	34.1	29.5	32.7	43.1	38.8	34.8	33.1	73.7
Worcester	2 500l	23.0	19.7	38.4	34.2	37.3	49.7	49.2	63.2	39.3	73.7
Groblersdal	2 500l	53.5	49.9	62.1	52.5	63.0	59.9	49.1	38.6	53.6	73.7
Groblersdal	2 500l	50.7	50.1	56.8	44.4	57.8	46.2	38.7	26.2	46.3	73.7
Groblersdal	2 500l	No	No	No	0.0	73.7	69.2	61.3	24.3	45.7	73.7

Table 9: Performance of the sub 2 500l ovens - July 2016 to Feb 2017

4.1.2.4 5 000l – 6 000l ovens

Similar to the 2 200l and 2 500l, the 5 000l tank range is a significant contributor to JoJo Tanks' revenue and profit margins. The key indications from Groblersdal is that, they could and often run mono-product productions and that allowed the company to observe the BDPs over a longer period. On the other side of the scale, one 5 000l oven within the same fleet is performing poorly even when an unfavourable mix is put through the oven.

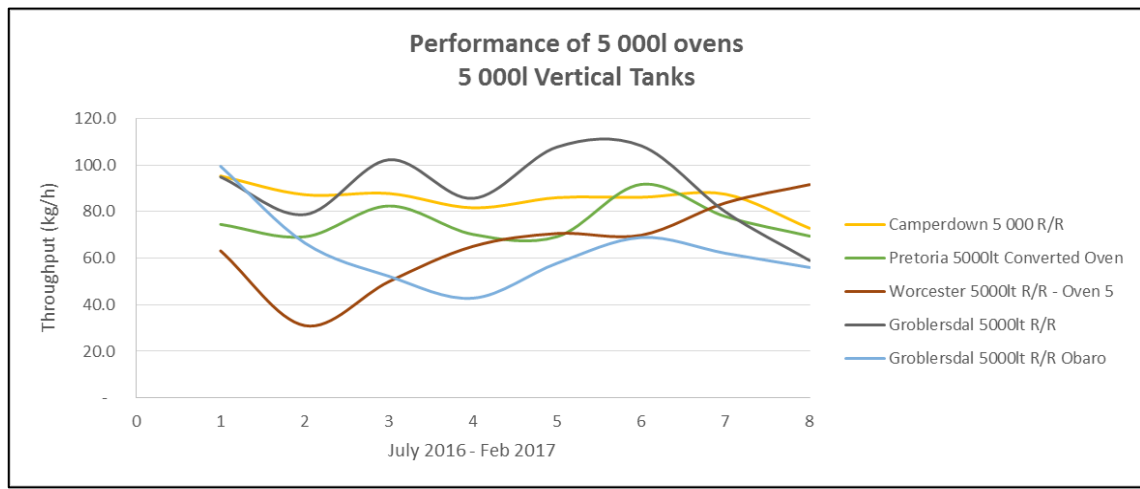


Figure 25: Performance of the 5 000l ovens manufacturing 5 000l tanks

Both Pretoria's 5 000l ovens as well as Camperdown's four 5 000l ovens have shown consistent performance and this provides an opportunity to improve the process – as they are 'way off' vs. the BDP.

Factory	Oven Size	Throughput Rate (kg/h)								Average Throughput per month (kg/h)	Actual BDP for oven size (kg/h)
		July	Aug	Sep	Oct	Nov	Dec	Jan	Feb		
Glencoe	5 000l	60.6	52.2	53.7	59.5	55.6	59.6	56.8	49.4	55.9	108.2
Camperdown	5 000l	26.9	25.4	37.8	32.7	32.9	26.3	26.8	14.6	27.9	108.2
Camperdown	5 000l	47.3	50.6	53.5	50.5	52.1	45.5	45.2	49.7	49.3	108.2
Camperdown	5 000l	95.3	87.2	87.8	81.6	86.0	86.1	87.5	72.8	85.5	108.2
Camperdown	5 000l	43.5	40.6	42.3	42.3	45.8	43.9	39.9	42.7	42.6	108.2
Pretoria	5 000l	74.5	69.2	82.4	70.2	69.3	91.7	77.9	69.5	75.6	108.2
Pretoria	5 000l	57.3	68.5	60.1	60.4	68.0	65.3	63.7	46.8	61.3	108.2
Worcester	5 000l	63.2	31.1	49.9	65.1	70.6	69.9	83.7	91.6	65.6	108.2
Groblersdal	5 000l	94.8	78.7	102.3	85.7	107.8	108.2	79.9	59.0	89.5	108.2
Groblersdal	5 000l	54.8	54.5	59.7	48.9	56.5	52.5	34.9	26.7	48.6	108.2
Groblersdal	5 000l	29.0	26.6	34.3	26.7	36.8	35.1	20.8	16.4	28.2	108.2
Groblersdal	5 000l	38.0	40.2	43.0	38.1	63.6	55.1	35.6	18.4	41.5	108.2
Groblersdal	5 000l	99.4	66.5	52.2	42.8	57.9	68.9	62.1	56.0	63.2	108.2
Groblersdal	6000l	80.2	70.8	61.9	67.1	59.6	54.4	62.7	52.6	63.7	80.2

