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Revisiting the Concept of Value Stream Mapping

A research on the benefits, problems and challenges of a company tailored Value Stream Mapping

Master thesis within International Logistics and Supply Chain Management

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Abstract

Value Stream Mapping is a common tool used in a lot of instances in today's industries who have adopted any kind of Lean initiatives. However, Value Stream Mapping (VSM) may not always fit to the best extent and intention of the industry applying it; therefore a need for tailoring certain aspects of it have been seen in some cases where the original tool has not been enough. However there is little research on how to adopt VSM towards the tire industry, it is the case that some adaptation is needed in order to fully map the value the chain is trying to capture as seen by some authors who use VSM on other industries. This leads to conclude that further research is needed in order to see the benefits and challenges in the creating of a tailored value stream tool in order to understand how it would affect the company its applied on as well as increasing the knowledge of its capabilities and drivers for it application.

The impact this research would have is to begin bridging a gap of the usage of how a Tailored Value Stream Mapping (TVSM) tool would affect when applied to a specific industry. For this paper, a case study within a Tire Company located in Europe, who stated that they had issues regarding their current usage and utilization of VSM, was conducted. The company has projects going all over the globe but sees a lack of initiative and success without the direct involvement of its central plant. The purpose of this research is to investigate the perceived impact as well as the benefits and challenges of utilizing a company TVSM, instead of a standardized one, taking into consideration both particularities of the industry, as well as the culture of the firm. Also an understanding is sought to recognize the motivations that drove the Tire Company to choose a tailored approach.

The research was conducted as a qualitative single case study involving three different sites belonging to the tire industry located in Europe. It is built upon both a theoretical part, comprised by a literature review of the concepts of VSM, Lean and TVSM; and an empirical part derived from the case. The Empirical data was collected through semi-structured interviews as well as participant observations, supported by secondary data collected from the company in form of written documents concerning the internal training of VSM.

The findings concluded that, the reasons for sustaining a TVSM are its ease of use, and ability to reach out and be understood by people with little to no training in VSM's. The company fitted training documents would decrease the training needed and the time spent doing so. Some other benefits were the empowerment of employees and the sharing of knowledge across multiple sites in a standardized company language. Albeit with the challenge of creating and upholding such documents and training, compelling the company to have experts with knowledge of VSM and the company processes and culture with the added challenge of also maintaining regularly updates as the company moves forward.

Implementation of a tailored approach is practical where there has been identified that it exists a gap between different plants or departments, local or globally, regarding knowledge or experience when there is a requirement for standardisation, communication and need for change.

Definitions

5S: Is an organizational tool stemming from a prerequisite to Just-In-Time as part of Lean. It means to organize by sorting, streamline, shine, standardize and sustain (the organizing) (Womack, Jones, & Roos, 1991).

Bullwhip effect: A phenomenon that occurs when actors of the supply chain or network are faced with great uncertainty. It is defined as the existence of higher inventory or stock out costs caused by said uncertainty (Usha & Ramakrishnan, 2014).

Jidoka: Defined by Toyota as "automation with a human touch", it encompasses a machine with the capability to assert certain judgments, for example, a machine that stops when certain defects is detected or a failure is occurring in the process (Cudney, Furterer, & Dietrich, 2013).

Just In Time: Can be described as having the right quantity, at the right place in the exact time that they are needed, in the right quality, and they would be replenished only when said pieces have been consumed (Ohno, 1988).

Kaizen: Defined as "*change for the better*", it is related to the continuous improvement of the processes. It is a common phrase among companies using Lean for improvement projects (Cudney, Furterer, & Dietrich, 2013).

Muda: Japanese term that identifies any kind of waste, most commonly referred to as the seven wastes in Lean; such wastes are overproduction, inventory, motion, defectiveness, transportation, over processing and waiting (Cudney, Furterer, & Dietrich, 2013); (Chiarini, 2013).

Mura: Is a term describing that the workload is not even and may fluctuate over time; an uneven workload translates into uneven use of resources over time, be they material, tools or personnel leading to an increase of Muda (Taylor & Francis, 2012).

