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Lean Manufacturing in a South African Automotive Manufacturer

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A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand in partial fulfillment of the requirements for the degree of Master of Business Administration.

Johannesburg, 2010

Abstract

Even though lean manufacturing has been around for many years it is still influencing how vehicle manufacturers conduct their business.

Customer demand on customization is becoming a big influencing factor in how motor manufacturers evolve into the future, and with the amount of models available the customer is becoming spoilt for choice putting pressure onto the manufacturers to customize as much as possible but still not increase costs.

In today's competitive market, companies have had to find ways of reducing costs and maximizing profits. BMW realized the way they design and produce cars was far too expensive and that the Japanese could do it much better, by producing high quality with low cost.

The purpose of this research is to evaluate how successful and sustainable lean manufacturing has been at BMW South Africa. An extensive literature survey was carried out on this subject.

Qualitative research was conducted through an interview process to investigate how successful BMW South Africa has been in implementing lean manufacturing. The results suggest that BMW have been quite successful in implementing lean manufacturing within their manufacturing division, but less successful in other areas of the business. The results also show that the success and sustainability of lean manufacturing at BMW is very reliant on leadership involvement and that communication and team work have been vital to its success. The results also suggest that BMW South Africa is at the moment more focused on reducing costs than on increasing flexibility. This could be as a result of their limitation of producing only one variant within the model lineup.

Even though BMW has shown moderate success in a short amount of time a lot of work remains before they can be considered a truly lean organization.

DECLARATION

I, Ryan Michael Rider, declare that this research 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 University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

(Ryan Michael Rider)

Signed at ……

On the …….. day of …… 2010

DEDICATION

To my wife, children and parents who have supported me unconditionally for the last three years while completing this MBA. Thank you for the belief and understanding through this trying time.

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1 INTRODUCTION

1.1 Purpose of the study

The purpose of this research is to evaluate how effectively the motor vehicle manufacturing industry in South Africa has implemented lean manufacturing processes as originated from the Toyota Production System (TPS). The aim of this system is primarily to reduce waste and work to a one piece flow.

With the current competitive global environment that the motor vehicle manufacturing industry in South Africa finds itself, coupled with the growing export competition from lower-cost markets such as China and India, the South African industry has had to consistently improve their manufacturing processes and find the ways and means to remain competitive with regards to the rest of the world.

One way this can be done is by eliminating unnecessary steps in the process which aren't adding value to the business, by saving time and resources and therefore extracting maximum value from their manufacturing processes.

1.2 Context of the study

The automotive industry in South Africa needs to establish itself as a World Class Manufacturer; lean manufacturing is considered a strategic tool in becoming world class.

In 1990, James Womack and Daniel Roos coined the term lean production in their book The Machine that Changed the World. Lean production refers to a manufacturing paradigm based on the fundamental goal of the Toyota Production System – continuously minimizing waste to maximize flow. (Tapping et al. 2002)

Lean manufacturing or lean production, which is often known simply as "Lean", is the practice of a theory of production that considers the expenditure of resources

for any means other than the creation of value for the intended customer to be wasteful, and thus a target for elimination.

Lean implementation is therefore focused on getting the right things, to the right place, at the right time, in the right quantity to achieve perfect work flow while minimizing waste and being flexible and able to change.

Implementing lean processes is a balancing act between carrying too much stock which could lead to downselling at a loss, or stock shortages which could lead to lost sales. (R. Schonberger 2008)

1.3 Problem statement

1.3.1 *Main problem*

The purpose of the research is to evaluate the success of the implementation and sustainability of lean manufacturing in the motor vehicle manufacturing industry in South Africa.

1.4 Significance of the study

The study fills a gap in that no known research has been done in lean manufacturing in the South African Automobile manufacturing industry.

Much has been written on the successful implementation of lean manufacturing within the manufacturing world, since James Womack and Daniel Roos wrote their book The Machine that Changed the World.

This research will look into how successfully this type of manufacturing has been implemented within the South African context, the drivers for its success or failure and how management should approach lean manufacturing in future.

The study will provide guidance to those motor vehicle manufacturers who are trying to implement lean manufacturing within the South African environment.

1.5 Delimitations of the study

- This study will look into the success and sustainability realised from implementing lean manufacturing from the view of people and not from the analysis of financial, operational or any such data.
- The research is specific to BMW S.A, a manufacturer of luxury vehicles in the South African market, who market themselves as world class and have implemented some form of lean manufacturing.
- The research will attempt to highlight the key issues that have led to the successful implementation of lean manufacturing.

1.6 Definition of terms

All terms have been defined in the literature review and presentation of results

1.7 Assumptions

The assumptions are as follows:

- That the respondents will be knowledgeable about lean manufacturing.
- That some form of lean manufacturing has been implemented within the companies interviewed.
- That lean manufacturing is still perceived to provide a competitive advantage to manufacturing processes.

2 LITERATURE REVIEW

2.1 Introduction

The literature review will firstly give a historical background into the origins of mass production, which led to the rise of lean manufacturing. The focus will then turn to the benefits and challenges facing vehicle manufacturers, when implementing lean manufacturing and finally an introduction into the flexibility and agility needed by vehicle manufacturers in differing market conditions. This should assist in providing a good overview and background into addressing the research problem.

2.2 Definition of topic or background discussion.

2.2.1 *Mass Production*

In the 1800's Ford (Henry Ford) and GM (Alfred Sloan) revolutionized the manufacturing industry, by implementing mass manufacturing, resulting in the United States becoming an industrial powerhouse. They implemented production lines and divided the work into parts. Each worker was given a set task which he would perform continuously to a set cycle. (Womack et al. 1991)

Productivity under Ford's mass production increased substantially, beyond what was obtainable through the common craft techniques.

One of the most important aspects of Ford's ideology was the division of labour. Workers performed assembling tasks, while engineers and management personnel dealt with line organization and optimization. (Womack et al. 1991)

There was little communication between divisions, departments and even between workers. Each concentrated on producing their parts to the required

productivity and quality, with little regard to the interests of their surroundings. Due to the lack of communication between these parties, large inventories were required between manufacturing and suppliers. This inventory was needed due to different production cycles between assembling stations and suppliers and in order to maintain production flow. Quality problems were not addressed at the source, and were often only discovered at the end of the assembly line requiring large amounts of rework.(Womack et al. 1991)

Engineering developed new product designs with little regard to the manufacturability. Communication between sales and manufacturing was also disconnected resulting in large inventories of vehicles on dealer lots that customers did not want. (Womack et al. 1991)

2.2.2 *The rise of Lean Manufacturing*

The threat to mass production techniques came from an unlikely source, in the form of a Japanese manufacturer, Toyota. (Womack et al. 1991)

In the late 1970's Japanese manufacturers made a big step into the market place, not only could they offer a similar product, but at a lower cost and a much higher level of quality and durability. What emerged was their ability for continuous improvement (CIP) (Hayes and Pisano 1994).

Eiji Toyoda went to the US to learn about mass production from Henry Ford in order to better implement auto manufacturing in Japan. Toyoda saw many inherent shortcomings in mass production techniques. This coupled with the constraints of capital, labour laws and lack of space prompted Toyoda and his production chief Taiichi Ohno to create an alternative to mass production, called the Toyota Production System (TPS), the forbearer of lean production. (Womack et al. 1991)

Toyota's philosophy regarding space was the opposite of the conventional mass producers, who filled theirs with inventory and cars needing rework. Toyota saw

this as waste and used as little as possible to encourage face-to-face communication and to minimise inventories (Womack et al. 1991).

All inventory/buffers between processes and the suppliers were reduced or eliminated to promote a continuous, but very fragile flow. This technique was known as Just-In-Time (JIT). By minimising stock levels, parts were only produced to demand, creating a pull system instead of the conventional push system. This immediately highlighted inefficient processes within the production chain, which could be resolved immediately. Due to the fragility of JIT, manufacturing problems were addressed at the source rather than leaving them until the end of the line for unnecessary rework. As a result the quality of finished products was nearly perfect, with minimal additional rework required. (Womack et al. 1991)

Communication was vital to maintaining the lean production system. Information about manufacturability flowed easily from manufacturing to engineering departments. This ensured engineers understood how their decisions would impact the manufacturing process.

Engineers were then less likely to introduce complicated designs into the production plants. This coupled with continuous design improvements enabled Toyota to improve product flow and quality even further. (Womack et al. 1991)

The ease of manufacturability of the vehicle is extremely important in the manufacturing process. It is one of the most important results found in lean process design.

Stable supply and demand was necessary to keep the lean manufacturing system running without excess inventory/buffers. Key to this was the cooperative relationships Toyota had with its suppliers, allowing lean manufacturing's best practices to pass freely along the supply chain. (Womack et al. 1991)

It is common practice to find strong working relationships between manufacturer and supplier in lean manufacturing. It is about sharing information and determining cost, price and profit that will be mutually beneficial to both parties. Value

engineering and value analysis techniques are used to achieve cost reductions. These are techniques used to analyse each assembly step within the process to find areas for improvement which can lead to future cost reductions. This requires a strong working relationship between supplier and assembler and sharing information on a continual basis. Suppliers are viewed as part of the production process, and strong working relationships are encouraged in lean manufacturing. It is often the case that the assembler is part owner of the business thus ensuring their commitment to a long term working relationship. (Womack et al. 1991)

Toyota are also focused on getting it “right the first time” (RFT). They allow workers to halt production if problems occur, when a team of problem solvers will assist to resolve the problem and not allow defects to be carried over to later stages for rework. This empowering of the people and making them responsible for what they produce is one of the key reasons why Toyota’s quality and on-time-delivery is of such a world class standard.

Lean producers have also skewed the correlation between high costs leading to good quality. It was always thought more effort was needed in producing good quality. Lean producers believe quality is free and one can produce high quality and high productivity at the same time. (Womack et al. 1991)

Toyota used the principles of customer focus and labour flexibility to ensure the long-term integrity of their lean manufacturing system.

Lean production has been applied worldwide by Japanese and non-Japanese firms with much success. This style of manufacturing is based on several production concepts:

- Waste elimination is key to all manufacturing operations.
- Continuous improvement techniques contribute to productivity and product quality and can lead to perfect first run quality.
- Continuous communication between workers, engineers, retailers and customers is vital to keeping the system working.

(Womack et al. 1991)

2.2.3 *From mass to lean manufacturing*

There has been considerable interest in Toyota and its TPS over the past years with its focus in Lean Manufacturing and the elimination of waste (muda) (Hayes and Pisano 1994)

It is thought that for mass producers to successfully implement lean manufacturing within their business, they require:

1. A lean manufacturer in close proximity, to be used as a benchmark to their production techniques

2. Less assistance from the government in subsidising inefficient production techniques to help them remain competitive with the lean producers

3. A crisis. This will force assemblers to re-evaluate the way things are done. It often brings workers and executives closer together to look for the most beneficial manufacturing techniques that can help them survive.

(Hayes and Pisano 1994)

Many manufacturers worldwide have been implementing 'world-class' manufacturing strategies such as Total Quality Management (TQM), JIT production and lean manufacturing. While some of these improvements have been successful, the majority have not. Even the pioneers in Japan are having second thoughts. Due to the differing success of the industry many manufacturers have been left feeling extremely frustrated, blaming either poor management or the programmes themselves. What has been found is that the problem doesn't lie with the programmes or the implementation, the problem lies with organisations abandoning their strategy and then thinking that adopting a few of the best practices is going to lead to a competitive advantage (D.R. Towill 2006b).

Lean manufacturing should not be seen as a solution to a problem, rather it should be used as a tool that can help an organisation to gain an advantage over its competition. Like many quality programmes and new advanced technology these can give you the edge but only for a short while, as any of these

programmes or technology can and will be copied along the way. Companies should rather focus on the skills and knowledge of their workers at implementing these programmes or technology, they are the key to success, and no matter how good the concept/programme it is only as good as the people using it (Hayes and Pisano 1994).

One of the biggest problems which will face mass producers when converting their operations to a lean manufacturing style, is what to do with the excess capacity (Womack and Jones 1994). The problem that faces the workers is that they have not gained any meaningful skills that they can use in other sectors, and unless the manufacturer can find new markets for their product, these workers will find themselves without a job and any specialised skills which they can use to sell themselves in the open market. (Womack et al. 1991)

Many mass producers have tried to compete with lean manufacturers by producing in the developing world and using the low wages as an advantage to produce lower cost vehicles. This has given them an initial advantage but what is often the case is that the product quality is below standard, due to the lack of skills used to produce the product, forcing the manufacturer to sell the product at a lower cost or to increase the skills of the workforce which leads to higher wage demands. The result is the competitive advantage dwindles and the lean producers reclaim their competitive advantage in the long term. (Womack et al. 1991)

2.2.4 *Key Instruments in becoming Lean*

The key behind the successful implementation of this system is by

- reducing uncertainties,
- eliminating waste (non-value adding time),
- reducing work-in-progress (WIP),
- minimise total cycle time and set-up times and,

- having a reliable and consistent process that responds as and when required.

This helps to ensure orders are delivered when necessary. The knowledge gained from this can be used to support and enhance supplier working relationships. This is what makes Toyota the leader in Lean Manufacturing and results in consistent volumes and low volatility (D.R. Towill 2006b).

Just-in-Time (JIT) Production – “is a production technique for producing only what is needed, when it is needed, in just the amount needed” (D.R. Towill 2006a:21) aimed at eliminating waste from all process steps.

Lean manufacturing is a step towards becoming a World Class Manufacturer. All manufacturers aspire to be world class, but even if you do achieve world class status this still will not ensure a competitive edge over your competition, as world class today may not mean world class tomorrow. It is a continuous process of improving, while at the same time your competitors are advancing at a similar pace. A manufacturer has to be flexible and able to adapt to market conditions (Hayes and Pisano 1994).

Strategists had argued for years that manufacturing facilities, when building new production systems, would have to choose which strategy to adopt, either low cost, high quality or flexibility. Many Japanese factories who had implemented lean manufacturing could do all this at the same time. The Japanese were able to combine the skills of both the mass and the craft producers, with half the amount of workers, half the space, half the investment and half the amount of engineering hours to design a new product in half the time. Even with these achievements they were still able to produce excellent quality products with low inventories and with the flexibility to adapt to market conditions. (Womack et al. 1991)

The Lean Approach is defined by Hayes and Pisano as:

- Speed and flexibility rather then volume and cost
- Workers should be broadly trained and not specialized
- Employees are overhead and overhead is bad
- Horizontal informal communication, instead of the hierarchical approach
- Production cells that can produce a range of products rather than in stages
- Measuring through put time is more important then measuring people or equipment utilization
- Inventory is seen as waste (muda)
- Problems should be resolved at the source when they happen and not reworked later
- Relationships with suppliers are strong, long term and cooperative. Both manufacturer and supplier should benefit from continuous improvements
- Product development should be carried out by cross-functional teams

Long term success does not come from adopting the latest “fad”, rather it comes from evolving and differentiating oneself from one’s competition. “Great manufacturing strategies are built on unique skills and capabilities, not on investments in buildings, equipment, or specific individuals.” (Hayes and Pisano 1994:86) (R. Schonberger 2007)

A company should not adopt a new programme or programmes because the competition is adopting it, rather they should identify what makes them unique and how can they remain or become the market leader. Then they should identify what tools are needed to help them along the way (Hayes and Pisano 1994).