Table 10: Performance of the 5 000l – 6 000l ovens - July 2016 to Feb 2017

The 6 000l oven has a lower BDP even though it is used to produce heavier septic tanks due to numerous mechanical problems where breakdown time was not recorded – as shown in Figure 26 below.

SKOF 1	SKOF 2	SKOF 3	URE	KOMMENTAAR
8	8	8	24	No production, gearbox bro
8	8	8	24	No production, breakdown
8	8	8	24	
8	8	8	24	
8	8	8	24	
12	0	0	12	1 Shift
12	0	0	12	1 Shift
8	8	8	24	No production, breakdown

Figure 26: Snapshot of the 6 000l tank schedule Excel Sheet

4.1.2.5 10 000l Ovens

The large ovens in this category are expected to have high throughputs, due to the weight of the products manufactured and a medium demand for 10 000l ovens. Table 10 provides an indication that, Pretoria's oven has the highest throughput and average over the 8 month period.

Another important note from the analysis is how the compromise on oven utilisation in Orania (which has two 10 000l coal ovens), is how their performance varied. Notably is the low production and lack of actual oven hours on January and February 2017.

Factory	Oven Size	Throughput Rate (kg/h)								Average Throughput per month (kg/h)	Actual BDP for oven size (kg/h)
		July	Aug	Sep	Oct	Nov	Dec	Jan	Feb		
Glencoe	10 000l	99.8	84.6	94.2	88.5	89.5	86.9	86.6	66.0	87.0	143.5
Orania	10 000l	52.1	41.6	54.3	47.3	51.5	69.5	98.6	92.7	63.5	143.5
Orania	10 000l	30.9	20.7	53.4	47.6	55.8	59.3	1.5	4.5	34.2	143.5
Camperdown	10 000l	72.8	63.6	57.0	47.4	68.5	61.3	63.0	63.8	62.2	143.5
East London	10 000l	100.0	98.8	104.4	98.4	102.1	93.7	91.5	99.4	98.5	143.5
East London	10 000l	84.3	91.9	85.0	80.0	83.0	81.0	79.8	77.0	82.7	143.5
Pretoria	10 000l	140.6	129.7	128.5	127.4	113.9	119.4	143.5	98.5	125.2	143.5
Worcester	10 000l	99.9	53.1	64.2	66.1	67.8	50.2	85.4	87.4	71.8	143.5
Groblersdal	10 000l	80.9	95.8	101.3	85.5	109.8	97.1	78.0	64.2	89.1	143.5
Groblersdal	10 000l	66.5	45.8	74.9	73.5	71.9	57.5	58.2	44.3	61.6	143.5

Table 11: Performance of the 10 000l - July 2016 to Feb 2017

4.1.2.6 20 000l Oven

As the single largest oven at JoJo Tanks, the 20 000l oven's performance is driven by the demand for extremely large and heavy products. The demand for this week is reflected by non-production in January 2017.

Factory	Oven Size	Throughput Rate (kg/h)								Average Throughput per month (kg/h)	Actual BDP for oven size (kg/h)
		July	Aug	Sep	Oct	Nov	Dec	Jan	Feb		
Groblersdal	20 000l	83.7	98.5	62.8	79.1	106.8	86.1	0.0	24.4	67.7	106.8

Table 12: Performance of the 20 000l - July 2016 to Feb 2017

4.1.3 Production Quality

The amount of mass rejected (or categorised as B Class whereby the low quality tanks are sold at cost) during the 8 months under review was less than 0.55%. A summary of the quality ratio for each factory (as rejects or low quality products were not linked to a machine), is provided below.