Muri: Is identified as the "*The waste of overburden"*. This relates to both processes and people, meaning that excessive pressure is exerted to both resources, mostly by demanding too much work or output from them over a certain period of time (Taylor & Francis, 2012).

SMED: Single-Minute-Exchange of Die refers to ensuring that setup time and changeovers between products takes no more than ten minutes. It is one of the tools used in Lean (Shingo, 1985).

Takt Time: Defined as the rate at which work progresses through a facility. It also illustrates the time it takes from the reception of an order to the actual fulfilment of said order (Hobbs, 2004).

Abbreviations

CRM: Customer Relationship Management

CSM: Current State Map

ERP: Enterprise Resource Planning

FSM: Future State Map

JIT: Just in Time

MRP: Material Resource Planning

MRPII: Manufacturing Resource Planning

NVA: Non-Value Adding

NNVA: Necessary Non-Value Adding

SCM: Supply Chain Management

TC: Tire Company

TPS: Toyota Production System

TVSM: Tailored Value Stream Mapping

VS: Value Stream

VSM: Value Stream Mapping

WIP: Work In Progress

1 Introduction

This chapter aims to introduce the reader to the topic of the utilization of VSM as one of the tools under the Lean Initiative in order to achieve the firms' goals. The general background, the problematization and the purpose of this work are presented in this first section, as well as the research questions that the authors aim to address. Furthermore, the research limitations and delimitations are presented as well as the structure of the present thesis

1.1 Background

Over the last years, Supply Chain Management (SCM) has been recognized as an important source of competitive advantage across industries. It is said, that granting the ability to successfully design, coordinate, and operate progressively more complex networks of suppliers, customers, products, etc., will allow the firms to successfully execute the corporate business strategy. Nonetheless, the same chains should remain flexible and dynamic in nature in order to cope with the ever-changing world of today (Cristina Barros, Barbosa-Povoa, & E. Blanco, 2013).

There has been a plethora of initiatives and techniques that experts suggest in order to attain greater efficiency and effectiveness of the supply chain in order to successfully fulfil the businesses' strategies. Initiatives such as pull strategy, push strategy, manufacture to order, engineer to order and Just in Time have been the centre of attention of supply chain experts (Usha & Ramakrishnan, 2014). Nevertheless, there is still no "perfect" initiative or tool that applies to every industry that can solve all the problems in one firm, least to say, all firms in an industry.

Lean Manufacturing has been one of the most recurred initiatives by several firms in order to remain competitive in today's market. The main idea of this approach is to reduce costs by removing Non-Value Added (NVA), activities in the processes involved (Abdulmaleka & Rajgopal, 2006). One of the main concepts used to identify NVA activities comes from the Lean tool, VSM, which is a tool to map a Value Stream (VS) which can be defined as a group or sequence of activities that a specific firm or organizations undertakes in order to deliver a customer request, it represent what the customer values or is willing to pay for (Martin & Osterling, 2013).

It is the case in some firms that, in order to supply what the customer specified as a need or request, the firm has to incur in different activities that, sometimes, might add little to no value to the final customer/consumer itself such as internal transportation, internal warehousing, maintenance of manufacturing equipment, training, movement of materials, reworks, repairing defects, amongst others, as defined by Hines & Rich (1997). Even when that is the case, the company incurs in these costs which, most of the time, can hardly be avoided. The VSM focuses on identifying which activities could be avoided and which activities, even when they don't add value, must be carried on. (Rother & Shook, 2009).

By reducing the waste (the non-value adding activities for which the customer is not willing to pay for), the firm can obtain not only higher efficiency, but also higher effectiveness, all of this while attaining lower costs (Hines, Rich, Bicheno, Brunt, & Taylor, 1998).

One of the tools that the Lean concept uses to achieve this is VSM. It offers a holistic view of how material and information flows through the entire systems, being them departments

or firms. It identifies the areas and activities that are Value adding (VA) to the customer and the ones that are NVA. This allows managers to take strategic decisions as to whether conserve these activities, either because they are needed, or the firm doesn't have the means, technology or knowledge to avoid or eliminate those (Martin & Osterling, 2013).