Table 1: New Production Models (Toni and Tonchia 2002)

Traditional Production Paradigm	New Production Models
Principles • Repetitive production of few products • Intermittent production of many products • Push production into the market • Reference to standards • Human Resources as antagonists	**Principles** • Repetitive production with product variety • Market pull • Continuous improvement • People involvement
Managerial consequences • Organisational structure only by functions • Flexibility mainly due to plant automation • Performance trade-offs • Mono-phase & mono-lever actions	**Managerial consequences** • Organisational functions and processes • Greater importance of organisational flexibility • Performance compatibility and cumulativeness • Multi-phase and multi-lever actions

Table 1 summarises the differences between production pull versus production push. The idea behind the mass production facilities is to keep productivity high, thus the reason to push the system along and at the same time hold high inventory levels to ensure availability when demanded. Lean manufacturing sees the push principle as generating waste, as high inventory levels lead to a consumption of man hours and space whereas a pull system works from the principle of building to request, as the customer request a vehicle the system pulls the product through the stages, this eliminates the need for large inventory levels (Toni and Tonchia 2002).

The aim of continuous improvement is to improve the processes all the time, to continuously optimise the processes, it is an idea that the system is never good enough and can always be improved upon (Toni and Tonchia 2002).

The importance of the people in the process is key to lean manufacturing principles, as the systems such as CIP & JIT would not function without their input. The lean system provides the people with the ability to stop the line by pulling a cord as problems should be resolved at the source and not reworked later on. This is how lean manufacturers are able to maintain an optimal level of throughput time (Toni and Tonchia 2002).

Organisation by process and not by function. The worker in a lean process needs to take ownership of his area, and is responsible to suggest improvements. They also need to be flexible at performing many tasks (Toni and Tonchia 2002).

Limited automation. It has often been suggested that for a manufacturer to become more flexible, they should increase the levels of automation, but the opposite is actually true - that people adapt more easily to changes in the market than machines and at a lower cost (Toni and Tonchia 2002).

Compatibility rather then incompatibility. It was previously believed that to produce good quality, products would come at a higher cost. Lean manufacturers have been able to produce the highest levels of quality, at a lower cost then the traditional mass producers (Toni and Tonchia 2002).

Multi-phase and multi-lever instead of mono-phase and mono-lever'. Programmes such as JIT, TQM and Concurrent Engineering have been implemented horizontally across the organisations from suppliers to the customers this is seen as multiphase whereas mono-phase is seen to be kept within the realms of production (Toni and Tonchia 2002).

Lean production is best known for its concepts such as JIT, TQM and Concurrent engineering. All of the above concepts are based on the premises of reducing waste and eliminating unnecessary activities. Lean production is also continually

focused on developing the optimum result for the customer (R.J. Schonberger 1992).

Very few manufacturers have successfully implemented a lean manufacturing system. They have often implemented only parts of the process. However, to be successful in lean manufacturing requires adherence to all of the following requirements:

- Making a commitment to adopt lean processes
- Understanding customer demand
- Knowing your current state and depicting it accurately
- Thorough and regular communication

(Toni and Tonchia 2002)

Making a commitment requires the involvement of all employees on all levels within the organisation starting from the top. It will offer you no value if you have one champion trying to get everyone to buy into the ideas and adopt the processes.

Understanding customer demand is about fitting your manufacturing process to the fluctuating demands of the customer. (Womack et al. 1991)

Only by knowing and understanding your processes accurately can you begin to look for a future condition and begin a plan to change it.

Communication is one of the most important steps in a lean process. One can only achieve true lean manufacturing with the buy-in of the workers. The workers will only react positively to this process if they understand why it is being done and what the benefits of it are. Lean manufacturing is about eliminating waste in the process and will lead to a reduction in personnel. Therefore employee involvement is critical to the success. (Womack et al. 1991)

In a pull system, workers are central to the improvements and cost reduction ideas within the process. They pull the resources and training needed to make improvements, this is preferred to the traditional push system where management traditionally push for improvements within the process. However, management support is still crucial. Their commitment to the lean objective is critical and they must ensure information flows from top down and from bottom up. Management have to show their commitment by getting involved, not by sitting in an office expecting regular feedback but by regularly going to the shop floor and observing first hand. (Womack et al. 1991)

To succeed in lean manufacturing, management need to view and treat their employees as assets, and invest and grow these assets by giving them the opportunity to learn, through experience and training. These employees are critical to the success of lean manufacturing as they are familiar with the operations and are in the best position to offer ideas for improvement. At the same time it is important to make employees feel secure in their jobs as they will not be willing to offer ideas of improvement if their jobs are at risk. (Womack et al. 1991)

Manufacturers are constantly under pressure to reduce cost and delivery times but at the same time improving quality. Traditionally manufacturers would calculate their costs to produce and add on a margin for profit, but today with the competitive environment those manufacturers find themselves in, this is no longer possible. They now need to identify ways of reducing costs by eliminating waste and reducing inventory. This is known as the cost reduction principle (Tapping et al. 2002).

The seven deadly wastes are as follows:

1. Overproducing, producing parts or completed vehicles not for immediate use or sale.

2. Waiting, operations waiting for parts or products before they can produce. This is usually due to line unbalancing or incorrect scheduling.

3. Transportation, unnecessary distances travelled from one operation to the next due to bad layout planning.

4. Processing, carrying out unnecessary steps in the process which do not add value to the product e.g. rework, inspection.

5. Inventory or work-in-progress, excess material produced or buffers between stations due to unbalanced lines or inefficient processes.

6. Waste of motion, this is unnecessary motion carried out by the workers that doesn't directly contribute to the product e.g. fetching parts or tools, bending or stretching.

7. Defects, producing parts that aren't correct the first time resulting in unnecessary rework or a halt in production

   (Tapping et al. 2002)

To try to eliminate or reduce this waste, manufacturers have been implementing programmes such as, Just in time (JIT) production, which is a process of one piece flow. Producing a single part to replenish the previous part pulled by the system, to achieve a state of continuous flow. It is also known as the supermarket concept, due to the fact that supermarkets only replenish items on the shelves once a customer has taken them (Childerhouse et al. 2004) (D.R. Towill 2007).

The Twelve Simple Rules of material flow are as follows:

1. Only produce to demand, this ensures a pull instead of a push material flow system.

2. Only produce in small batches between stations, this helps to eliminate work-in-progress between stages which reduces space requirements and reduces stock levels.

3. Streamline material flow and minimize throughput time, this helps to keep the flow of material from one station to the next at an optimum level.

4. Work to achieve the shortest possible planning periods, this helps to accurately forecast demand and reduce inventory levels.

5. Use a pull system on suppliers so that they only deliver just in time to help reduce stock levels.

6. Synchronize cycle times between stations. This helps to optimise material flow and reduce buffers between stations.

7. Allow for flexibility in your production line. This helps to adapt quickly to differing customer demands.

8. Identify and eliminate all problem areas in your assembly line, as this can affect your material flow between stations.

9. Have a structured approach to problem solving. This ensures nothing is overlooked and documentation can be revisited at a later stage.

10. Have information visible for all. This helps to motivate workers to identify possibilities to improve and ensures all workers are aware of their progress

11. Use proven and robust measures in problem solving exercises and not gut feel as this can often lead to incorrect decision making.

12. For any supply chain system to work effectively it needs the buy-in of all workers within the system. If one fails all will fail.

(Childerhouse et al. 2004)

By managing one's material flow, manufacturers can reduce their inventories, as inventories and buffers should only be seen as a short term requirement, usually as a result of fluctuations in customer demand. Large inventories should not exist to hide inefficiencies in the process. As demand stabilises these inventories should be reduced or eliminated. (D.R. Towill and Childerhouse 2006)

2.2.5 *Flexibility & Agility manufacturing models*

Levelling of production activities is extremely important in the TPS as this helps to minimise the effect on suppliers and upstream and downstream operations. Levelling of production means not building cars in batches of two and then four door models as this leads to spikes in supplier demand, forcing the supplier or manufacturer to hold high levels of inventory. Rather implement a smooth flowing operation that produces only to customer demand. Providing suppliers with accurate, predictable and regular supply schedule is of utmost importance in reducing the need for high levels of inventory (D.R. Towill 2006b).

This is only made possible by acquiring continuous and accurate feedback from retailers on sales trends and detailed customer demands. Toyota achieves this by displaying the retailer's accuracy in determining customer demand and their effect on imposing volatility on the delivery system. This is in stark contrast to what many western manufactures do by pooling inventory of finished stock and putting pressure on retailers to match this inventory to customer demands (D.R. Towill 2006b).

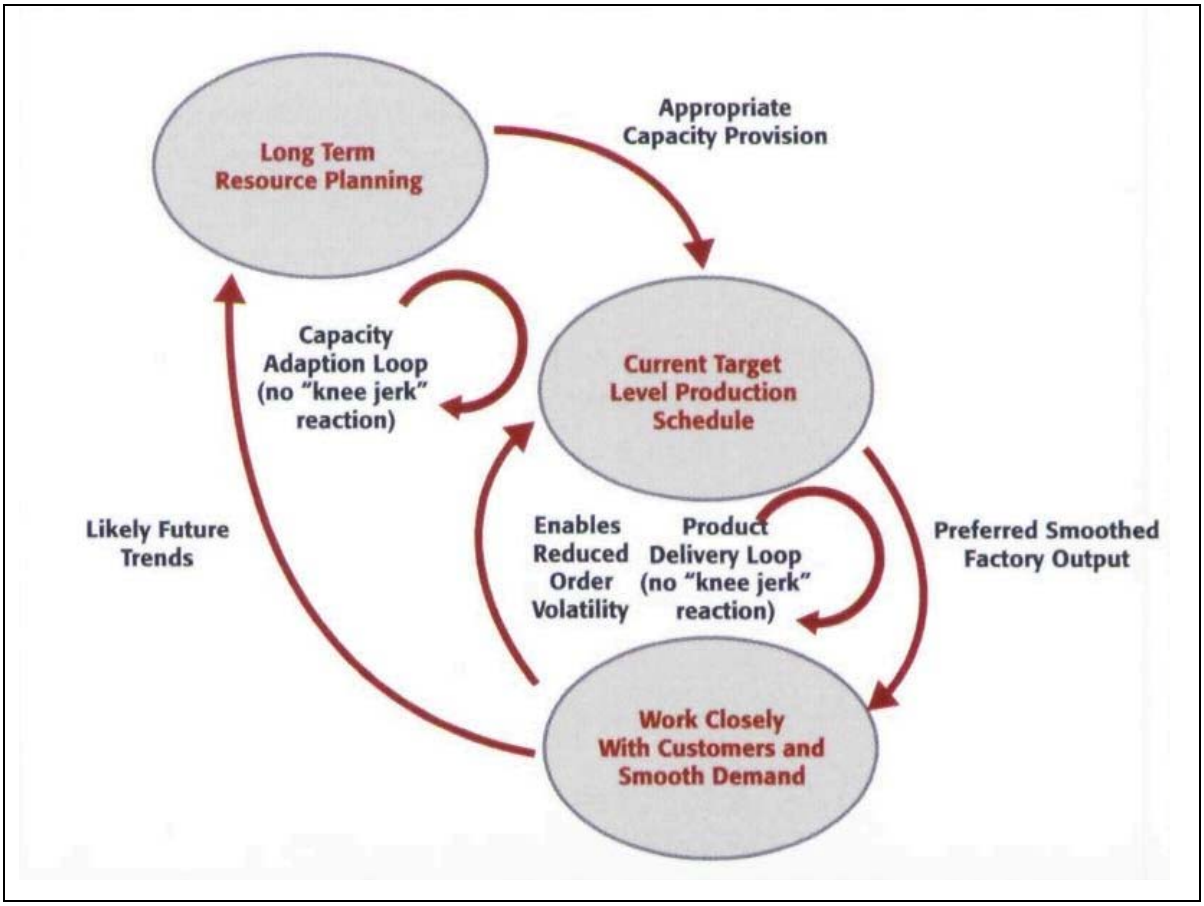

Figure 1: How working with customers results in TPS Generation of Collaborative virtuous circles (D.R. Towill 2006b)

It has also been argued elsewhere that lean manufacturing works well when demand is stable and predictable, whereas agility in manufacturing works better where demand is volatile and customer requirement for variety is high (D. Towill and Christopher 2002).

Flexibility is key to any agile organisation (Toni and Tonchia 1998). It was previously believed that to obtain a flexible manufacturing system, automation was necessary to reduce set-up times and therefore provide a quicker response to changes in demand. This idea has now been extended into a wider business context and brought about a new manufacturing concept the Agile Manufacturing Concept as summarised in Table 2.

Table 2: Relevance of Core Characteristics of Agile Manufacture (D. Towill and Christopher 2002)

Activity	Agile Characteristics
Marketing	• Customer enriching, individualised products and services
Production	• Ability to produce to customer requirements
Design	• Holistic methodology integrating suppliers, business processes, customer and product use and disposal
Organisation	• Ability to synthesise new productive capabilities from expertise of people and physical facilities regardless of their internal or external location
Management	• Emphasis on leadership, support, motivation and trust
People	• Knowledgeable, skilled and innovative employees

Agile is seen as nimble and being able to quickly respond to changes in the market place, whereas lean is seen as reducing inventory and eliminating waste. It is said that many motor manufacturers who are lean are by no means agile and would struggle to adapt to radical changes in the market place (D. Towill and Christopher 2002).

It is the view of Towill & Christopher that there are four different paradigms that can be used in lean and agile manufacturing being same place/same time, same place/different time, different place/same time and different place/different time as shown in Fig.2.

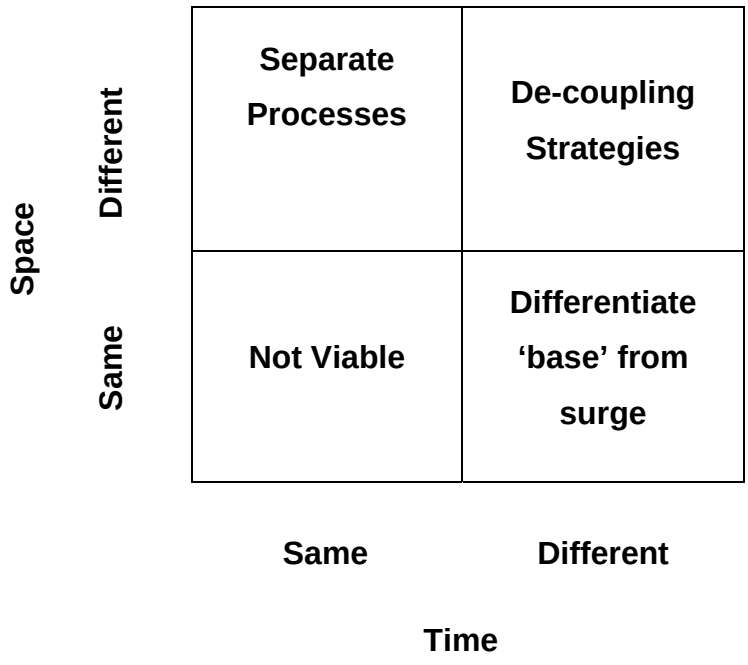

Figure 2: The Time/Space Matrix (D. Towill and Christopher 2002)

Separate Processes (Different space/Same time) – This lends itself more to a lean manufacturing system where volume is more predictable and produced using low cost and more efficient processes, whereas an agile process will be less predictable and slow moving. An example of this is a two line process, one being lean and the other agile (D. Towill and Christopher 2002).

Differentiate 'base' from surge (Different time/Same space) – Demand is forecasted to occur, where a level of demand is forecasted with high certainty, additional capacity is made available through any 'surges' in demand (D. Towill and Christopher 2002).

De-coupling strategies (different space/Different time) – This strategy works off lean principles by maximising efficiencies and economies of scale up to the de-coupling point, thereafter it becomes agile and highly responsive to actual demand (D. Towill and Christopher 2002).