Factory	Quality Rate
Glencoe	99.64%
Orania	97.60%
Camperdown	99.84%
East London	99.81%
Pretoria	99.86%
Groblersdal	99.49%
Worcester	99.89%
Total	99.45%

Table 13: Quality Performance per Factory

4.2 OEE for each oven

Post the analysis of the three attributes, the OEE values for each oven were computed. The main product for each oven (as the process always ran in combinations e.g. 2 500l – 5 000l – 2 500l) was designed in the production model. The summary for each factory analysis is attached in Annexure A.

Oven Size	Pretoria	Glencoe	Groblersdal	East London	Worcester	Orania	Camperdown
210l				21%			
500l			23%	5%	17%		5%
1 000l					17%		
10 000l	61%	43%	41%	30%	23%	22%	24%
2 500l	34%		47%	39%	28%		
20 000l			19%				
5 000l	44%	35%	41%		34%		29%
750l			43%				
6000l			60%				
Average	46%	39%	39%	24%	24%	22%	19%

Table 14: Calculated OEEs per factory per oven size

With the limitations stated above, the absolute OEEs values were perhaps not the end results but a means to identify opportunities for improvement and gain efficiencies and decrease production costs. The objective of the exercise is to produce the right product, at the right time and frequency and at the right quality – commonly known as takt time.

4.3 Financial Analysis from the Break Even Analysis

Due to the limited opportunity to discuss the financials of JoJo Tanks, a breakeven analysis was performed for each oven based on the main product. The Financial Analysis was based on figures in Table 14.

Factory Fixed Cash Cost Analysis			
Production & Maint Man and Sup	44%		
Admin Team	22%		
Loading Teams	6%		
Security and Cleaning	9%		
Rental	5%		
Rates & Taxes	0%		
Base Electricity Costs	1%		
Water	1%		
Telephone and Comms	2%		
Other	10%		
Total Fixed Costs per month	6		
Fixed Costs/Oven/Month	R	64 083	
Large Product - 1500lt Septic	Per Unit	Per kg	
Selling Price - Netto	R	3 962	R 60.95
Less nominal tpt cost	R	398	R 6.13
Less TVC	R	1 458	R 22.44
Variable Margin	R	2 105	R 32.39
BE Point		30	1979
Capacity per Month		633	41 134
Profit Cont at full Capacity	R	1 268 104	R 1 268 104

Table 15: Breakeven analysis template and cost terms

Key discussion points with management were:

- How certain products were not making money for the company; and
- How JoJo Tanks was pricing themselves out of the market as they were not willing to sell below a specific price per kilogram.

5 Discussion of Results

The developments during the project were communicated to the Project Team and as such, these provided insight to understand the business and some of the challenges that numbers may be pointing to.

5.1 Manufacturing Practices and Standards

The key variations in performance across the country were attributed to ‘minor’ variations in producing the same products. The term ‘minor variation’ is loosely utilised as the baking process is standard or else the product and the associated quality would differ.

However; the variation in production times (from the Throughput) pointed out key variations in cycle time – as shown in Figure 27 respectively. When the same capacity ovens were compared (vs. the same products), the throughput rate has a significant impact on the cycle time (i.e. time it takes to produce a single product) and henceforth, the capacity of the factory for a particular period.

Factory	Oven Description	Fuel Type	Oven Size	Main Product(s)	BDP (kg/h)	Mass of Main Product (kg)	Cycle Time (Excl. Maintenance; min)
Groblerdsdal	Corner Oven	Paraffin	5 000l	1 000l Vert		18	
Glencoe	5 000 R/R	Paraffin	5 000l	2 200l Vert	60.63	30	29.69
Camperdown	5 000 R/R	Paraffin	5 000l	2 200l Vert		30	
Camperdown	5 000 R/R	Paraffin	5 000l	2 200l Vert	45.78	30	39.32
Pretoria	5000lt R/R	Paraffin	5 000l	2 200l Vert	68.53	30	26.26
Groblerdsdal	Mix Oven 2	Paraffin	5 000l	2 200l Vert	59.70	30	30.15
Groblerdsdal	Septic Oven	Paraffin	5 000l	2 500l Sep		80	
Camperdown	5 000 R/R	Paraffin	5 000l	2 500l Vert	53.49	40	44.87
Camperdown	5 000 R/R	Paraffin	5 000l	5 000l Vert	95.28	75	47.23
Pretoria	5000lt Converted	Paraffin	5 000l	5 000l Vert	91.71	75	49.07
Worcester	5000lt R/R - Oven	Paraffin	5 000l	5 000l Vert	91.60	75	49.12
Groblerdsdal	5000lt R/R	Paraffin	5 000l	5 000l Vert	108.23	75	41.58
Groblerdsdal	5000lt R/R Obaro	Paraffin	5 000l	5 000l Vert	99.44	75	45.25