1.2 Problematization

Even though a fair amount of research has been done in order to face the challenges that arise related to SCM (or parts of it), there is no tool that can fit all companies and, moreover, there is no company that's equal to the other, each with its own strategies, goals and issues. The interest in this topic arises from the fact that several companies are faced with similar dilemmas of "the modern world". Meaning to optimize their supply chain and production/manufacturing networks and/or lowering the costs of said networks. These firms are pressured to mainly decrease their production costs and expenses while at the same time maintaining their production levels and customer satisfaction (Usha & Ramakrishnan, 2014). These objectives can be attained by several initiatives and strategies such as those mentioned above.

Our particular interest is drawn to VSM. This tool seeks to highlight waste in a manufacturing system with the goal to reorient production practices and align them to Lean thinking. Not only that, but it allows for the development of future plans derived of the systems analysed (Brown, Amundson, & Badurdeen, 2014). One of the drawbacks of using this tool is the fact that it takes into consideration only a holistic view but not the individual internal processes involved in the manufacturing system (Abdulmaleka & Rajgopal, 2006). Further inclusion of different metrics and performance measurements should be included in the creation of a more effective VSM tool that allows not only the measurement of the manufacturing system, but also the internal processes involved in the system (Brown, Amundson, & Badurdeen, 2014).

There have been some incursions in the topic of Tailored VSM (TVSM) such as: green value stream, sustainable manufacturing paired to VSM and VSM in continuous manufacturing industries (Marimin, 2014); however, none of the authors propose a specific tool for the tire industry. In fact, when trying to apply VSM to a specific industry, it is the cases that some adaptation is needed in order to fully map the value that the chain is trying to capture. This leads us to conclude that further research is needed surrounding the creation of said tool.

Another source of motivation was the fact that a problem was presented to us by a Tire Company, (TC). There was a wish for having a company TVSM that fits specifically to the tire industry in order to help with training around different sites and to set a standard of similar projects in the future. This opportunity highlights what was mentioned before, a company or industry TVSM is needed in order to further increase efficiency and decrease wastes and non-value adding activities. This lack of a more effective VSM is what inspired us to focus on the topic. Seeing the relevance of a specialized VSM tailored specifically to the tire industry coming as a request from the company itself, the authors wished to know more about what concrete benefits this would have in the firm compared to how they had been using "standard" VSM's up to this point.

1.3 Purpose

The purpose of this thesis is to investigate the perceived impact as well as the benefits and challenges of utilizing a company TVSM, in lieu of a standardized one, taking into consideration both particularities of the industry, as well as the culture of the firm. Moreover; this thesis aims to understanding the motivations that drive TC to opt for a tailored approach. In order to gain a thorough understanding of the differences between the stated methods, the research is focused on the perceived benefits, as well as the challenges of using a TVSM in a case study given by a tire manufacturer.

1.3.1 Research Questions

The authors are looking to answer the following questions:

- Which are the benefits and challenges that arise when using a company TVSM, compared to a standard VSM?
- What are the reasons for TC to opt for a tailored approach instead of a standard approach? And how can these reasons be applied to other companies?

The thesis is based on both theoretical and empirical studies. The literature is reviewed to draw insights about what and when the utilization of VSM as a tool to reduce waste makes sense in the case of manufacturing firms, as well as to understand the impact of following said initiative. Furthermore, a Tire Company is involved in the project to provide a support for the study and to fulfil the aim of the thesis in the form of a case study of the identified problem.

Due to the nature of this thesis' approach; which is reviewed in detail in the methodology section, the authors were able to go back and forth between theory and practice, identifying particularities and premises in TC that allowed them to present a third research question.

- When is it appropriate and viable to adapt a VSM?

As a result, the authors hope to present to the company the observations, suggestions, and differences between a company TVSM and a standard one in order for them to perform VSM's in the future, as well as help them create the tools and materials necessary to achieve this objective. This will be done by applying the theoretical tools available in current research, as well as identifying particularities of TC, and adapting it to fit the processes and culture at the firm. The scientific and academic contribution would be to systematically analyse what benefits and challenges of the usage of a TVSM approach would raise compared to the existing benefits of using a systematic and standardized tool for developing of VSM's on sites owned by the company.