With the current volatility and unpredictability of the market place there is need for motor vehicle manufacturers to be closely linked to the market place and a decision must be taken of which strategy to follow: lean, agile or a combination of both. It is very rare for any manufacturers to be that closely linked to the market place even if they do think they are. The reality is that their marketing and operations departments do not work in unison.

It is more common to find the operations department more focused on improving efficiency and reducing costs through the measurement of a cost/unit metric, rather then the functional metrics of customer orientated approach e.g. order-to-delivery time, cash-to-cash cycle time, perfect order achievement. Unless these measures are given precedence it is unlikely that one would see unity between these departments (D. Towill and Christopher 2002).

It is important to establish what the demands of the market place are and to fit your strategy to this by:

1. Identifying the market winners and qualifiers
2. Looking for opportunities to implement lean and agile techniques
3. Locating feasible decoupling points within the supply chain
4. Using performance metrics that will align the requirement of both departments

   (D. Towill and Christopher 2002)

In a stable environment implementing programmes such as lean manufacturing can be enough to defend one's position but in turbulent environments manufacturers have to be able to adapt quickly to changing market conditions. This is when the skill and capabilities of the organisation to adapt become more important. Manufacturers have to decide whether lean or any other manufacturing programme is going to help them on the road to success. (Womack et al. 1991)

The problem is, neither the conventional mass production approach, nor the lean approach, are going to make an organisation more flexible. The problem is not with lean manufacturing but the way it has been used, rather then adopting the lean strategy to improve over the long term, organisations use it to resolve particular problems, for example, cost per unit or quality problems. Lean manufacturing is not a quick fix, rather it is a process to improvement and needs to be a continuous long term commitment and these programmes should not be seen as a solution to a problem but rather a development into new capabilities that can strengthen the organisation. (Hayes and Pisano 1994) (Kusunoki et al. 1998)

2.3 Success and sustainability of lean manufacturing

To establish whether the South African motor manufacturing industry has successfully implemented some form of lean manufacturing, and to evaluate how sustainable it will be.

2.3.1 *Advantages of lean manufacturing*

Proposition: Lean manufacturing does lower your operational costs and improve your overall quality.

2.3.2 *Effective communication*

Proposition: Communication is vital to the effective implementation of lean practices.

2.3.3 *Empowering the people*

Proposition: Empowering the workforce is key to effective adoption of lean practices.

2.3.4 *Sustainability*

Proposition: It is important to maintain the focus and measure one's success to ensure long term sustainability.

2.3.5 *Flexibility and agility*

Proposition: Lean manufacturing leads to production flexibility but not production agility.

2.4 Conclusion of Literature Review

Henry Ford revolutionised the industrial world, by implementing mass production in the 1800's. This form of manufacturing allowed for vehicles to be manufactured in a large scale, at much lower prices then had been experienced through the traditional craft techniques.

Even though this type of manufacturing was very efficient, there was still room for further improvement. It was thought that good quality could only be achieved with high costs and manufacturers would have to choose either to produce with high quality or with high productivity, both could not be achieved at the same time.

Toyota turned this philosophy on its head, by proving quality is free and one could produce high quality and high productivity at the same time. Toyota learnt mass production techniques from the then giants of manufacturing Ford and General Motors, but saw an opportunity to improve on the mass production model. These improvements that Toyota focused on were throughput time, right first time quality and Just-in-Time supply. This was achieved by empowering their people and making them responsible for what they delivered.

Lean manufacturing quickly caught on in the western world, as Japanese manufacturers started to dominate the world market by producing high quality vehicles, with similar costs to the mass producers.

Many vehicle manufacturers have struggled to implement lean practices and have tried other ways to compete with lean manufacturing. One of these ways was through cost, by producing in third world markets with cheaper labour, but this strategy has only provided short term advantages, as with an improvement in skills results in a demand for increased wages.

What manufacturers have not realised is that lean manufacturing is a tool not a strategy, it will help you become more competitive, but companies still have to identify what makes them unique and how this can make them market leaders.

A new production philosophy has emerged, different from the lean approach which relies on stable and predictable market demand. Agile manufacturing works better in a volatile market, where variety is high and demand is volatile, with the ability to respond quickly to changes in market demands.

3 RESEARCH METHODOLOGY

This research is concerned with evaluating the success and sustainability of implementing lean manufacturing in a South African Automotive Manufacturer.

The study is therefore descriptive and explanatory in nature. This negates the necessity of acquiring statistical evidence in the form of financial, operational or any measurable data. (Tziatas 2005)

The intention is to assess the understanding the respondents have in regard to lean manufacturing and what, if any, benefits have been gained from its implementation, and how sustainable it will be in the long term.

Data was collected using a single method of an in depth interview. A questionnaire was prepared to ensure structure and direction would be followed by the interviewer.

3.1 Qualitative research methodology / paradigm

Qualitative techniques are not concerned with measurement. They are less structured and allow the process to be more tailored to the respondent and the nature of the subject. The material gathered from a qualitative technique is more explicit, creative and personal than in quantitative analysis. (Walker 1985)

The research is concerned with measuring the perceptions of the people interviewed of the advantages gained from implementing lean manufacturing and the sustainability of it in future.

Data will be collected by a single qualitative method, through an in depth interview.

3.2 The In-Depth Interview

The in-depth interview will be used to obtain complex information from a relatively small sample, which cannot be done using a quantitative survey. (Leedy 1989)

The in-depth interview allows the researcher the opportunity to probe deeply, so as to uncover information based on personal experiences. (Walker 1985)

“Open-ended questions are used extensively in depth interviews because they give greater freedom for respondents to answer in their own terms rather then within the tramlines of set alternatives in closed questions” (Walker 1985:49)

In in-depth interviewing one must be careful not to simply accept the data at face-value, but to think of how the data may have been influenced. To counter this, one can conduct more than one interview or commit to feedback the findings at a later stage. (Walker 1985)

3.3 Population and sample

3.3.1 *Population*

The research population consists of one motor vehicle company who manufacture vehicles within the borders of South Africa and whom lean manufacturing would benefit.

3.3.2 *Sample and sampling method*

The sample is of a single world class manufacturer based in South Africa. The sample is essentially a convenience sample but should be representative of motor vehicle manufacturers within South Africa.

The manufacturer who has been selected has implemented some form of lean manufacturing over the past few years.

Interviews will be conducted with representatives of this company, preferably Managers in the manufacturing technologies and Lean Manufacturing mentors.

Table 3: Target Sample of Company and Respondents to be interviewed

Company Name	**Respondent & Position within the Company**
BMW S.A	Lean Mentors
BMW S.A	Production Managers
BMW S.A	General Managers
BMW S.A	Production Manager
BMW S.A	Technical Director
BMW S.A	Planning Manager
BMW S.A	Production Associate

Table 4: Profile of respondents

Description of respondent type	**Number to be sampled**
Production managers	2
Lean mentors	2
General Managers	2
Technical Director	1
Planning Manager	1
Production Associate	1

3.4 The research instrument

The in-depth interview will be aided by the use of a questionnaire (, see APPENDIX A).

The questionnaire will contain the five propositions as formulated in the consistency matrix. Each proposition will contain prompts to guide the interview and aid the discussion to prevent monosyllable answers and ensure elaboration on the topics presented.

3.5 Procedure for data collection

The data will be collected by contacting the relevant company via telephone and e-mail. The selected participants will be sent an e-mail containing a letter inviting them to participate and giving an explanation for the purpose of the study. Refer to APPENDIX B for the introductory letter. An appointment will then be set up with the respondents to be interviewed.

An in-depth interview will be carried out either telephonically or face to face. The interview will be taped if permission is granted and subsequently transcribed. Extensive notes will also be taken during the interview so as to ensure the salient points are not missed.

The interview will be based on the five central propositions as stated in the consistency matrix.

3.6 Data analysis and interpretation

According to Leedy the researcher must:

- Select a population and study it
- Minimise the possibility of bias
- Observe the data directly

- Record and systematize the facts

  (Leedy 1989)

In descriptive research interpretation of the data is extremely important (Leedy 1989). The facts as much as possible shouldn't be influenced to support the hypothesis, the facts should speak for themselves (Leedy 1989).

3.7 Limitations of the study

Due to the fact that the research will be based on a convenience sample, it is not representative of the entire population. Though according to Leedy, "Convenience sampling may be appropriate to less demanding data collection."(Leedy 1989:153)

One must also be careful not to let one's personality affect the responses of the interviewee. (Leedy 1989:167)

To overcome these concerns the interviewer practised with a coach who could elicit suggestions. Personalised interviews with each interviewee and use of an interview guide was also utilised to ensure continuity.

3.8 Validity and reliability

It has been argued that qualitative research is high on validity but low on reliability, but a rigorous, systematic and transparent approach should lead to a substantial improvement in reliability. (Walker 1985)

Significance in in-depth interviewing can be gained by achieving a balance between structure and ambiguity by sometimes abandoning our predetermined framework in response to what our respondents are telling us. This is significant in my research topic. (Walker 1985).

3.8.1 *External validity*

This is concerned with the generalising of the conclusion reached. (Leedy 1989:27) and how accurately the instrument measures the facts. (Leedy 1989)

Due to the fact that the sample is not random, generalised findings of the entire population will not be possible. (Tziatas 2005)

3.8.2 *Internal validity*

"Is the freedom from bias in forming conclusion from the data."(Leedy 1989:27)

The researcher must acknowledge the likelihood of bias in his data. (Leedy 1989)

Therefore the data collected must accurately represent the response and the researcher must prevent his own opinion from influencing the result.

To test for validity a pilot study will be run to test the interview instrument.

3.8.3 *Reliability*

Their will be no reliability testing for this study.

CHAPTER 4: PRESENTATION OF RESULTS

4.1 Introduction

The results as obtained from the in depth interview process are presented in APPENDIX D. In this chapter the results will be presented according to the propositions, themes and sub themes as obtained during the interview process.

All interviews were transcribed and subsequently summarised by identifying and extracting key comments and references. The content was then grouped according to proposition, where key themes and sub-themes were identified these were then grouped and tabulated according to:

- Proposition;
- Theme within proposition;
- Sub-theme;
- Interviewee and position within the organisation;
- Detailed response

4.2 Demographic profile of respondents

The initial objective of the research was to determine whether lean manufacturing had been implemented in all vehicle manufacturers country wide, this idea was revisited and for reasons of convenience a case study on the success of lean manufacturing at BMW South Africa was chosen instead.

A sample of respondents was chosen from a wide variety of positions within BMW so as to obtain a more thorough and honest reflection of how lean manufacturing had been implemented and how successful it had and would be in future.

Table 5 below identifies the respondent number and position held within the organisation

Table 5: Respondents and position held within the company

Respondent	Position	Department
1	Manager: Value Added Production Systems	VPS Plant Rosslyn
2	Production Manager	Body Shop
3	General Manager	Assembly Plant
4	Production Associate	Body Shop
5	Technical & Logistics Director	BMW South Africa
6	General Manager	Painted Body
7	Production Specialist VPS	Painted Body
8	Manager: Quality & Offline Production	Assembly Plant
9	Manager: Planning & Process	Body Shop

4.3 Selecting the Themes and Sub-Themes

During the interpretation of the data obtained through the interview process, key words and phrases emerged. These keywords and phrases were allocated to different sections of the data so as to group the data for interpretation purposes.

Themes and sub-themes were then selected based on these keywords and phrases.

For each proposition the themes and sub-themes that were allocated to the data are indicated in Table 6 below.

Table 6: Propositions and Themes

Proposition	**Theme**
1. Lean manufacturing does lower your operational costs and improve your overall quality.	Benefits of Lean Manufacturing
2. Communication is vital to the effective implementation of lean practices.	Driving force
	Challenges or hindrances
	Manufacturability
3. Empowering the workforce is key to effective adoption of lean practices.	Buy-in
4. It is important to maintain the focus and measure one's success to ensure long term sustainability.	Long-term goal
	Benchmarking

	Success
5. Lean manufacturing leads to production flexibility but not production agility.	Customisation
	Flexibility/Lean

Proposition 1, the main theme that emerged from this proposition was the *"Benefits of Lean Manufacturing".* Several sub-themes then emerged within this theme ranging from financial to cultural benefits.

Proposition 2, several questions and responses were grouped under this proposition, *"Driving Force"* refers to which stance BMW took and furthermore, how did they get the message through to the workforce? *"Hindrances"* refers to any obstacles that may have emerged that could possibly derail the process. *"Manufacturability"* refers to constant communication between manufacturing and whether engineering supports the adoption of lean practices.

Proposition 3, the main theme that emerged during this proposition was how they obtained the *"Buy-in"* for the workforce to actively participate and adopt these principles.

Proposition 4, several themes emerged from the questions and responses related to this proposition, the main two being *"Success"* and *"Long-term goal"*, what success has been achieved and how this will transform into the long-term sustainability of lean practices. Another theme that emerged during the interview process was the importance of *"Benchmarking"* and how this can and does assist in establishing how one is progressing and what more can be done to further improve.

Proposition 5, the two main themes that emerged from this proposition were *"Customisation"* which relates to how BMW will meet and manage future customer demand and how this will impact on the lean principles, the second theme that

follows on from this is what type of production techniques will be needed to be able to best meet this future demand *"Flexibility or Lean"*.

4.4 Benefits of Lean Manufacturing

The question posed to the interviewees with regard to whether "Lean manufacturing does lower your operational costs and improve your overall quality" was:

"Has lean manufacturing provided benefits to the organisation, and if so can you quantify these benefits?"

The theme and sub-themes that emerged from their responses are tabulated below.

Table 7: Themes and sub-themes relating to Proposition 1

Theme	**Sub-Theme**	**No. of interviewees**
Benefits of Lean	Financial Benefits	14
	People Development	10
	Process Improvements	13
	Quality Impact	2
	Transparency	6
	Teamwork	2

	Flexibility	1
	Job Security	1

From Table 7, it can be seen that several sub-themes emerged from the main theme the *Benefits of Lean.*

The majority of the respondents identified the *financial benefits* as the major influencing factor with regard to the benefits gained from implementing lean manufacturing, this is understandable as it is seen as the leading reason why an organisation would implement this form of manufacturing.

Two of the other major influences were *process improvements*, which relate to streamlined processes, waste elimination and productivity improvements and *people development* which has a lot to do with involving the workforce and making them part of the lean process, which has led to an improvement in the skill levels of the workforce and created greater production flexibility.

Transparency and *team work* also seem to be major themes within the benefits gained from lean manufacturing. The interviewees felt that by involving the workforce and making them work together and then illustrating their progress were instrumental to the benefits gained.

Job security was also highlighted as a benefit, this was a bit unusual to find one of the repercussions of lean manufacturing as a benefit, but the interviewees felt that by eliminating waste (unnecessary steps within the process) would reduce costs and therefore justify the need for a manufacturing plant to remain in South Africa and therefore create job security.

It is clear from the responses to the question posed on the benefits gained from lean manufacturing, that all the benefits of implementing lean manufacturing as highlighted by Womack were envisaged and that to date it has been a resounding success within the production facility.

4.5 Effective Communication

The questions posed to the interviewees with regards to whether “Communication is vital to the effective implementation of lean practices”

“What has been the driving force behind implementing lean processes?”

And,

“Have there been any hindrances to implementing lean practices, for example high absenteeism, age profile of the workforce affecting the loading of the people?”

And,

“The ease of manufacturability of the vehicle is extremely important in the manufacturing process. It has a considerable impact on implementing successful lean processes, how much influence does production have on influencing product design?”

Table 8 summarises the interviewees responses to the questions posed and the themes and sub-themes that emerged from their responses.