Figure 27: Cycle Time Analysis for similar products from same oven sizes

An example is how Groblersdal can produce a 5 000l tank in 41.58 minutes whilst it takes Worcester 49.12 minutes for the same product. A difference of 8 minutes means that Worcester has 19% less capacity. Alternatively, labour costs (measured in hours) are 19% more in Worcester vs. Groblersdal.

Equally so, a difference of 39.32 minutes for Camperdown's 5 000l oven to produce 2 200l tank is almost 50% greater vs. Pretoria's cycle time of 26.26 minutes.

Such discussions indicated a labour resistance into producing more – something that affects coastal factory's vs. inland ones. Henceforth, JOJO TANKS's management has not done analysis at a factory level to note the significant impact of these variations.

The above-mentioned variation was identified as one of the key initiatives that management would run with during the September 2017 EXCO engagement but additional opportunities to improve were highlighted as follows:

5.1.1 Overproduction

Known as one of the key signs of waste in the manufacturing business, JoJo Tanks' inventory holding (as of September 2017) was over R10 million (post production). One of the key reasons for over producing was that:

- The company always had health inventory buffers to take opportunity of seasonal purchases;
- The mould configuration was seldom an all one product at times due to the limited number of moulds and as such;
 - Additional unnecessary products were manufactured (e.g. 750l Tank – 1 000l Tank – Large dog kennel);
 - The product with the longest cycle time held the 'production queue'

Oven utilisation as times seen as something that should take place – limitations of management accounting and break-even analysis. The additional strain was seen in the common maintenance issues noted in the "Shift Sheets" namely:

- Paraffin Pipe Breaking
- Oven Chain Fault;
- Gearbox / Chain Issues

5.1.2 In-Process Waiting

This was not identified as a key challenge in the processes witnessed at Groblersdal however, the limited space on Worcester meant the use of engine hoists (as opposed to other factories which use hydraulics).

5.1.3 Transportation

No excessive handling was identified in Groblersdal due to the demand of stock products however; due to the mould misconfiguration, Pretoria and some other smaller factories would store tanks in the inventory (outside) for long. As a result, they would increase their time spent on stock counting, washing the tanks which have gathered dust (over a short to medium period) and move tanks around to accommodate new production (or stop if there isn't space).

5.1.4 Inappropriate Processing

Many organisations use expensive high precision equipment where simpler tools would be sufficient – this may not seem like the case with JoJo Tanks but the use of ovens to produce certain products can be optimised

5.1.5 Unnecessary Inventory

As discussed above, the mould mismatch had led to the production of unnecessary products (especially during peak periods). One of the key calculations made for the EXCO was that, if the company operated 24/5 at 80% of the BDP for each oven size, the company would produce 50% vs. the 2016/17 sales. The keys to success were:

- In the ability to surge and be flexible with production;
- Maintain minimum buffer stocks for key Top 5 products; and

- Adjust timeframes for non-stock items.

The stock holding of JoJo Tanks can be seen from an aerial photo from Google Maps – as shown in Figure 28



Figure 28: Aerial Photograph of JoJo Tanks, Groblersdal Google (2017)

5.1.6 Unnecessary or excess motion

The limited spaces in the factories (even large ones) limited unnecessary motion however, the double handling products was common in Pretoria and Groblersdal.

5.1.7 Defects

As discussed in Section 4.1.3, the quality rate of JoJo Tanks as measured by mass was about 99.5%. The opportunity to maintain that whilst increasing other OEE variables (utilisation and throughput) is key.