1.4 Delimitations

With respect to the limited time, resources and word limitation of this study, in addition to the wide scope of the topic, certain delimitations have to be drawn. This thesis will explore the perceived benefits and challenges of utilizing a company TVSM for further implementation in the tire industry, and is based on a case study involving a Tire Company in Europe.

The authors would like to bring to attention the fact that, even when VSM is a tool to advance towards a Lean firm, it is not the only tool and it might not suit all the firms in the industry, not to mention other manufacturing firms on different industries. This thesis encompasses only the use of VSM and TVSM in the case company.

The knowledge generated by the case study at the Tire Company should be addressed as an option to achieve a Lean firm, but in no way, shape or form should be treated as a series of steps to follow in every firm. Moreover, the TVSM benefits and challenges that will be presented in this work should also be treated as a collection of guidelines to be used in conjunction with other tools not described in this paper, to achieve the best possible solution. It is also important to consider that, due to a confidentiality accord signed within the involved parts, no specific information about the firm will be published since it might include delicate and sensitive information that could be used by the company's competitors in order to gain an advantage in the market or mitigate the company's efforts to increase its market participation.

Another important factor to bring forth is the fact that the impact and effectiveness of the initiative might, and most assuredly, will differ depending on geographical location and local culture, both nationwide and company wise. This case is situated in Europe, following not only the local European legislation, but also the company's own internal rules and regulations, which may differ greatly on other sites due to its internationally spread.

Lastly, it is important to note that, due to the nature of the research, as well as time constraints and the researchers' capabilities, the creation and implementation of a company TVSM will not be touched upon in this paper. This thesis represents and illustrates the benefits and challenges of utilizing a company TVSM in lieu of a standard one.