Table 8: Themes and sub-themes relating to Proposition 2

Theme	**Sub-Theme**	**No. of interviewees**
Driving Force	Leadership	3
	Strategy	4
	Transparency	3
	Competitive advantage	11

	Financial Benefits	2
	Process Improvements	1
Challenges/Hindrances	Communication	2
	Process Improvements	4
	Transparency	3
	People Development	5
	Strategy	1
	Leadership	3
	Job Security	2
	Quality Impact	1
Manufacturability	Product Development	3
	Process Improvements	1
	Teamwork	5
	Strategy	3
	Transparency	1

From Table 8, it can be seen that three main themes emerged from this proposition being *Driving Force*, *Challenges/Hindrances* and *Manufacturability*.

With regard to the first theme being the driving force behind implementing lean manufacturing, several sub-themes emerged. The most influential, according to the interviewees, was competitive advantage, this relates to the need for BMW to remain competitive in the global vehicle manufacturing market and for BMW S.A. also to remain financially competitive with the other BMW manufacturing plants. This then led to a change in BMW's *strategy* that VPS (value adding production system) would now become an essential part of BMW's strategy going forward. The board realized that for VPS to be successful would require involvement and commitment from top levels of management, thus making *leadership* essential in the success of VPS. Transparency as illustrated in Appendix E was also seen by the interviewees as extremely influential in the communication campaign. Another driving force that emerged during the implementation phase which helped to drive the success of VPS was the financial crisis and the necessity to reduce costs.

The second theme that was grouped under communication was challenges/hindrances, again several sub-themes emerged most notably *people development* as the interviewees felt that for VPS to be successful in South Africa which had a completely different culture to Asian and European manufacturers, would require a complete mindset change in how the people thought and carried out their daily tasks. The second most influential sub-theme was *process improvements*, as according to the interviewees before any VPS activity is carried out an ergonomic study of the work area needs to be carried out to evaluate whether the changes would affect the working ability of the person involved. The next two influential sub-themes were *transparency* and *leadership* as for VPS to be effective and to be implemented correctly requires support from management and effective communication to the workforce and to prove that changes to peoples' working environment was not only of benefit to the company but also to the people affected by the changes, transparency was extremely important as practical examples showed the benefits and advantages of making the changes. Job security and communication were extremely influential in the success of VPS at BMW S.A., according to the interviewees people fear change and the most common reaction to lean implementation is the fear of job losses which made communication a vital part of effective lean implementation.

The final theme was how much influence production has on influencing product design, the manufacturability of the vehicle. The most common sub-theme that emerged during the interviews was *teamwork*, how good or bad the co-operation and communication was between the designers and the manufacturers and how this does affect the ability of effective lean manufacturing. This is echoed in the literature by Womack and Schonberger though there seems to be a level of *transparency* between the manufacturing plants on sharing ideas on *process improvements*. The next most influential sub-theme was *product development* and how much of a driving force this is in product design, more so than process development and how this inadvertently affects lean manufacturing. This leads to the next sub-theme being BMW's *strategy* regarding more focus on product development rather then process development which is in contrast to some of the leading lean manufacturers.

According to the interviewees communication and transparency is essential to effective lean manufacturing. This is similar to the view taken by Womack that, *"Continuous communication between workers, engineers, retailers and customers is vital to keeping the system working."* (Womack et al. 1991) Effective lean manufacturing can only be implemented through a strong working relationship between management, engineers, designers and manufactures.

4.6 Empowering the Workforce

The question posed to the interviewees with regard to whether “Empowering the workforce is key to effective adoption of lean practices”

“How did you obtain the buy-in from the workforce to participate in implementing lean activities?”

Table 9 gives a summary of the themes and sub-themes as obtained from the interview process and corresponding analysis.

Table 9: Themes and sub-themes relating to Proposition 3

Theme	**Sub-Theme**	**No. of interviewees**
Buy-in	People Development	3
	Transparency	7
	Teamwork	12
	Communication	4
	Leadership	3
	Job Security	2
	Sustainability	1

From Table 9, it can be seen that several sub-themes emerged from the main theme the *Buy-in.*

The most influential sub-theme to emerge from the interviews was *teamwork*, all the interviewees felt that the most important step in achieving the acceptance of

the lean principles was through teamwork and the involvement of everyone from the start. This sub-theme led to the second most influential sub-theme being *transparency.* The initial roll-out of the whole idea of lean manufacturing was to use pilot projects to market the advantages that could be realised by implementing lean concepts not only for the organisation but for the workforce by improving their working environment. *Communication* again played a vital role to ensure that everyone understood the reason for implementing this manufacturing style. The credibility and involvement of management/leadership was also essential to the acceptance of VPS. The VPS-mentors had to learn what lean manufacturing was all about and then train the workforce in the new way of doing things. This ensured everyone first understood the methodology before implementing any projects to ensure future success. Part of the communication strategy was to emphasise that even though lean is about reduction and being more efficient in the way things are done, no one would lose their jobs as a result of any lean projects and that management would find a position elsewhere for the individuals affected by the changes.

According to Womack, *"To succeed in lean manufacturing, management need to view and treat their employees as assets, and invest and grow these assets by giving them the opportunity to learn, through experience and training."*

Teamwork, communication, transparency, leadership and people development were all key factors in getting the workforce to buy-in to the idea of lean manufacturing, with the most essential element being making people part of the process, it is clear from the interviewees responses that for VPS to be a success it was important to get the buy-in from the people early on and to involve them throughout.

4.7 Long term Sustainability

The questions posed to the interviewees with regard to whether “It is important to maintain the focus and measure ones success to ensure long term sustainability”

“Is there a long term goal to implement lean practices across the value chain from suppliers to dealers, or is the focus solely on the production facility?”

and,

“In the literature it is often said that having another company in close proximity to benchmark off is critical to be becoming a successful lean manufacturer, what is your opinion on this and do you have a company to benchmark your progression with?”

and,

“Lean manufacturing is a long term strategy and commitment, how would you rate BMW South Africa’s success so far and what is your long term goal?”

Table 10 gives an overview of the themes and sub-themes obtained from the responses to the questions on Long term sustainability.

Table 10: Themes and sub-themes relating to Proposition 4

Theme	**Sub-Theme**	**No. of interviewees**
Long-term goal	Transparency	6
	People Development	4
	Strategy	10

	Process Improvements	1
	Teamwork	4
	Communication	2
	Leadership	3
Benchmarking	Transparency	9
Success	Sustainability	10
	Leadership	3
	Strategy	2
	People Development	4
	Teamwork	1
	Transparency	3
	Competitive Advantage	1
	Financial Benefits	1

From Table 10, it can be seen that three main themes emerged from this proposition being *Long-term goal*, *Benchmarking* and *Success*.

From the first theme being *Long-term goal*, several sub-themes emerged the most influential being *strategy,* the objective was to make lean a long-term strategy and roll it out to the rest of the organisation. Then to make it successful company

wide, the company must rely on the same levels of *transparency* in all departments. The interviewees felt that cultural differences exist between the different departments and therefore *people development* and a mindset change among the people is essential for future success, *teamwork* and strong *leadership* have been some of the most influential factors in BMW's success so far this would remain essential for future success. They felt that c*ommunicating* the advantages and success would help to sell the concept to other departments.

For the second theme *benchmarking*, one main sub-theme emerged being *transparency.* The interviewees felt that transparency between other BMW plants and other vehicle manufacturers would help to establish their progress and highlight areas for further improvement.

The third theme to emerge was the *success* achieved, the first major sub-theme was *sustainability,* the interviewees felt that good progress had been made but that there was a long road ahead of them. *People development* emerged as the second most influential sub-theme as they felt that due to the mind set change among employees and the awareness amongst the staff of this being a long-term strategy, they also felt that the continued success relied heavily on continued management support, and that *transparency* through benchmarking with other manufacturers would help to measure their progress and success. The final sub-theme namely the *financial benefits* gained form VPS were seen as a good motivator for the long term success.

It is thought for mass producers to successfully implement lean manufacturing within their business they require a lean manufacturer in close proximity, to be used as a benchmark to their production techniques (Hayes and Pisano 1994). The feeling amongst the interviewees is that this is a long term strategy for BMW and that so far they have made good progress, but a lot of work remains before they are seen as a truly lean manufacturer. They also feel that advantages could be gained from benchmarking with other lean manufacturers.

4.8 Production Flexibility and Agility

The questions posed to the interviewees with regard to whether "Lean manufacturing leads to production flexibility but not production agility"

"Vehicle manufacturing has gone through several transitions over its lifespan starting with the craft market to mass manufacturing through lean and onto flexible, with customers demanding greater customisation. How do you see it going in future and is BMW South Africa ready for that transition?"

and,

"How do you know and what do you think is going to be more important in the long term to cater to market demands an agile flexible model or a lean stable approach?"

Table 11 summarises the interviewees responses to the questions posed and the themes and sub-themes that emerged from their responses.

Table 11: Themes and sub-themes relating to Proposition 5

Theme	**Sub-Theme**	**No. of interviewees**
Customisation	Flexibility	3
	Competitive advantage	4
	Process Improvements	2
	Strategy	1
Flexibility/Lean	Process Improvements	1
	Strategy	2

	Competitive Advantage	3
	Financial Benefits	5
	Product Development	1
	Flexibility	13
	Sustainability	3
	Job Security	2

From Table 11, it can be seen that two main themes emerged from this proposition being *Customisation* and *Flexibility/Lean*.

With reference to the first theme customisation, several sub-themes emerged the most influential being *competitive advantage.* As BMW is a premium product to remain competitive in this segment, the interviewees felt they need to be flexible to customer demand, the opinions varied with regard to the interviewees on the amount of flexibility that a lean system allows but there was a consensus that lean has an effect on the flexibility of the system. The next most influential sub-theme was process improvements and this related to the effect that customisation has on on-time delivery and that this leads on to the need for a change in strategy by localising more content and thereby reducing the lead time.

The second theme flexibility/lean, also provided several sub-themes, the most influential being *flexibility.* The interviewees felt that even though flexibility is a necessity in current market conditions lean will remain pivotal to any manufacturing system, *financial benefits* also ranked highly, as they felt that having a flexible system reduces the investment costs needed to produce more derivatives. The competitive advantage sub-theme relates to the need to remain competitive in current and future market conditions. They felt manufacturers will always have to adapt to customer demand, they felt flexibility and lean will remain

a necessity for long-term sustainability thus the sub-theme *sustainability*. Flexible systems create the need for flexible employment and this will remain a challenge for the other sub-theme *job security*. The next two sub-themes *strategy* and *product development* are a result according to the interviewees of BMW's current strategy on product development which is currently not flexible in nature as the majority of parts are not carried over from one model to another.

Agile is seen as nimble and being able to quickly respond to changes in the market place, whereas lean is seen as reducing inventory and eliminating waste. It is said that many motor manufacturers who are lean are by no means agile and would struggle to adapt to radical changes in the market place (D. Towill and Christopher 2002). From the responses by the interviewees it is clear that even though flexibility is an important part of their strategy there is greater focus on lean implementation as this has provided big financial benefits, and with the South African plant only producing one model their isn't a lot of allowance for high flexibility but more to gain from being an affordable manufacturer.

4.9 Summary of the results

From the numerous themes and sub-themes to emerge from the interviews, there are several sub-themes that are carried over from one proposition to another.

The most notable is transparency - the feeling amongst the interviewees is that this is the leading reason for their success so far and it has been extremely influential in making lean a success at BMW S.A.

The next two most notable sub-themes are process improvements and strategy, the reason that VPS has been more successful than many of the other projects implemented at BMW S.A. is this has been made part of BMW's strategy and is not seen as an ad hoc project, the most notable benefit gained from lean manufacturing has been the process improvements realised from implementing this style of manufacturing, from on-time-delivery to right first time - these process improvements have led to improved quality and large financial gains through cost reductions.

Leadership, people development, teamwork and communication follow closely on and according to the interviewees these are all essential elements in making lean manufacturing a success

CHAPTER 5: DISCUSSION OF THE RESULTS

5.1 Introduction

This chapter will discuss the results obtained from the interviews with regard to the stated propositions and with reference to the literature review.

5.2 The Benefits of Lean Manufacturing

Lean or as BMW refers to it, VPS, supported the plant to achieve very good productivity improvements.

As during the time of the interview the world economy was going through a recession and many people were losing their jobs, through the savings made through lean implementation the need to downsize the workforce was eliminated.

By focusing on each operation and re-arranging the equipment so the people have no idle time they were able to eliminate a lot of waste. In 2006 there were 2300 people working in BMW S.A, today there are 1600 producing the same number of cars and there is still opportunity for further reductions. By simply changing the mindset they were able to reduce their headcount by 700 people in only three years.

Within the first year of implementing VPS and carrying out projects BMW S.A. realised savings of around R15 million. These are baseline savings, meaning these same savings would be realised for years to come. These calculations do not include the many indirect savings - for example floor space and office space which have lead to energy and building maintenance savings (air conditioners, lighting, etc.).

VPS has led to a major mind set change in people,

- They are now consistently looking at ways to save whether these are direct or indirect savings. People feel responsible for eliminating potential waste.

- There is greater transparency in the production areas. Marketing their progress was a motivating factor behind the success that has been achieved so far.
- The workload is more evenly distributed and people are increasing their skills through multi-tasking, which allows for a more flexible workforce.
- With one part flow, people are more focused and too busy to distract others.
- The people are now more outcome based.

It is important to continuously focus on the importance of remaining lean. If the organisation should stop the focus is lost and the importance is forgotten.

Obstacles are only encountered when the processes are not well defined. There was an initial feeling or threat that work would be taken away, but if the operations are well defined, and people are made to feel part of the process they are more accepting of changes.

When comparing the benefits of a lean enterprise to the benefits gained from BMW S.A.'s implementation of lean practices, many similarities can be seen, thus enforcing the proposition that lean manufacturing does lower your operational costs and improve your overall quality.

5.3 Effective Communication

Driving Force

The reason for implementing lean manufacturing was that the Japanese manufacturers were now producing the best quality vehicles with the same levels of innovation as the premium manufacturers had in the past and at a fraction of the cost. They realised to stay in business and remain competitive to other motor manufacturers they would have to become lean and remove all waste (unnecessary tasks) to make the product cost competitive.

VPS came as an instruction from Mr. Reithofer the current Managing Director of BMW. He realised lean manufacturing is the future of vehicle manufacturing. He wanted to shift the focus from the European model of exclusively focusing on innovation and quality to the Asian way of focusing on waste elimination and efficiency.

This was important as it set the base for management and leadership involvement. It is vital for lean manufacturing to be effective, that they have a presence and show the workforce they are serious about maintaining the emphasis.

They didn't want to convince people of the viability through theory alone. They wanted to show people how successful it could be through practical projects. This was done by allowing people whose area was to be changed to be part of the project so that they felt personally responsible for it and that when other people came to see the changes in their area they could be convinced of the success by speaking to the people working in the area, this is how they promoted VPS.

The focus had to be on a complete mindset change, they had to get the buy-in for it to be a success, this meant working together with the people involved. They began by showing the workforce the benefit is not only for the organisation but for them as well, whenever they conducted a project they always spoke of the area as being their area to personalise the project. It wasn't about VPS doing the change it was about them doing the change for themselves, so that they felt

important and proud of their own success. The focus was on getting the people in the right mindset to effect the change and take the negativity out of it.

In 2009 due to the financial difficulties being faced they changed the focus from the marketing concept to more of a focus on saving money.

In 2009 they have already realised a direct saving of about R15 million through headcount, energy, working hours, obsolescence and stock savings, whereas in 2008 they had also saved close to R15 million but this was calculated to include indirect savings of space, cost of time, etc. which were all theoretical savings.