5.2 Constraints in the System

The major constraints in the production lines is the limited number of moulds. The production station cannot operate on less than three moulds as:

- The time required to cool down sufficiently is between 100% and 150% cooking time. Handling a mould that has not cooled down enough is in breach of Safety and Health standards
- The machine operator would not be sufficiently used for the production and that would indirectly increase labour costs (i.e. same labour costs for a 33% less of production)

Producing a product due to 'availability' is not a financial sound option as those products might need to be sold at cost or at a lesser price.

Whilst it was acknowledged that systems might not be in place to automate production, a 'factory manager template' was developed to assist factory managers in assessing their capacity for the day and indirectly, monitor their OEE per desired period. A sample of this template is shown in Figure 29.

	Fri, 01-Sep-2017	
Oven Size	5 000l	
1. Availability		
Number of Shifts Planned	3	Factory Manager Inputs – Availability per oven Factory manager decides on required shifts to meet the takt time
Number of Hours per Shift	8	
Lunch Time per Shift (min)	45	
Number of Breakdowns (reported)	5	
Breakdown Time (min, reported)	125	
Setup and Adjustment Time (min)	30	
Capacity for the day (min)	1113	
Time Available (less maintenance and breakdown)	1150	
2. Performance		
Product 1 Manufactured	5000lt Water Tank	Factory Manager Inputs – With standardised cycle time, the factory manager can calculate his daily target by product
Product 1 Produced Quantity	20	
Product 1 Cycle Time (min)	27.32	
Product 1 Weight (kg)	75	
Product 2 Manufactured	2500lt Septic Tank	
Product 2 Quantity	9	
Product 2 Cycle Time (min)	63	
Product 2 Weight (kg)	80.8	
Product 3 Manufactured	260lt Water Tank	
Product 3 Quantity	0	
Product 3 Cycle Time (min)	21	
Product 3 Weight (kg)	7	
Total Throughput for the day	2227.2	
Throughput vs. BDP (kg/h)	120	
3. Quality - we could pull this up from existing sheets		
Rejects (kg)	7	Factory Manager Inputs – Quality variables can be pulled through existing sheets
B Class (Kg)	30	
Quality Rate	98.34%	
Oven OEE Attributes		
1. Availability	96.82%	
2. Performance	63%	
3. Quality	98.34%	