1.5 Thesis structure

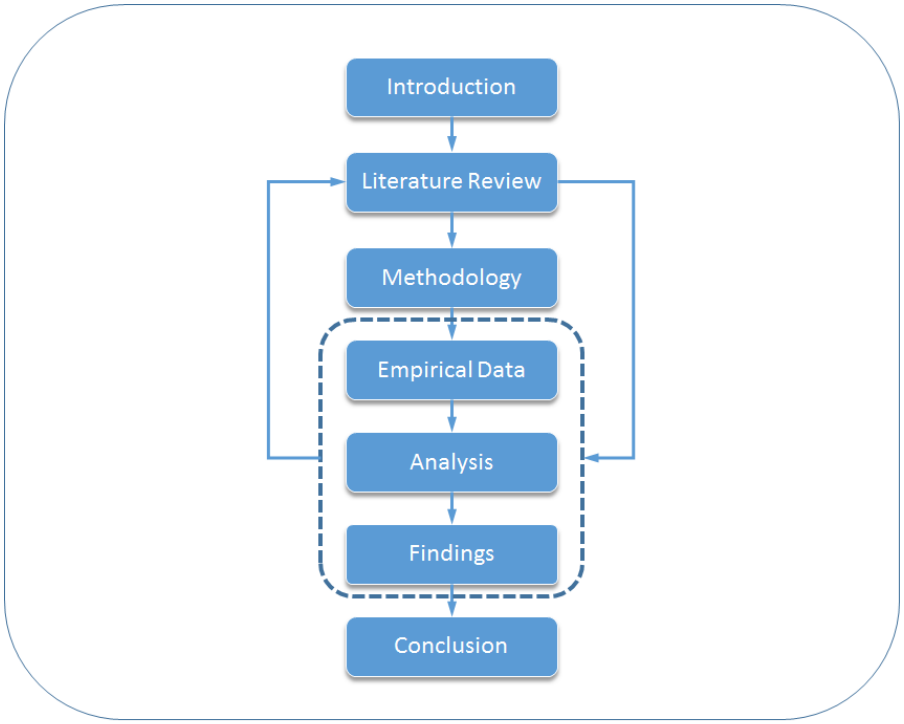

Figure 1 – Thesis structure

The thesis will include a theoretical research followed by the empirical study. The theoretical part consists of an academic literature review and also reviewing of the documents the TC is currently using in VSM practices as part of the data collection. In the beginning of the thesis a literature review will be presented to the reader. Several topics are endorsed and reviewed in this part including: Application of VSM to achieve a Lean approach, Standardization of VSM methodology, etc. Said topics are investigated and researched through a traditional literature review. The objective of this is to provide a deep understanding of how to apply VSM to identify areas of opportunity and unavoidable wastes, best practices and general information. Further in the study, theories and methods in the literature will be adapted to the firm's culture and operational needs. Some keywords, such as VSM, standardization, Lean Manufacturing, Agile Manufacturing, waste reduction, seven wastes, etc. were used to narrow down and filter the literature to be used as a basis of the research.

The empirical section consists of a case study. For that purpose, one of the team members conducted an internship at the TC. The researcher collected internal information regarding the current state of the company and "as is" production processes, through interviews and observations with owners, operators and creators of the processes, amongst other roles such as managers of the different areas that are involved, and empirical observation in the shop floor (Saunders, Lewis, & Thornhill, 2012).

The thesis structure is depicted in *Figure 1*. Starting with the introduction part in which the authors discuss the background, problematization and purpose of the thesis.

The second part is the Literature Review, where the authors explore research what has been done in the field previous to the writing of this thesis. Furthermore, several authors' theories and perspectives are presented in order to provide a deeper understanding of the topic treated in the thesis.

The third part presents the methodology that the authors used to fulfil the presented Research Questions, as well as the approach and data collection techniques.

The next part is empirical data in which the authors present the empirical findings derived from the interviews carried out

In the Analysis part the authors consolidate the findings and cross-checked those with benefits and challenges identified in the literature

Lastly, conclusions derived from the research are presented, as well as suggestions for further research.

2 Literature Review

In this chapter the authors will present the theoretical framework in which this thesis is based. Related literature and previous research and efforts on the area will also be presented. Further, benefits and challenges of Lean tools, particularly those concerning VSM, will be stated in order to allow the reader to fully understand the concepts that will be used for the upcoming parts of this thesis. We begin by using a funnel approach first on the importance of Supply chain management, narrowing it down to the use and implications of the usage of VSM in order to validate the importance and usage of the VSM method in modern companies, and to emphasize its value and contributions to firms. This will serve as a base for the analysis part where empirical data collected about the benefits of VSM, both standard and tailored, will be analysed and compared.

2.1 Supply chain management

The concept of SCM, dates as far as 1980; however, the moment that mid to high management levels started to pay attention was around the 1990's, as put by Morash (2001), supply chain capabilities are the building blocks for supply chain strategy and a source of competitive advantage for the firms' success.

The concept itself has been the focus of several studies and experts in the field for over the last 30 years, and it has been recognized that SCM is an important source of competitive advantage (Burgess, Singh, & Koroglu, 2006). The idea of making the supply chain networks as efficient and effective as possible is no new concept.

Several initiatives to achieve a more efficient and effective management of the supply chain and supply network have erupted in the later years. The fact that several trends have erupted in the last two decades hint that the tools and initiatives should evolve as well; an example of this is the appearance of the concept of Supply Networks in place of Supply Chains (Håkan & Göran, 2004); this is further supported by the fact that new concepts and methods are appearing, with SCM being the central topic and concern (Ahi & Searcy, 2013). While SCM might not be the *buzzword* anymore, it certainly has not lost its importance.

SCM initiatives such as managing inventories, managing sources of supply, demand planning and forecasting; amongst others, have all seen changes and are adapting to the new emerging markets and are being shaped and evolved by the same forces previously mentioned (Tummala & Schoenherr, 2008). One of the ways to handle the ever-changing environment within manufacturing and logistics was presented by Taiichi Ohno, when introducing an initiative that targets to control the flow of materials through the plant in order to control the output and hence the behaviour of the supply chain: the Toyota Production System (TPS).