Communication is one of the most important steps in a lean process. One can only achieve true lean manufacturing with the buy-in of the workers. The workers will only react positively to this process, if they understand why it is being done and what the benefits of it are. Lean manufacturing is about eliminating waste in the process and will lead to a reduction in personnel. Therefore employee involvement is critical to the success. (Womack et al. 1991)

Challenges/Hindrances

One of the biggest problems which will face mass producers when converting their operations to a lean manufacturing style, is what to do with the excess capacity (Womack and Jones 1994)

One of the biggest challenges VPS implementation faced in the early stages, was that in the past there were similar types of projects to VPS, for example KOVP (customer orientated sales and production process), CIP programmes, six sigma and many more unsuccessful programmes, and when VPS came about peoples first thought was this was another one of those projects here today gone tomorrow therefore people didn’t at first take it seriously. This became the first real challenge to the VPS team to convince people that this was not to become another similar unsuccessful project, they needed to show and convince people this was here to stay.

They chose a strategic area to conduct the first project, and decided that for it to be successful it would require the buy-in of the people, the project would not be forced onto the group leader and people working in the area they would rather do it through consultation and gain the people's trust and commitment, the focus shifted away from how it was done in the past to how can they improve for the future. It wasn't an easy exercise and took a lot of convincing to get the workers' buy-in, remember lean is about removing buffers, increasing loading and removing excess stock and therefore exposing the people and the area to any glitches in the system, people like the comfort of buffers it gives them free time and the possibility to hide inconsistencies in the process.

Lean can pose a risk to stability and one has to be careful if the process is not stable. Lean exposes the weaknesses which can be a concern if these can't be rectified quickly and with minimal cost. Many unstable processes have had buffers built around them to manage these problems. Lean is about identifying problems and focusing on them to resolve them, that is why lean is important and it will take a long time to fully implement.

Other issues you need to consider are the dexterity and versatility of the people to ensure you fit the right person to the right job, health issues and the acceptance of the processes always remain a challenge but they try to accommodate people as far as possible, people are monitored on their suitability to perform certain tasks and if they are able to work a specific station. They have also realised by showing that even people who have health disabilities are able to perform certain functions this becomes a good motivator to the rest of the workforce. It is important to monitor all workers health and you need to balance the willingness and ability of all workers, age doesn't mean the person is unable to perform the task. Many times the older people upstage the younger workforce through their knowledge and passion for their jobs. At times one has to focus more attention on the younger generation to motivate and manage their negativity at times, it is a balancing act of fitting the right people to the right job.

Implementing lean and doing the initial exercises went quite well but the progression of it has been a lot more difficult, finding new opportunities is

becoming more of a challenge. At the same time they are not sure how well they have progressed they don't have anyone to compare themselves. To establish if they are on track or far behind similar manufacturers, benchmarking would offer a lot of value in positioning oneself and identifying new areas that could be improved.

Manufacturability

The ease of manufacturability of the vehicle is extremely important in the manufacturing process. It is one of the most important results found in lean process design.(Womack et al. 1991)

BMW still has a lot of a variants built into it making the vehicle more complex, there has been a movement and pressure from the manufacturing side onto the design team to make the vehicle less complicated, but design is still driving the product and not the processes. The designers though are making changes to the product to allow for simpler processes but have a long way to go. There is more carry over between the products than before, but BMW still redesign the complete car from model to model.

Even though BMW S.A. don't have a major influence on product design they do on process design, they are ensuring to carry over the best practices learnt from lean manufacturing to the next model to be built in 2013.

They are therefore focusing more on impacting the process design by coming up with ideal processes that can then be implemented in all plants to maximise the benefits which in turn then allows for feedback to the product design.

The manufacturing division of BMW S.A. test new processes and provide valuable input on what will be successful and assist in process design and improvements. The planning department consult with the manufacturing divisions on new processes and ideas, who intern provide valuable feedback and at times suggest viable alternatives, it is an important part of the process of new design that manufacturing are part of the design, planning and implementation of any projects to ensure success and sustainability.

It is also vitally important that the lean processes that have already been implemented are carried over from one product to the next. Manufacturing consult with planning to ensure the streamlined processes that are currently successful will be implemented in any follow up projects or products.

It is concluded that there is good support for the proposition that communication is vital to the effective implementation of lean practices, but what was also emphasised from the interviewees is that leadership involvement is just as important to the continued success of lean manufacturing at BMW S.A.

5.4 Empowering the Workforce

To succeed in lean manufacturing, management need to view and treat their employees as assets, and invest and grow these assets by giving them the opportunity to learn, through experience and training. These employees are critical to the success of lean manufacturing as they are familiar with the operations and are in the best position to offer ideas for improvement. At the same time it is important to make employees feel secure in their jobs as they will not be willing to offer ideas of improvement if their jobs are at risk. (Womack et al. 1991)

For any process to be successful you need a good relationship between management and the workforce, people must feel that management are part of the process and their to support them to achieve their goals, the credibility of the leader and the relationship he has with his people are vital to implement any change management.

If you play open cards with the people by ensuring their jobs are secure, but at the same time explain that headcount will be reduced through the exercises and that people would be redeployed to ensure job security.

The emphasis was put on job security, business sustainability and process streamlining to ensure the job is well defined and to ensure the customer gets maximum value out of their investment.

A consultative process was conducted with the worker representatives (shop stewards) to explain lean manufacturing to them, once they had the buy-in from the shop stewards they used them to help sell the idea to the workforce. After the consultation the workers were broken into small groups to explain and define the importance of lean manufacturing and what benefits it can offer through well defined streamlined processes, cost reduction and waste elimination, which can all lead to better product quality. The people were involved in all improvements they had a training area set up to mimic their online conditions and practical examples were used to show them the benefits of lean implementation.

Examples of successful projects were shown to the workers to illustrate the benefits and to prove that no people were negatively impacted during or after the implementation, it was also explained that many people will be given a higher workload but with a better defined job and a more structured cleaner work environment as this is essential in providing for business sustainability.

It is concluded that there is good support for proposition 3 which states that empowering the workforce is key to effective adoption of lean practices, BMW S.A. have clearly seen the need to involve the workforce from the start and use them to help make VPS a success.

5.5 Long-term Sustainability

BMW S.A. feel they have been very successful so far, the people have bought into the lean approach they have also implemented lean activities along the value chain from production to the suppliers to ensure they follow similar processes, suppliers are made aware of the importance of lean manufacturing and consulted and instructed to follow the same method of approach to their processes, to ensure on time delivery is maintained together with quality products to ensure no stoppages in the system.

The focus is on long term sustainability of the lean approach and the commitment is to it being a long term venture.

This is a highly exposed initiative with annual visits from the board in Germany, recognition is important, they have to show that they are constantly improving and becoming better at what they do.

The directors involvement is crucial to the success, there are targets set per area that align to the VPS strategy and it is an agenda topic on most high level discussions, to monitor progress and offer support were needed. Everyone is constantly discussing it, but it hasn't been completely rolled out company wide as yet.

It needs to be implemented across the board in all areas of the business, the success in the production facility is good, but a lot needs to be done in other areas of the business, BMW S.A. has still got a long way to go. Lean will only be a success once everyone has adopted this throughout the organisation.

The feeling is also that the further success of it is dependant on the board remaining with the emphasis for years to come and not changing the current strategy.

What will assist on knowing that their progress is on track would be to have someone to benchmark off that they could learn from as well as position themselves against to show their progress and where they might still need to

improve, the problem is that there is no known manufacturer in close proximity to benchmark with, their feeling is that they are making good headway but there is still along way to go but how do you know if you don't have any indicator to compare to.

They have had visits from the German plants to see how they are progressing, but benchmarking with plants in similar social, economic environments that produce similar volumes with more manual content will offer more of an advantage then comparing themselves to highly automated plants where labour costs are more of an influencing factor.

The feeling from the interviewees is that benchmarking best practices will offer more advantages but finding who to benchmark with is still a concern, BMW S.A. is looking to form a more communicative link and to benchmark with the three international plants of Spartanburg, China and Oxford, there is also an opportunity to benchmark with Mercedes Benz in East London but nothing solid has been established as yet.

For the amount of time they have been implementing lean they feel they have been quite successful. Compared to the previous projects like six sigma, CIP, etc. which never really gained much momentum it has been one of the most successful projects so far conducted in BMW S.A.

There is good support for proposition 4 that it is important to maintain the focus and measure ones success to ensure long term sustainability, and BMW S.A. feel they have made good progress and the formula is there for this to be a long-term success, but at the same time to be truly considered a lean manufacturer would require the entire organisation to adopt the lean principles and this has as yet not happened. Benchmarking also remains a challenge for them with limited local manufacturers to position themselves against.

5.6 Production Flexibility and Agility

BMW are a premium car manufacturer and have to produce a car to customer demand, they must be able to customise to requests.

The demand on customisation is becoming a big influencing factor in how motor manufacturers evolve into the future, and with the amount of models available the customer is becoming spoilt for choice putting pressure onto the manufacturers to customise as much as possible but still not increase costs.

Lean is more involved in reducing cost and streamlining processes therefore eliminating waste, where agile is more catering to customer demand, it depends on what type of customer you are providing for but in the long term the agile approach caters better to differing customer demand and is flexible in timing, business is determined by the market and all companies need to be able to cater to this differing customer demand.

With lower levels of automation at BMW S.A. it is easier to adapt to flexibility. When demand changes even the most lean systems are susceptible to problems, this shows that flexibility is key to long term sustainability. Automation though is becoming a lot cheaper making the argument for using manual operations less concrete as building in off hours is cheaper with automation then with manual processes. Robots have moved from 35 000 Euros to 14 000 Euros, making the argument for automation easier.

With the market downsizing their requirements, this will lead to the need for a vast variety of models that are all seen as individual premium cars, this will be a big challenge, but at the same time will allow South Africa to build more models on the existing production lines.

Localising content also supports lean manufacturing shortening the supply window, which is a big drive for future models.

When it comes to a customer orientated approach, if you want to produce a car to what the customer requires you need to shorten the lead time, this will entail

minimal stock. Throughput time is where you loose interest on money therefore it should be as short as possible. This is the way BMW S.A needs to go and they feel they are ready for this, the only real problem that exists in South Africa is the lead time of 9 weeks for part delivery, the disadvantage of being a long way from the suppliers. What would benefit BMW S.A. more is if they had a more comprehensive local supplier base, this would then shorten the lead time.

BMW has great product flexibility but production flexibility is limited. Investment is still the driving factor for flexibility.

Lean principles need to be established in the design phase where a modular approach is becoming essential in vehicle manufacturing, a base that can be used for many models, VW have been very successful in this approach, BMW have not been as successful, they still require different floor plans for the different models, the approach BMW has taken is to stay away from mass and remain premium.

Flexibility will be more important in future but still with a lean approach, they have to follow the customer demand, as to produce a car without a customer is the highest possible waste one can produce, this requires setting up the line as flexible as possible, even though this goes against the lean principles.

There is a differing of opinions with regard to proposition 5 that lean manufacturing leads to production flexibility but not production agility. They believe the one cannot work without the other; one must be flexible to cater to continuously changing customer's demands and at the same time not forfeit the lean principles as they have to become more competitive in the manufacturing market to ensure sustainability and to follow their dream of being seen as a World Class Plant.

5.7 Conclusion

The implementation of lean manufacturing at BMW S.A. has been rather successful especially in the manufacturing department, a lot more work though remains for this same success to be carried over to the other departments.

The lean approach has brought about significant headcount reductions and financial savings. This is mainly due to the emphasis on involving the workforce in the changes and showing greater transparency on the achievements that have been realised.

The interviewees have also highlighted the importance of communication and leadership involvement in ensuring the initial drive and the continued success of VPS at BMW S.A.

BMW still need to do a lot of work on the ease of manufacturability of their products, with the focus currently more on the product then the processes which could create less opportunity to further improve and to be viewed as a true lean manufacturer.

They also feel more progress could be made by benchmarking with similar manufactures, by sharing ideas for further improvements.

As a premium manufacturer the focus is more on the product and customisation of the product. This hampers flexibility within the production line as options vary from product to product. Currently they feel more could be gained from implementing lean activities rather than on creating greater manufacturing flexibility. At the same time manual manufacturing is becoming less of an advantage with automation becoming cheaper and allowing for better time flexibility and lower manufacturing costs.

Overall BMW S.A. are moving towards becoming a true lean manufacturer and have made good progress in short time, the objective now would be to continue the emphasis.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The purpose of this research was to evaluate the success and sustainability of lean manufacturing in a South African automobile manufacturer. This chapter will conclude the results of the study by showing to what extent the propositions were met and provide recommendations for further research.

The objectives of the research in line with the specified context were met, management and workers can gain valuable insight from this study of what systems have and have not been successful at BMW S.A. Though one must bear in mind that certain limitations do exist such as that this research is based only on one vehicle manufacturer in South African, who has had some success in implementing lean manufacturing and therefore can be limiting in providing answers to those manufacturers who have not had similar success in implementing these initiatives. These conclusions are based on what worked for BMW S.A. and therefore might not be as successful for other manufacturers.

The first section looks at answering the main question posed at the beginning of this research project. This will be done by breaking it down into the five propositions used throughout this research.

The second section looks at providing recommendations to the organisation on what could be done to ensure the long term sustainability and success of lean manufacturing at BMW S.A.

The third section looks at providing suggestions for further research in the area of Lean Manufacturing in the South African Automotive Industry.

6.2 Conclusions of the study

The purpose of the research is to evaluate the success and sustainability of lean manufacturing in the motor vehicle manufacturing industry in South Africa.

Advantages of lean manufacturing

Proposition: *Lean manufacturing does lower your operational costs and improve your overall quality.*

There are numerous benefits to implementing lean manufacturing mentioned throughout the literature (Womack et al. 1991; Childerhouse et al. 2004; D.R. Towill 2007; Tapping et al. 2002) from waste reduction to improvements in process reliability, each of these benefits somehow contribute to the organisation from an improvement in skills of the workforce to increasing the bottom line.

From the data gathered through the interview process it is clear that BMW S.A. in a relatively short period have gained numerous benefits through their lean implementation (VPS).

Financial Benefits - a reduction in headcount of 700 people negating the need to retrench workers during the financial crisis, realised direct savings in excess of R15 million and many indirect savings.

Process Improvements – Workload more evenly distributed which contributed to greater worker flexibility through multi-tasking and more reliable processes, which all led to a reduction in waste.

Human Resource Benefits – Greater transparency in the workplace, an improvement in overall skills which helped to provide a more outcome based workforce.

These are some of the more noticeable benefits gained through the lean practices implemented. Many more benefits were realised which can be seen in the results section of this paper.

Effective communication

Proposition: *Communication is vital to the effective implementation of lean practices.*

Communication is one of the most important steps in a lean process. For any organisation to effectively implement lean manufacturing requires management and leadership involvement from the beginning. Management support and their commitment to the lean objective is critical. Management have to show their commitment by getting involved not by sitting in an office expecting regular feedback but by regularly going to the shop floor and observing first hand. (Womack et al. 1991). This was highlighted many times during the interview process, and it is clear from the responses that BMW management were a big part of the successful implementation of VPS, the feeling is that for VPS to continually be a part of BMW's long term plans will require the same levels of management involvement in future.

Communication is also seen as important as it leads to teamwork between the departments, the interviewees felt that teamwork improved between engineers, management and workers, as workers were seen as central to the improvements. This ensured engineers understood how their decisions would impact the manufacturing process and rather worked together to find the optimum solution.

Communication as stated in the literature is essential to successfully implementing ones lean objectives, BMW have made this a vital part of their implementation strategy and this is further justified in the results section of this paper.