Figure 29: Factory Manager Template

5.3 Upgrade path to Excellence

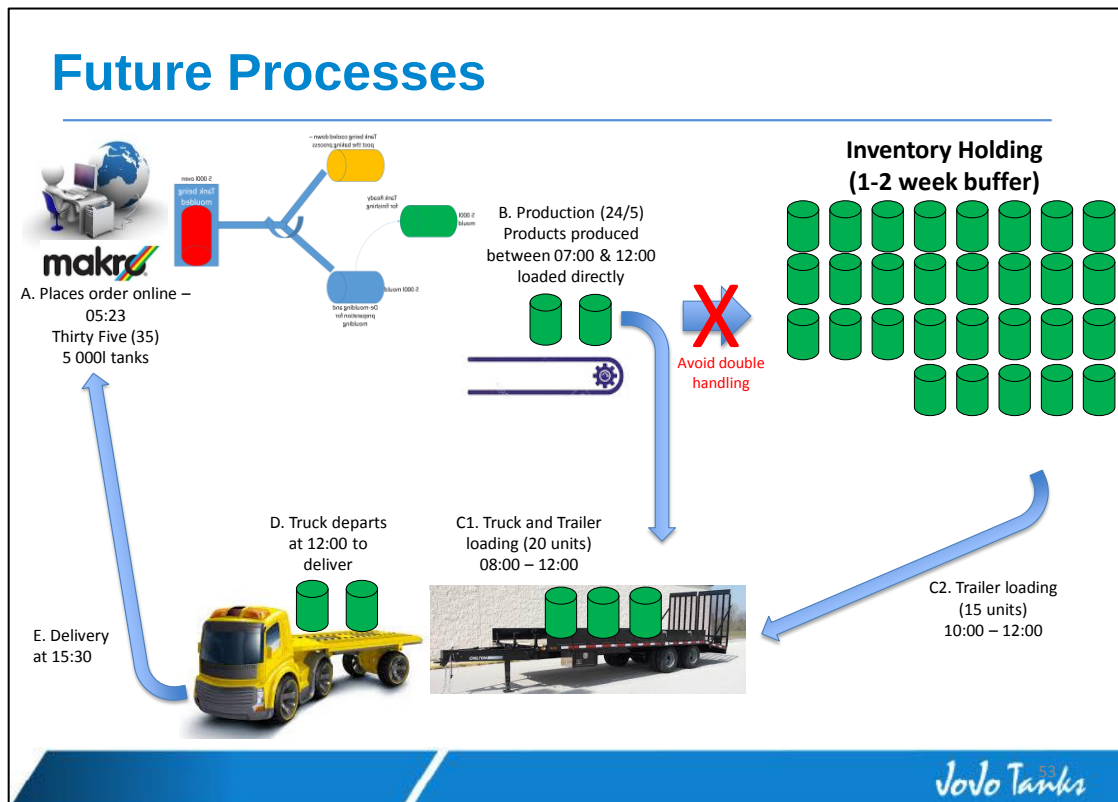


Figure 30: Envisaged future processes

Figure 30 about summaries the envisaged operating model of JoJo Tanks whereby (letters linked to the picture descriptions):

- A. The customer would be able to order online (and the function would be handled centrally)
- B. The mould configuration would enable us to produce the required products at takt time – i.e. at the right pace, right price, and great quality
 - The Service Level Agreements (currently 7 days) would give us artificial buffers for large orders
 - Two week buffers would enable us to deliver the right quality to the client within the same day or at worst, within three days
- C. Products would move from the production line to trailers (and not collect dust on the inventory)
- D. A truck would be called in, just-in-time to make a delivery to the client during office hours (or as per agreement)

The above-scenario was presented to the EXCO and whilst it may have been accepted as the future, the scepticism was around inventory levels (currently around 3 months but stock products are minority). However; the model outlined by Goraya (2017) indicated that successful companies are those which are competitive in the following dimensions:

- Cost
- Delivery
- Quality and
- Flexibility

Taking the above into account, the following upgrade programme is proposed:

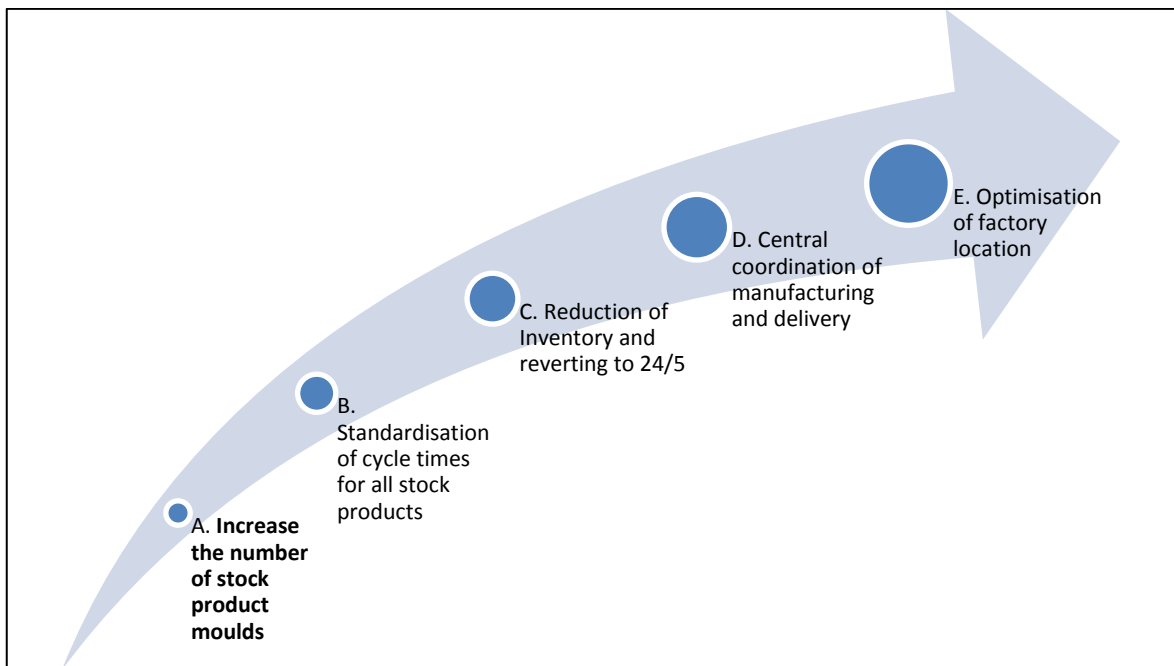


Figure 31: Upgrade path for JoJo tanks (short term)

5.3.1 Increase the number of stock product moulds

Aligned to the Theory of Constraints, the key objective of improving any production is to identify constraints in the process and address the challenges. One of the major constraints in the operating model is the lack of moulds for stock products (i.e. 80% of the revenue comes from 4 products and yet, ovens

run 24/7 on a 2-1-2-1 configuration, where 1 (out of 3) products are not stock or not required at the time).

The capital expenditure of customised moulds (as discussed with EXCO) is not significant vs. producing products for the sake of increasing utilisation rates. At this stage, the process is not envisaged to affect staff members nor the high inventory levels.

The expected timeframe to implement this process is 2-3 months.

5.3.2 *Standardisation of cycle times*

The critical element in this process is training of factory managers on what is expected. The template is aimed at monitoring factory production from three levels:

- Ensuring the utilisation rate is healthy;
- Monitoring the throughput – which is linked to the capacity of the factory; and
- Ensuring the changes in the process do not negatively affect quality.

Whilst inter-factory competition can be exciting, it is important to monitor this carefully and ensure managers are not sacrificing a lot to achieve or beat OEE targets.

Standardisation of cycle times will ensure factory capacity is accurately calculated for planning purposes. Customers located in-between factories can be serviced with ease – knowing there is no additional transport cost incurred as a result of moving an order from one factory to another (e.g. Camperdown and Glencoe).

5.3.3 *Reduction of Inventory and reverting to 24/5*

Engagements during the EXCO session in September 2017 indicated the company had 3 months' worth of stock. Two fundamental problems (as discussed) are:

- Majority of items in the inventory are not stock items (i.e. Top 4 products);
- Some of the items need to be re-washed as they have accumulated dust.

The objective to reduce stock holding is to address the above challenges, and focus on producing what is required at the right time. As such, the following recommendations are made:

- Post getting the mould configuration correctly, factory managers should aim to have drop the quantity of finished goods (stock items) from 2 months to 2 weeks (by the end of the Financial Year, i.e. June 2018);
- Have non-stock items' inventory reduced to 1 day
 - This is to be supported by an amendment on the SLA for non-stock items. Due to droughts, orders to Western Cape are expected to be delivered in 14 days (vs. the normal 7 calendar days)
- Shifts A (06:00 – 14:00) and shift C (22:00 – 06:00) should always focus on delivering JIT (i.e. produce and load) whilst shift B should focus on building up buffer stock
 - It also means that during low sales periods, one of the shifts is dropped.

This process should be led by Executives as it involves employees and affects their pay at the end of the month. With the labour rate of R55 per hour (and 15% more on overtime), workers would have at this stage, budgeted on set number of hours.

In order not to have workers slowing down the process for the sake of inducing an overtime shift(s), management should consider increasing the labour rate to R60 per hour (9% increase), for example and use that as leverage during engagements.

The recommendation that raw material should be 2 weeks was rejected due to SASOL's reliability problems. In August 2017, SASOL engaged JoJo Tanks and another major manufacturers to export raw material as they had experienced issues in their plants. Even though SASOL compensated JoJo Tanks, the export process delays could have had a negative effect if JoJo Tanks did not

have enough stock for two months. As such, management felt raw material stock cannot be dropped to less than two months,

5.3.4 Central coordination of manufacturing and delivery

Due to the customer's ability to order from any of the factories they deemed closer to them, planning and scheduling is done at factory level and complaints for non-delivery are received at Head Office in Midrand. Furthermore, the decision to centralise scheduling can make factory managers disempowered about their roles as such, the following recommendations are made:

- Post the optimisation of processes, scheduling of production can be left to Factory managers however; order allocation based on volume and transport costs should be decided at Head Office.
- The ability to produce quality products in line with sales demand will be left to Factory Managers.

The process to manage these activities should be looked into in the next Financial Year (2018/19).

5.3.5 Optimisation of Factory Location

The company has started the process of looking at ideal factory locations, partially due to high operating and transport costs from Orania. During this review process, one tool that was developed was the distance/factory optimisation tool.

The tool (showed in Figure 32) allows the user to select a town from a dropdown and see which factories are closest. It also allowed users to deselect factories if they were not available (e.g. Gaborone as shown below).