Empowering the people

Proposition: *Empowering the workforce is key to effective adoption of lean practices.*

One can only achieve true lean manufacturing with the buy-in of the workers. The workers will only react positively to this process, if they understand why it is being done and what the benefits of it are. (Womack et al. 1991)

When BMW began the implementation of VPS they decided that playing open cards with the workforce through consultative processes with the shop floor representatives would assist in the buy-in. They explained the objectives they wanted to achieve and made sure they marketed the programme before making changes to the production systems. One of the major concerns raised by the workforce was that of job security, as when implementing any lean programmes usually results in a reduction of personnel, it was explained to the workforce that savings would be made, but through normal attrition no worker would be retrenched as a result of any VPS activity.

The importance of the people in the process is vital to lean manufacturing principles, as the systems such as CIP & JIT would not function without their input. Organisation by process and not by function, the worker in a lean process needs to take ownership of his area, and is responsible to suggest improvements, they also need to be flexible at performing many tasks (Toni and Tonchia 2002).

Making a commitment requires the involvement of all employees on all levels within the organisation starting from the top. It will offer you no value if you have one champion trying to get everyone to buy into the ideas and adopt the processes. BMW made sure to involve all workers in improvements in their respective areas. They also used these improvements as a marketing tool to show the value offered by implementing VPS activities in the respective areas.

The involvement of the workforce is important to any organisation wanting to implement lean manufacturing. The success BMW has achieved so far is as a direct result of the commitment of the workforce to these programmes as can be seen in the results section of this paper.

Sustainability

Proposition: *It is important to maintain the focus and measure one's success to ensure long term sustainability.*

The long term sustainability of VPS at BMW will remain the biggest challenge going forward, as many other programmes such as CIP, six sigma and the like have not provided the benefits as expected or shown any form of sustainability over the years. The feeling among the employees is that VPS has all the makings of being successful in years to come. This though will rely on the continued support from local and overseas management.

VPS is also part of BMW's target commitment process which measures each department's performance in relation to targets set at the beginning of every year, tough cost saving and headcount reduction targets are set for all departments which are achieved through implementing more lean programmes through the year.

It is thought for mass producers to successfully implement lean manufacturing within their business they require a lean manufacturer in close proximity, to be used as a benchmark to their production techniques (Hayes and Pisano 1994). The interviewees agreed with this statement saying that they feel at times more could be done but they were at a loss to find further savings. Benchmarking practices were being carried out but more internally between the different BMW plants. Minimal benchmarking was being done with other vehicle manufacturers which could help to identify further improvements.

VPS has been successfully implemented within the manufacturing departments but as yet has not been rolled out company wide, for BMW to be considered a true lean manufacturer they will need their marketing and operations departments to work in unison.

Even though VPS has been the most successful project so far at BMW a lot of work remains for it to show similar success in the long term as can be seen in the result section of this paper.

Flexibility and agility

Proposition: *Lean manufacturing leads to production flexibility but not production agility.*

In a stable environment implementing programmes such as lean manufacturing can be enough to defend ones position but in turbulent environments manufacturers have to be able to adapt quickly to changing market conditions this is when the skill and capabilities of the organisation to adapt become more important. Manufacturers have to decide whether lean or any other manufacturing programme is going to help them on the road to success. (Womack et al. 1991)

The feeling amongst the interviewees is that flexibility in manufacturing is becoming more essential as greater emphasis is placed on building to customer's request, though at the same time they feel that a lean approach will remain vital in keeping costs down and eliminating any potential waste.

The need still remains for a lean approach to be adopted early on in the design phase for further savings to be realised, and the feeling is that at BMW this has not yet been implemented to the extent that Toyota has.

Limited automation. It has often been suggested that for a manufacturer to become more flexible, they should increase the levels of automation, but the opposite is actually true, that people are a lot easier to adapt to changes in the market then machines and at a lot less cost (Toni and Tonchia 2002), but with automation becoming cheaper and more flexible to produce out of working hours this may not remain as big an advantage in future.

Plant Rosslyn see themselves as being quite adaptive in their approach, and with lower levels of automation to their European counterparts they have shown the ability to adapt quite quickly to market conditions. They also feel that localising more of the manufacturing content could further shorten their inventory window and bring about greater flexibility in manufacturing to customer demand.

Cost competitiveness remains key to BMW S.A. to continue to manufacture vehicles locally, thus lean manufacturing will play an important role in keeping costs down and in keeping their quality in check. Which are all very important to the demands set for their export programme. The focus at the moment for BMW S.A. is on a lean manufacturing approach as can be seen in the result section of this paper.

6.3 Recommendations

With regard to *Communication*

Going forward BMW should focus on:

- What has worked so far, and that is the involvement of management, this has been essential to VPS's current success, management have to continually remain focused on ensuring all new projects or installations are lean driven, they also have to ensure the workforce are lean orientated and are continually looking for new ideas and improvements.

- Teamwork, firstly they need to ensure the teamwork between their own staff remains strong, and that no single person is held responsible for improvements but rather the team. Then more importantly for BMW to become a true lean manufacturer they need to ensure lean ideas are incorporated early on in the design phase, you can't rely on manufacturing to continually have to improve or find ways of optimising what they are given with minimal support from the engineering divisions. The design of the vehicle can hamper lean initiatives and flexibility in production. The engineers need to adjust their approach to vehicle design, one does not need to reengineer every product from scratch, a lot of content can be carried over from one model to another without affecting the product performance or aesthetics, many manufacturers have been doing this successfully for years.

With regard to *Empowering the workforce*

Going forward BMW should focus on:

- BMW have been quite successful at implementing lean in the manufacturing areas, though it has been rather skewed towards the direct functions in the manufacturing areas. They need to ensure this focus is shared among all departments. Lean will not function unless everyone is

felt to be a part of it, if this strategy is followed this can help lead to more improvements and a shared responsibility.

- Lean will not function correctly if sales, design and manufacturing are not working towards a common goal. With the current volatility and unpredictability of the world market there is a need for motor vehicle manufacturers to be closely linked to the market place. It is very rare for any manufacturers to be that closely linked to the market place even if they do think they are. The reality is that their marketing and operations departments do not work in unison. It is more common to find the operations department more focused on improving efficiency and reducing costs through the measurement of a cost/unit metric, rather then the functional metrics of customer orientated approach e.g. order-to-delivery time, cash-to-cash cycle time, perfect order achievement. Unless these measures are given precedence it is unlikely that one would see unison between these departments (D. Towill and Christopher 2002).

With regard to *Sustainability*

Going forward BMW should focus on:

- Firstly the VPS mentors have done a good job of rolling out VPS into the manufacturing departments, but it is time that this is handed over to the departments, as after three years they should be self sufficient at implementing VPS. VPS needs to be seen as an operating procedure and not a project. Departments must take ownership for the sustainability of VPS in their areas.

- The mentors then have to shift their focus to the indirect and support functions, to ensure that they adopt lean practices and become as proficient in lean thinking as the manufacturing areas.

- BMW S.A. needs to find local or overseas lean manufacturers with similar economic and cultural environments to benchmark off, this will help to position themselves and identify areas for further improvements.

- VPS seems very reliant on the focus of its current leadership they need to ensure VPS is not seen as a project but a way of life, continual emphasis and training should be carried out to ensure that VPS doesn't become another project reliant on the current strategy.

With regard to *Flexibility and Agility*

Going forward BMW should focus on:

- Firstly they have to look at ways of increasing the local supplier base. This will shorten the inventory window and thus allow greater flexibility in building to customer request.

- Broader base on variables built. BMW S.A. are restricted in their flexibility due to only manufacturing one variant, more variants creates greater flexibility as customer demand is seldom stable as seen recently during the financial crisis.

- Currently they have an advantage of a low cost workforce, but due to increasing globalisation and China becoming more of a force in world markets, with even lower operating costs, this coupled with the costs of automation declining, will become less of an influencing factor in future. The need to continually optimise their processes, improve first time quality and reduce costs is becoming more important. Thus the importance of ensuring the sustainability of lean in future.

6.4 Suggestions for further research

- Replica study during an economic boom to see if BMW are as committed to lean manufacturing.
- Replica study in a few years time to determine whether BMW have successfully implemented lean manufacturing company wide and to establish its long term sustainability.
- Replica study of all vehicle manufacturers in South Africa to determine if they have implemented any form of lean manufacturing and how successful and sustainable it has been.

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APPENDIX A: QUESTIONNAIRE

Proposition 1

- **Lean manufacturing does lower your operational costs and improve your overall quality**
    - Has lean manufacturing provided benefits to the organisation, and if so can you quantify these benefits?

Proposition 2

- **Communication is vital to the effective implementation of lean practices**
    - What has been the driving force behind implementing lean processes?
    - Have there been any hindrances to implementing lean practices, for example high absenteeism, age profile of the workforce affecting the loading of the people?
    - The ease of manufacturability of the vehicle is extremely important in the manufacturing process. It has a considerable impact on implementing successful lean processes, how much influence does production have on influencing product design?

Proposition 3

- **Empowering the workforce is key to effective adoption of lean practices**
    - How did you obtain the buy-in from the workforce to participate in implementing lean activities?

Proposition 4

- **It is important to maintain the focus and measure one's success to ensure long term sustainability**

- Is there a long term goal to implement lean practices across the value chain from suppliers to dealers, or is the focus solely on the production facility?

- In the literature it is often said that having another company in close proximity to benchmark off is critical to be becoming a successful lean manufacturer, what is your opinion on this and do you have a company to benchmark your progression with?

- Lean manufacturing is a long term strategy and commitment, how would you rate BMW South Africa's success so far and what is your long term goal?

Proposition 5

- **Lean manufacturing leads to production flexibility but not production agility**

    - Vehicle manufacturing has gone through several transitions over its lifespan starting with the craft market → mass manufacturing → lean → flexible, with customers demanding greater customisation how do you see it going in future and is BMW South Africa ready for that transition?

    - How do you know and what do you think is going to be more important in the long term to cater to market demands an agile flexible model or a lean stable approach?

APPENDIX B: LETTER OF INTRODUCTION

Dear Sir/Madam,

I am currently in the process of doing my research study as part of my MBA requirement.

The topic chosen for my research is titled:

Lean Manufacturing in a South African Automotive Manufacturer

The purpose of the research is to evaluate the success of the implementation and sustainability of lean manufacturing in the motor vehicle manufacturing industry in South Africa. I have selected your company as it is considered a World Class Manufacturer and has or is in the process of implementing a form of lean manufacturing.

I would appreciate if you could set some time aside for me to conduct an interview with you, on your thoughts with regard to the formerly mentioned topic. Attached is a list of the questions I would like to pose to you. The results of the interview will be returned to you before submission to ensure the transcript was a correct record of the interview.

It would be advantageous to the process if you would allow me to record the interview to ensure accuracy of the transcribed material.

Thank you in advance for your participation.

Regards,

Ryan Rider

Lean and Agile Manufacturing overview

Lean manufacturing or lean production, which is often known simply as "Lean", is the practice of a theory of production that considers the expenditure of resources for any means other than the creation of value for the presumed customer to be wasteful, and thus a target for elimination.

Lean implementation is therefore focused on getting the right things, to the right place, at the right time, in the right quantity to achieve perfect work flow while minimizing waste and being flexible and able to change.

Waste elimination is key to lean manufacturing.

- Continuous improvement techniques contribute to productivity and product quality and can lead to perfect first run quality.
- Continuous communication between workers, engineers, retailers and customers is vital to keeping the system working.

- Lean production is best known for its concepts such as JIT, TQM and Concurrent engineering. All of these are based on the premise of reducing waste and eliminating unnecessary activities while remaining continually focused on developing optimum results for the customer.

Implementing lean processes is a balancing act between carrying too much stock which could lead to down-selling at a loss or stock shortages which could lead to lost sales.

A new production philosophy has emerged, different from the lean approach which relies on stable and predictable market demand. The ***agile manufacturer*** works better where demand is volatile and customer requirement for variety is high.

Agile is seen as nimble and being able to quickly respond to changes in the market place, whereas lean is seen as reducing inventory and eliminating waste. It is said that many motor manufacturers who are lean are by no means agile and would struggle to adapt to radical changes in the market place.

APPENDIX C: CONSISTENCY MATRIX

The purpose of the research is to evaluate the success of the implementation and sustainability of lean manufacturing in the motor vehicle manufacturing industry in South Africa.

Sub-problem	Literature Review	Hypotheses or Propositions or Research questions	Source of data	Type of data	Analysis
To establish the success and sustainability of Lean Manufacturing	Womack et al. (1991); Hayes and Pisano (1994); Towill (2006a & 2006b); Toni and Tonchia (2002)	Lean manufacturing does lower your operational costs and improve your overall quality	In depth interview Question 1:	Qualitative descriptive survey method	• Select a population and study it • Minimise the possibility of bias • Observe the data directly • Record and systematize the facts

The purpose of the research is to evaluate the success of the implementation and sustainability of lean manufacturing in the motor vehicle manufacturing industry in South Africa.

Sub-problem	Literature Review	Hypotheses or Propositions or Research questions	Source of data	Type of data	Analysis
	Womack et al. (1991); Schonberger (1992); Towill (2006a & 2006b); Hayes and Pisano (1994)	Communication is vital to the effective implementation of lean practices	In depth interview Question 2:	Qualitative descriptive survey method	• Select a population and study it • Minimise the possibility of bias • Observe the data directly • Record and systematize the facts
	Womack et al. (1991); Toni and Tonchia (2002); Hayes and Pisano (1994)	Empowering the workforce is key to effective adoption of lean practices	In depth interview Question 3:	Qualitative descriptive survey method	• Select a population and study it • Minimise the possibility of bias • Observe the data directly • Record and systematize the facts

The purpose of the research is to evaluate the success of the implementation and sustainability of lean manufacturing in the motor vehicle manufacturing industry in South Africa.