Factory	Factory Considered? (X=Yes)	Select Town ->>	GABORONE	Ranking (Calculated)
Groblersdal	X		443	3
Klerksoord	X		331	2
Kimberley	X		515	4
Vryburg	X		310	1
Gaborone			Not Applicable	
Glencoe	X		Not Applicable	
Camperdown	X		Not Applicable	
East London	X		Not Applicable	

Figure 32: Distance-algorithm tool developed for JoJo Tanks

6 Conclusion

The project was initiated by management to determine opportunities for improvement, efficiency gains, cost savings and define a sensible and practical upgrade path. The JoJo Tanks management acknowledged the threat of 2 – 3 major competitors and the fact that, customers are being offered other brands in local hardware stores. Furthermore, they also realised that JoJo Products' prices were a benchmark for most if not all competitors and as such, they were at risk of out-pricing themselves.

Quick results to identifying these pockets of efficiencies were narrowed down to manufacturing practices i.e. improve product mix, improve plant utilisation, decrease inventory holding and achieve these through schedule optimisation.

The research and data analysis indicated that:

- JoJo Tanks produced stock and non-stock products with similar priorities due to:
 - Limitation of moulds; and
 - Flexibility to use various mould sizes in a single oven
- The lack of analysis on oven performance did not provide an opportunity to internally benchmark and set manufacturing standards across the country;
- Over production of non-stock items increased inventory holdings and decreased space – which at times affected the production line (i.e. production was stopped due to space constraints);
- High inventory holdings also resulted in double handling – at times washing the tanks before dispatch due amongst others, it had collected dust over the few weeks / months in inventory;
- Whilst the OEE figures were low, these were used as benchmark as some information was not captured (e.g. breakdown time).

The analysis provided insights on how same size ovens producing similar sized products, were significantly different in output and cycle times and what benchmark JoJo Tanks management could set post addressing the following:

- Increase the number of stock item moulds to ensure production is streamlined;
- Oven operators and management adhere to standard processing times without compromising the quality of the tanks.

The use of three theories was relevant in this exercise and for JoJo Tanks management and these are:

- **Lean Thinking** – producing the right product for the client. Alternatively, the definition of takt time resonated with the principles of Lean Thinking – “Takt Time – producing what the customer wants, at the right time, right pace and right quality”. In line with the Lean Thinking methodology, JoJo Tanks was responding to the customer pull incorrectly, allowing the limit in the number of moulds to increase inventory and overtime.
- **Lean Manufacturing** – The identification and elimination of the 7 types of manufacturing wastes were relevant to this exercise. The most prominent type of wastes for JoJo Tanks were overproduction and high inventory holdings.
- **Theory of Constraints** – where the major constraint was the limitation of the number of moulds which limited the ability to surge or increase production (at critical times), to meet sales / customer demands,

This exercise has provided JoJo Tanks management with areas of improvement that will operations through necessary use of overtime, minimising stock holding and optimally using ovens against set benchmarks – “That is, if we switch on an oven, we should use it optimally”.

Furthermore, JoJo Tanks have been provided with OEEs for all ovens and can implement the recommended upgrade path such OEE information. To further improve the OEE measure, a factory template has been provided to assist Factory and Operations Managers to:

- Monitor oven performance and identify bottlenecks early (not in real time);
- Initiate preventative maintenance routines;

Lastly, on Stage E of the upgrade programme – a distance algorithm sheet has been developed to assist with work allocation to factories based on distance. This will enable or fast track centralisation of orders, post implementation of stages A to D.

The above-mentioned solutions could:

- Affect the net pay of employees as the company produces the right product at the right time without the use of overtime;
- Improve the work/life balance of employees as they work a more relaxed 24/5 shift system vs. 24/7;
- Increase productivity and revenues for the company and these profits may not necessarily flow through to workers how are compensated on the labour effort they put in; and
- The increase in profits may lead to workers demanding a higher rate to compensate for the 'loss' of overtime.

7 Annexures

7.1 Annexure A – OEE Analysis for all ovens



Final_Analysis_Report
_Summaries.xlsx

7.2 Annexure B – Presentation to EXCO on 22 September 2017



JoJo Ops
Optimisation - Final R

7.3 Annexure C – Factory Template



Factory_Manager_Te
mplate_vEXCO.xlsx

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