Sub-problem	Literature Review	Hypotheses or Propositions or Research questions	Source of data	Type of data	Analysis
	Womack et al. (1991); Schonberger (1992 & 2007); Hayes and Pisano (1994)	It is important to maintain the focus and measure ones success to ensure long term sustainability.	In depth interview Question 4:	Qualitative descriptive survey method	• Select a population and study it • Minimise the possibility of bias • Observe the data directly • Record and systematize the facts
	Towill and Christopher (2002); Towill (2006b); Womack et al. (1991); Hayes and Pisano (1994); Toni and Tonchia (2002)	Lean manufacturing leads to production flexibility but not production agility.	In depth interview Question 5:	Qualitative descriptive survey method	• Select a population and study it • Minimise the possibility of bias • Observe the data directly • Record and systematize the facts

APPENDIX D: SUMMARY OF RESULTS

Proposition	Theme	Sub-Theme	Interviewee	Position	Response
1	Benefits of Lean	Financial Benefits	1	VPS Mentor	Direct and indirect savings
1	Benefits of Lean	People Development	1	VPS Mentor	Mind set change feeling of responsibility
1	Benefits of Lean	People Development	1	VPS Mentor	30% conversion rate, people adopting lean practices
1	Benefits of Lean	Job Security	2	Production Manager: Body Shop	Job protection
1	Benefits of Lean	Process Improvements	2	Production Manager: Body Shop	Streamlined and well defined processes
1	Benefits of Lean	Process Improvements	2	Production Manager: Body Shop	Reduction in buffers, on time delivery
1	Benefits of Lean	People Development	2	Production Manager: Body Shop	People feel part of the process
1	Benefits of Lean	Process Improvements	3	General Manager: Assembly & Logistics	Productivity improvements

1	Benefits of Lean	Financial Benefits	3	General Manager: Assembly & Logistics	Headcount reduction
1	Benefits of Lean	Quality Impact	3	General Manager: Assembly & Logistics	Quality improvements which have led to reduction in warranty claims
1	Benefits of Lean	Financial Benefits	3	General Manager: Assembly & Logistics	Financial benefits during the current recession
1	Benefits of Lean	Process Improvements	4	Production Associate	Waste elimination, early problem detection
1	Benefits of Lean	Process Improvements	4	Production Associate	Reduction in buffers which led to early detection of problem areas
1	Benefits of Lean	People Development	4	Production Associate	People were more focused, too busy to be distracted
1	Benefits of Lean	Process Improvements	4	Production Associate	One piece flow, push pull system
1	Benefits of Lean	Quality Impact	4	Production Associate	Right first time quality easier to achieve
1	Benefits of Lean	People Development	4	Production Associate	Everyone was made to feel part of the improvement process
1	Benefits of Lean	Process Improvements	4	Production Associate	Improved the working environment, working area less congested, cleaner and more worker friendly

1	Benefits of Lean	People Development	4	Production Associate	Morale booster, more friendly work environment
1	Benefits of Lean	Transparency	4	Production Associate	Improves reaction time to problem identification
1	Benefits of Lean	Process Improvements	4	Production Associate	Workload more evenly distributed
1	Benefits of Lean	People Development	4	Production Associate	Multi-tasking, improving skill levels and creating more flexible workforce
1	Benefits of Lean	Financial Benefits	4	Production Associate	Savings for the company, led to job protection
1	Benefits of Lean	Financial Benefits	1	VPS Mentor	In 2009 they achieved direct savings of about R15 million, through headcount, energy, working hours, obsolescence and stock savings.
1	Benefits of Lean	Financial Benefits	1	VPS Mentor	In 2008 the savings were calculated to be close to R15 million but these included indirect savings which were more theoretical savings e.g. space savings
1	Benefits of Lean	Process Improvements	5	Technical Director	Waste elimination was central to the concept
1	Benefits of Lean	Financial Benefits	5	Technical Director	Through implementing some of these practices has generated large savings for the organization
1	Benefits of Lean	Financial Benefits	5	Technical Director	In three years they were able to reduce their headcount by 700 people and still produce the same amount of vehicles, with further optimization still to be

					done
1	Benefits of Lean	Teamwork	5	Technical Director	Biggest change is in the attitude and behavior of the people teamwork is driving the success.
1	Benefits of Lean	People Development	5	Technical Director	The lean approach gives the person doing the work the power, he is the focal point of the system
1	Benefits of Lean	People Development	5	Technical Director	The workers are made to feel part of the improvement.
1	Benefits of Lean	Transparency	5	Technical Director	Transparency is a vital tool to indicate inefficiencies in any process
1	Benefits of Lean	Financial Benefits	8	Manager Quality and Production Assembly	Headcount and non-value adding work reductions
1	Benefits of Lean	Process Improvements	8	Manager Quality and Production Assembly	Better working conditions improved ergonomics
1	Benefits of Lean	Process Improvements	8	Manager Quality and Production Assembly	Improvements have freed up headcount to cater for relief workers
1	Benefits of Lean	Financial Benefits	6	General Manager: Painted Body	Quality and cost improvements greater than 6% in 2009, cost savings per vehicle of R107
1	Benefits of Lean	Financial Benefits	6	General Manager: Painted Body	Warranty cost reductions of 20% in 2009

1	Benefits of Lean	Financial Benefits	6	General Manager: Painted Body	40 Heads reduced in 2009
1	Benefits of Lean	Transparency	9	Planning Manager	Transparency of processes improved, better online support to production
1	Benefits of Lean	Teamwork	9	Planning Manager	In-house optimizations as they have a better understanding of the processes, saves costs and more involvement from internal staff
1	Benefits of Lean	Transparency	9	Planning Manager	Staff are more outcome based
1	Benefits of Lean	Flexibility	9	Planning Manager	Absentee and Springer relief is now provided for production facilities
1	Benefits of Lean	Transparency	9	Planning Manager	The processes are more standardized
1	Benefits of Lean	Financial Benefits	7	VPS Mentor: Painted Body	Cost savings, throughput time and improved utilization of the people
1	Benefits of Lean	Transparency	7	VPS Mentor: Painted Body	Greater transparency in the production facility
1	Benefits of Lean	People Development	7	VPS Mentor: Painted Body	Working smarter instead of harder
1	Benefits of Lean	Process Improvements	3	General Manager: Assembly & Logistics	Loading factor has improved from 87% to 92%, future target of 95%
1	Benefits of Lean	Process Improvements	3	General Manager: Assembly & Logistics	Stock levels have been reduced from 15 days in 2008 to 10 days in 2009 on imported stock, and on local stock from 4 days in 2008 to 2.5 days in 2009.

1	Benefits of Lean	Financial Benefits	3	General Manager: Assembly & Logistics	Scrap and obsolescence costs have been reduced from R9 million in 2008 to R3 million in 2009
2	Driving force	Leadership	1	VPS Mentor	Came as an instruction from the BMW board as part of the BMW strategy
2	Driving force	Strategy	1	VPS Mentor	It was seen as the future of vehicle manufacturing
2	Driving force	Strategy	1	VPS Mentor	Shift the focus from the European model of innovation and quality to the Asian model of waste elimination and efficiency
2	Driving force	Competitive Advantage	1	VPS Mentor	Asian manufacturers were now producing the same levels of innovation, high quality and low cost
2	Driving force	Competitive advantage	1	VPS Mentor	To stay competitive meant becoming more efficient
2	Driving force	Competitive advantage	1	VPS Mentor	Many European manufacturers were following this trend
2	Driving force	Leadership	1	VPS Mentor	Visits from BMW board members happen twice a year to check on progress
2	Driving force	Leadership	2	Production Manager: Body Shop	Management and leadership involvement is key, to maintain the emphasis.
2	Driving force	Transparency	2	Production Manager: Body Shop	Shared objectives and agenda

2	Driving force	Competitive advantage	2	Production Manager: Body Shop	To remain cost competitive and for job security
2	Driving force	Competitive advantage	2	Production Manager: Body Shop	Ensure customer gets maximum value from their investment
2	Driving force	Process Improvements	2	Production Manager: Body Shop	Cleaner work environment and well defined job
2	Driving force	Transparency	2	Production Manager: Body Shop	Examples of successful projects were marketed to the workforce
2	Driving force	Transparency	3	General Manager: Assembly & Logistics	Efficiency and productivity improvements, together with cost parity between BMW manufacturers
2	Driving force	Competitive Advantage	3	General Manager: Assembly & Logistics	BMW S.A. needs to be a low cost manufacturer to remain viable in the long term.
2	Driving force	Competitive Advantage	5	Technical Director	Cost pressure, BMW was too expensive in designing and producing cars compared with Japanese manufacturers
2	Driving force	Competitive Advantage	5	Technical Director	Japanese manufacturers overtook BMW in quality, productivity and cost and positioned themselves as the leaders in profitability
2	Driving force	Strategy	5	Technical Director	The board realized that the TPS system was a lot more simplistic then they first thought

2	Driving force	Competitive Advantage	8	Manager Quality and Production Assembly	Cost savings and being more competitive
2	Driving force	Strategy	6	General Manager: Painted Body	Board decision, it is seen as part of the strategy not as a project
2	Driving force	Competitive advantage	6	General Manager: Painted Body	Many European manufacturers had started to implement lean manufacturing
2	Driving force	Financial Benefits	6	General Manager: Painted Body	Financial crisis of 2008-2009 put more emphasis on cost savings
2	Driving force	Competitive advantage	7	VPS Mentor: Painted Body	BMW board decision, seeing the benefits from other manufacturers
2	Driving force	Financial Benefits	7	VPS Mentor: Painted Body	Financial crisis put more emphasis on lean improvements
2	Challenges/hindrances	Communication	1	VPS Mentor	Unsuccessful projects in the past e.g. six sigma, other CIP programs. People didn't take it seriously at first.
2	Challenges/hindrances	Communication	1	VPS Mentor	VPS is about change, people are afraid of change
2	Challenges/hindrances	Transparency	1	VPS Mentor	Taking people out of their comfort zone and exposing underlying problems
2	Challenges/hindrances	Process Improvements	1	VPS Mentor	Lean exposes process weaknesses, which could lead to manufacturing instability, thorough investigation is often needed.

2	Challenges/hindrances	Strategy	1	VPS Mentor	Lean is a long term strategy and can't happen overnight.
2	Challenges/hindrances	Leadership	1	VPS Mentor	Currently only through self motivation is lean implemented in support functions
2	Challenges/hindrances	Transparency	1	VPS Mentor	People are very protective of their function, fear of job loss/demotion
2	Challenges/hindrances	Process Improvements	2	Production Manager: Body Shop	You need to consider dexterity and versatility to ensure job satisfaction
2	Challenges/hindrances	Process Improvements	2	Production Manager: Body Shop	People are monitored on their suitability to perform, fit the right person to the right job.
2	Challenges/hindrances	People Development	2	Production Manager: Body Shop	You need to balance the willingness and ability of all workers
2	Challenges/hindrances	Leadership	3	General Manager: Assembly & Logistics	Age and health of the workforce does pose risks but is manageable
2	Challenges/hindrances	Job security	3	General Manager: Assembly & Logistics	Initial fear of job losses
2	Challenges/hindrances	Process Improvements	3	General Manager: Assembly & Logistics	Balancing act between loading factor and quality, as amount of work content has to be limited to what will ensure good quality
2	Challenges/hindrances	People Development	5	Technical Director	Implementing lean would require a complete mindset change due to the

					cultural differences between Asian, German and South African plants.
2	Challenges/hindrances	Quality Impact	8	Manager Quality and Production Assembly	Increase in loading and responsibility has led to quality risks
2	Challenges/hindrances	People Development	6	General Manager: Painted Body	Employees need to accept lean as a way of life
2	Challenges/hindrances	People Development	6	General Manager: Painted Body	Cultural differences between Europe and South Africa make implementation challenging
2	Challenges/hindrances	Job security	6	General Manager: Painted Body	Job losses was the initial concern but through communication and time this concern was nullified
2	Challenges/hindrances	Transparency	6	General Manager: Painted Body	Show that improvements are not only for the company but for everyone
2	Challenges/hindrances	People Development	7	VPS Mentor: Painted Body	People are taken out of their comfort zone, change is a scary process
2	Challenges/hindrances	Leadership	7	VPS Mentor: Painted Body	Strong leadership is important when making changes
3	Buy-in	People Development	2	Production Manager: Body Shop	It has become a culture, makes acceptance easier
3	Buy-in	Transparency	4	Production Associate	Initial fear due to the changes, led to realization of the benefits

3	Buy-in	Transparency	4	Production Associate	It gave purpose and indicated the direction the company wanted to go
3	Buy-in	Transparency	4	Production Associate	Pilot projects were carried out in designated areas to showcase the benefits of lean
3	Buy-in	People Development	1	VPS Mentor	First six months was a learning phase, after plant visits to Toyota in Japan
3	Buy-in	Transparency	1	VPS Mentor	Pilot projects were used to market the benefits of lean
3	Buy-in	Sustainability	1	VPS Mentor	In the first year (2007) they successfully implemented 30 projects, in 2008 they implemented another 220 projects
3	Buy-in	Transparency	1	VPS Mentor	They used practical examples to market the viability instead of theory
3	Buy-in	Team work	1	VPS Mentor	All people involved in the area were made part of the projects
3	Buy-in	Communication	1	VPS Mentor	Communication was done by all involved to improve team participation
3	Buy-in	Teamwork	1	VPS Mentor	Implementation was done through consultation and gaining people's trust, not through force.
3	Buy-in	Teamwork	1	VPS Mentor	Shift in focus from how it was done to how it can be improved
3	Buy-in	Teamwork	1	VPS Mentor	Mindset change and buy-in was essential for success, remove any negativity

3	Buy-in	Teamwork	1	VPS Mentor	Show the benefits not only for the organization but for the people as well
3	Buy-in	Leadership	1	VPS Mentor	Personalize the projects make people feel a part of the success.
3	Buy-in	Teamwork	1	VPS Mentor	Making the associates part of the project helps to market the viability
3	Buy-in	Communication	1	VPS Mentor	Consultation with the union representatives was key to the initial success.
3	Buy-in	Job Security	1	VPS Mentor	Job protection was one of the biggest hindrances, as lean is about efficiency and efficiency is about reducing headcount.
3	Buy-in	Teamwork	1	VPS Mentor	Loading needs to be as evenly distributed as possible, meaning some workers would lose previous free time.
3	Buy-in	Teamwork	2	Production Manager: Body Shop	Support of the union is vital for implementation
3	Buy-in	Leadership	2	Production Manager: Body Shop	You need a good relationship between management and the workforce
3	Buy-in	Teamwork	2	Production Manager: Body Shop	People need to feel they are part of the process
3	Buy-in	Leadership	2	Production Manager: Body Shop	Credibility of the leader is vital to implement change management

3	Buy-in	Job security	2	Production Manager: Body Shop	Emphasis on job security, business sustainability and process streamlining
3	Buy-in	Teamwork	3	General Manager: Assembly & Logistics	Involvement and consultation of the workforce is extremely important
3	Buy-in	Communication	3	General Manager: Assembly & Logistics	Communication is vital to get the initial buy-in and to ensure sustainability.
3	Buy-in	Teamwork	3	General Manager: Assembly & Logistics	Involvement of the workforce in the improvements ensures success
3	Buy-in	Communication	8	Manager Quality and Production Assembly	Communication sessions with workers and union representatives
3	Buy-in	Teamwork	8	Manager Quality and Production Assembly	Good working relationship between workers, engineers and management
3	Buy-in	People Development	8	Manager Quality and Production Assembly	Training sessions through mimicked online activities
3	Buy-in	Transparency	7	VPS Mentor: Painted Body	SHE reps are used to do an evaluation of physical work, ergonomics and competence of the workforce before changes are made
3	Buy-in	Transparency	7	VPS Mentor: Painted Body	Pilot projects were used to market VPS in the early stages to highlight the advantages

4	Long-term goal	Strategy	1	VPS Mentor	In 2010 the focus will be on identifying elements to ensure long-term success
4	Long-term goal	People Development	1	VPS Mentor	Focus on skills, qualifications and training
4	Long-term goal	Strategy	1	VPS Mentor	Organization that is self sufficient and doesn't require a VPS team
4	Long-term goal	Strategy	1	VPS Mentor	Further benchmarking with other vehicle manufacturers
4	Long-term goal	Process Improvements	1	VPS Mentor	Implement best practices and standards
4	Long-term goal	Teamwork	1	VPS Mentor	All departments to take ownership for future VPS implementation
4	Long-term goal	Transparency	1	VPS Mentor	Alignment of targets across all departments
4	Long-term goal	Strategy	1	VPS Mentor	Implementing lean across the value chain, it is currently focused only on the production facility
4	Long-term goal	Strategy	1	VPS Mentor	They are only beginning to implement lean in indirect functions
4	Long-term goal	Transparency	1	VPS Mentor	Transparency is key to long term success
4	Long-term goal	Communication	1	VPS Mentor	Marketing of lean practices will also be carried out in indirect departments

4	Long-term goal	Teamwork	1	VPS Mentor	To ensure On Time Delivery is a success the involvement of suppliers is essential
4	Long-term goal	People Development	1	VPS Mentor	Additional manpower is needed to implement lean across the value chain
4	Long-term goal	Transparency	1	VPS Mentor	For lean to be a success at the suppliers BMW has to set an example first
4	Long-term goal	Strategy	1	VPS Mentor	For future models lean orientated suppliers will be used
4	Long-term goal	Teamwork	5	Technical Director	The focus for lean has been on the production facility, but this focus needs to be carried over to all business areas.
4	Long-term goal	Strategy	5	Technical Director	Cost savings from lean were initially exclusively for the production facilities, only recently has the potential been identified for other departments.
4	Long-term goal	People Development	5	Technical Director	Cultural differences between office staff and production staff, people enjoy their individuality and don’t like to be instructed on a systemized approach.
4	Long-term goal	Transparency	5	Technical Director	Throughput time is one of the key measurements of lean and this should be carried through all systems in the BMW network.
4	Long-term goal	Transparency	5	Technical Director	Improvement opportunities exist everywhere they just need to be highlighted
4	Long-term goal	People Development	5	Technical Director	Successful lean implementation relies on mindset change of the people

4	Long-term goal	Strategy	8	Manager Quality and Production Assembly	Long term process improvements don't always happen over night
4	Long-term goal	Leadership	8	Manager Quality and Production Assembly	Involvement from the top is critical to success
4	Long-term goal	Communication	8	Manager Quality and Production Assembly	Targets are set for the year to ensure continual improvement and regular feedback is required to management circle.
4	Long-term goal	Leadership	8	Manager Quality and Production Assembly	Group wide initiative, continual emphasis on implementation from Germany
4	Long-term goal	Leadership	6	General Manager: Painted Body	Support from management is essential to long term success
4	Long-term goal	Transparency	6	General Manager: Painted Body	The focus has been more on the technical division then the other departments
4	Long-term goal	Strategy	6	General Manager: Painted Body	That it lives longer than the current management board, long term sustainability
4	Long-term goal	Teamwork	7	VPS Mentor: Painted Body	Suppliers have been included in lean activities, this is one of the targets for the new model to use suppliers who have implemented lean practices
4	Long-term goal	Strategy	7	VPS Mentor: Painted Body	Roll out to other departments within the BMW network is one of the long term goals

4	Benchmarking	Transparency	4	Production Associate	Position oneself, identify new alternatives for improvement
4	Benchmarking	Transparency	1	VPS Mentor	Initial benchmarking has only been conducted internally within the BMW Group
4	Benchmarking	Transparency	1	VPS Mentor	No lean manufacturers exist in close proximity to BMW S.A.
4	Benchmarking	Transparency	1	VPS Mentor	No true measurement of lean effectiveness, only a few indicators that don't tell the true story.
4	Benchmarking	Transparency	1	VPS Mentor	They are looking for manufacturing plants in similar economic and social conditions to benchmark with
4	Benchmarking	Transparency	6	General Manager: Painted Body	Having a manufacturer in close proximity to benchmark off would be an advantage
4	Benchmarking	Transparency	7	VPS Mentor: Painted Body	Benchmarking is carried out between other plants within the BMW network
4	Benchmarking	Transparency	7	VPS Mentor: Painted Body	Processes are mapped and compared between the different plants to identify best practices, the ideal process is then implemented in all plants
4	Benchmarking	Transparency	7	VPS Mentor: Painted Body	Not enough benchmarking done locally mainly due to lack of local lean manufacturers
2	Manufacturability	Teamwork	2	Production Manager: Body Shop	Manufacturing has more influence on process design rather than on product design especially in South Africa

2	Manufacturability	Teamwork	2	Production Manager: Body Shop	Manufacturing test new processes and give valuable feedback on further improvements
2	Manufacturability	Teamwork	2	Production Manager: Body Shop	Teamwork between planning and production is essential for successful project implementation
2	Manufacturability	Strategy	2	Production Manager: Body Shop	Carryover of successful VPS improvements to future model updates
2	Manufacturability	Process Improvements	3	General Manager: Assembly & Logistics	Influence is more on process design rather than product design
2	Manufacturability	Strategy	3	General Manager: Assembly & Logistics	Carryover of best practices from the current model to the next model ensures long term viability.
2	Manufacturability	Transparency	8	Manager Quality and Production Assembly	Ideal process sharing between all manufacturing plants
2	Manufacturability	Product Development	8	Manager Quality and Production Assembly	Time and cost deadlines can get in the way of further design improvements
2	Manufacturability	Product Development	9	Planning Manager	More pressure has been placed on the designers to minimize complexity
2	Manufacturability	Product Development	9	Planning Manager	The product and not the process is still the driving factor behind vehicle design

2	Manufacturability	Teamwork	9	Planning Manager	Better working relationship between design and manufacturing but has not yet delivered the required results
2	Manufacturability	Strategy	9	Planning Manager	There is more carry over between the products then before, but BMW still redesign the complete car
2	Manufacturability	Teamwork	9	Planning Manager	Lean thinking is being used more in process and equipment utilization then in product changes
5	Customization	Flexibility	1	VPS Mentor	Lean supports flexibility, by freeing up time and space
5	Customization	Flexibility	1	VPS Mentor	Lean also limits flexibility by increasing the loading of workers
5	Customization	Competitive advantage	5	Technical Director	BMW being a premium car manufacturer have to be able to produce to customer request.
5	Customization	Process Improvements	5	Technical Director	Throughput time is where you lose interest on money therefore it should be as short as possible.
5	Customization	Process Improvements	5	Technical Director	The one problem facing BMW S.A. is the 9 week lead time for part delivery
5	Customization	Competitive advantage	5	Technical Director	BMW S.A. is able to customize the product 5 days prior to production start
5	Customization	Strategy	5	Technical Director	A comprehensive local supplier base would benefit BMW S.A. to shorten its

					lead time.
5	Customization	Competitive advantage	5	Technical Director	Vehicle customization is one of BMW's key strategic advantages.
5	Customization	Flexibility	7	VPS Mentor: Painted Body	Lean creates a more stable groundwork to support flexibility
5	Customization	Competitive advantage	7	VPS Mentor: Painted Body	Customer demand for more product customization is putting pressure on manufacturers to become more flexible but lean can support in eliminating waste and increasing transparency
4	Success	Sustainability	4	Production Associate	Sustainability is going to be more difficult than the initial changes
4	Success	Transparency	4	Production Associate	Lack of indicators to show how they have progressed
4	Success	Leadership	1	VPS Mentor	The success of VPS is due to the support and pressure from top management
4	Success	Strategy	1	VPS Mentor	Long term goal they have only scratched the surface
4	Success	Sustainability	1	VPS Mentor	Lean is viable in the long term and has proven its worth by already lasting three years
4	Success	Competitive Advantage	1	VPS Mentor	If comparing themselves to market leaders i.e ,Toyota, they have a long way to go, but looking locally they are far ahead of other manufacturers

4	Success	People Development	2	Production Manager: Body Shop	There has been a mindset change among the people they are more enthusiastic about future improvements.
4	Success	People Development	2	Production Manager: Body Shop	People are aware that this is a long term strategy
4	Success	Transparency	2	Production Manager: Body Shop	Benchmarking with other manufacturers would help to measure their progress and success
4	Success	Sustainability	2	Production Manager: Body Shop	They feel they have made good progress but there is still al ot to do.
4	Success	Sustainability	3	General Manager: Assembly & Logistics	Initial improvements are easily identified but becomes more complicated the further you go
4	Success	Sustainability	3	General Manager: Assembly & Logistics	Carryover of best practices has already begun to the new model to be built in 2013.
4	Success	Strategy	3	General Manager: Assembly & Logistics	VPS is part of their target management measurement
4	Success	Sustainability	5	Technical Director	BMW have begun implementing these practices but have far to go.
4	Success	Sustainability	8	Manager Quality and Production Assembly	It has been a lot more successful (running for 3 years) than previous projects e.g. six sigma

4	Success	Sustainability	8	Manager Quality and Production Assembly	It is viewed as a long term strategy but more work is required before it is considered a success.
4	Success	Sustainability	6	General Manager: Painted Body	A lot of work remains before it can be seen as self sufficient
4	Success	People Development	9	Planning Manager	Lean is becoming a way of life many people take the learning's home with them to use in their own homes
4	Success	People Development	9	Planning Manager	Complete mindset change it is not only leading to lean improvements online but also in the offices through time and data management
4	Success	Leadership	9	Planning Manager	Recognition from the board through yearly visits drives the success
4	Success	Teamwork	7	VPS Mentor: Painted Body	Teamwork has been essential for the success
4	Success	Transparency	7	VPS Mentor: Painted Body	A lot of success in the production facilities but not as much in the support departments
4	Success	Leadership	7	VPS Mentor: Painted Body	Long term success is very dependent on the continual support and pressure from the BMW board
4	Success	Financial Benefits	7	VPS Mentor: Painted Body	All financial indicators prove its success
4	Success	Sustainability	7	VPS Mentor: Painted Body	Lean is an enabler towards good quality, throughput time and further efficiency savings

5	Flexibility/Lean	Process Improvements	1	VPS Mentor	Lean is about reducing waste and in any model waste is never acceptable
5	Flexibility/Lean	Flexibility	1	VPS Mentor	Agility is important for flexibility in a changing market but lean will always be a part of any system
5	Flexibility/Lean	Competitive Advantage	2	Production Manager: Body Shop	Customization will always be important to meet demand, flexibility is essential to this
5	Flexibility/Lean	Flexibility	3	General Manager: Assembly & Logistics	Flexibility is important to cater to changing customer demands, but to remain cost competitive you need to eliminate waste.
5	Flexibility/Lean	Sustainability	3	General Manager: Assembly & Logistics	Lean ensures long term sustainability and being seen as a World Class Plant.
5	Flexibility/Lean	Flexibility	5	Technical Director	Flexibility will be more important in future but still with a lean approach
5	Flexibility/Lean	Financial Benefits	5	Technical Director	Producing a vehicle without a customer is seen as the highest possible waste
5	Flexibility/Lean	Flexibility	5	Technical Director	Flexibility is important even though it goes against the lean principles
5	Flexibility/Lean	Flexibility	5	Technical Director	A highly flexible system will never be a perfect lean system, but you can still implement lean ideas, there is always waste that needs to be eliminated.
5	Flexibility/Lean	Financial Benefits	5	Technical Director	The production facilities are becoming more flexible to allow more models to

					be produce on one line to reduce investment costs.
5	Flexibility/Lean	Strategy	5	Technical Director	A modular (a base that can be used for various models) design is becoming essential in vehicle manufacturing
5	Flexibility/Lean	Strategy	5	Technical Director	BMW's approach is still inherently to remain premium and not to carry over concepts from one model to another
5	Flexibility/Lean	Competitive Advantage	5	Technical Director	The challenge for BMW is to carry over as much as possible between models and at the same time not effect customer perception of product uniqueness.
5	Flexibility/Lean	Flexibility	5	Technical Director	The market has shifted to demand larger variety together with uniqueness this poses a challenge to not increase investment costs.
5	Flexibility/Lean	Flexibility	5	Technical Director	Lower levels of automation increase the ability to adapt
5	Flexibility/Lean	Sustainability	5	Technical Director	When demand changes even the leanest systems are susceptible to problems, this shows that flexibility is key to long term sustainability.
5	Flexibility/Lean	Job security	5	Technical Director	People are willing to adapt to changes but they need to trust their employment is secure
5	Flexibility/Lean	Job security	5	Technical Director	Flexibility poses a problem to employment as pure flexibility changes demand requirements of a workforce.
5	Flexibility/Lean	Competitive	8	Manager Quality and	Flexibility is a key competitive advantage for BMW

		advantage		Production Assembly	
5	Flexibility/Lean	Flexibility	8	Manager Quality and Production Assembly	Varying work packages leads to a higher likelihood for errors, whereas standardized processes is more sustainable
5	Flexibility/Lean	Flexibility	8	Manager Quality and Production Assembly	More variances will become a necessity which will lead to higher flexibility but waste reduction will always remain
5	Flexibility/Lean	Product Development	8	Manager Quality and Production Assembly	Work package grouping can alleviate complexity and allow for lean activities
5	Flexibility/Lean	Flexibility	6	General Manager: Painted Body	As a premium vehicle manufacturer you need to customize to the customers' demands, waste management can always be implemented
5	Flexibility/Lean	Financial Benefits	6	General Manager: Painted Body	Investment is still the driving force behind flexibility
5	Flexibility/Lean	Financial Benefits	6	General Manager: Painted Body	BMW has a lot of product flexibility but process flexibility is limited due to investment costs
5	Flexibility/Lean	Financial Benefits	9	Planning Manager	BMW S.A. are more focused on saving money and becoming the cheapest manufacturer than on flexibility
5	Flexibility/Lean	Flexibility	9	Planning Manager	Automation is becoming al ot cheaper and more flexible
5	Flexibility/Lean	Flexibility	9	Planning Manager	Single product line leads to less flexibility, localizing more content will help to support an argument for more models and greater flexibility

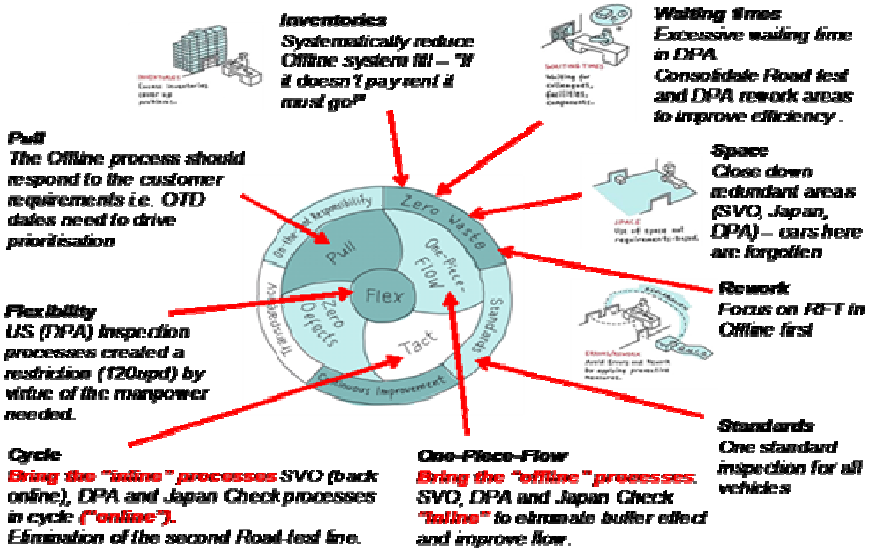
5	Flexibility/Lean	Sustainability	7	VPS Mentor: Painted Body	Lean thinking should be used in all manufacturing approaches
5	Flexibility/Lean	Flexibility	7	VPS Mentor: Painted Body	Flexibility helps you to adapt to changing market conditions, whereas lean helps to produce the product in the most efficient and fastest method

APPENDIX E: COMMUNICATION CAMPAIGN

An illustrated example of the communication campaign used by BMW to market the effectiveness of VPS.

Before.

- Massive cycle time variations existed between various processes
- Certain processes could only be loaded 50% at best
- The DPA inspection limited US production to +/-100 units/day
- As a result the Offline budget made up over 21% of the total ZA-T-4 budget
- OTD could only be achieved by maintaining at least a days production ahead condition
- TPT was almost 20 hours on average





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Results.

- **System fill** has on average dropped by 50%, resulting in a drop in "inventory" of 140 units or R35mil*
- **Throughput time (TPT)** reduction of 9hrs/unit (44%)
- **OTD** has increased to 94.1% in January 2007
- **Inspection** process more robust and now for 100% of units
- **Space** saving of 4200 square meters or 20% of the Offline area. Also major equipment savings like hoists, chargers etc.
- **RFT** improvement of 5% from 92% to 98% (end Jan07)
- **Cost** reduction (Offline to T4 cost ratio down 20.4% - 17.7%)