2.2 Toyota Production System

The TPS, included ideas such as Just In Time (JIT), adopted with the objective of reducing all the wastes in the system and rearranging the whole system with the purpose to become a fully "pull" system (Ohno, 1988).

Ohno (1988) states that TPS should be based on two pillars: JIT and *autonomation*. JIT can be described as having the right quantity, at the right place in the exact time that they are needed, in the right quality, and they would be replenished only when said pieces have been consumed. The ultimate goal of JIT is to achieve a zero inventory in the company. Howev-

er, it should be noted that the so called "ideal state" by Ohno (1988) is nigh impossible to achieve; since, for example, a product made of thousands of parts will, most assuredly, include a similar amount of processes; said processes will contain certain amounts of Work In Progress (WIP). Not only that, but some of these processes might require a long processing time, making the system prone to accumulate inventory on different stages. Some of the problems mentioned by Ohno (1998) that contribute to amassing inventory include defective products, defective supplies, rework and trouble with equipment to name a few.

The other pillar supporting TPS is the concept of *autonomation* which is used to describe a machine or a feature of said machine to affect the principle of *Jidoka*. By utilizing machines with the ability to exert *Jidoka*, the continuity of the processes involving said machines is ensured. Therefore, eliminating the need to wait and reducing the unnecessary stops in the processes (Ohno, 1988).

Basic elements of TPS include *Toyota style method of production*. The production ideal of Toyota was to try and sequence all of the manufacturing processes in order to attain benefits such as operators being able to operate several machines in sequence, visual control of the elements being processed and ability to stop the line if any failure is detected. The next concept is the *Kanban system*. Kanban utilizes a tool to ensure that the right parts are available at the time and in the quantity needed in a specific place (Ohno, 1988). This hints to the idea of controlling resources and reducing the overall waste. Such concept will be revised in the Lean chapter.

It is difficult to introduce Lean without presenting the ideas coined by Ohno. It is true that, over the years and the ever-changing and ever-present customer needs, TPS has adapted and, furthermore, adopted different concepts. In the next sections further and deeper explanation of relevant Lean methods will be presented.

2.3 Lean

Several efforts have been particularly dedicated to the evolution and development of Lean Practices, particularly, lean manufacturing was considered the buzzword in the area of manufacturing for two decades as stated by Pavnaskar et al., (2003). Lean Manufacturing is aided by the use of tools and concepts such as concurrent design, design for manufacture, mass customization, Kanban production system, push and pull production systems, and VSM, to fulfil and achieve its main goal, to reduce waste and increase value in a manufacturing chain (Greasley, 2008). Of the available tools, we delve deeper into the idea of VSM further on since it provides both visualization, as well as a performance improvement tool.

The concept of Lean began to be forged around the decades between 1970 and 1980 when, particularly Japan, started to translate cost as waste which then became targeted for elimination. This brought the idea that, while eliminating wastes, companies could thrive and become more competitive since they were reducing costs. This lead to United States and Europe being forced to change from the batch manufacturing system, which produced as much as possible with the highest quality possible, but not necessarily what the market demanded, to the new responsive methods which allowed faster responses, fewer inventories, reduced costs and higher quality (Hobbs, 2004). Lean Manufacturing is not only a set of steps that a company follows; it encompasses a change of mind and philosophy in the firms, as well as infrastructure, training and sequencing (Howell, 2010).

As mentioned by Hobbs (2004) and Howell (2010), Lean Manufacturing methodologies are encompassed by a series of techniques and tools that allow certain product to be produced one unit at a time, at a formulated and preconceived rate, while eliminating the non-value-adding wait time, queue time, or other delays. Each unit produced is pulled through the line by the actual customer demand, as opposed to being pushed by the orders launched to the shop floor. Products should be able to streamline flawlessly through the line as if they were liquid running through pipes: no stops, no waiting times, no waste and therefore, no costs. It is important to note that, as illustrated by Howell (2010), Lean Manufacturing main focus is not to cut on costs and headcount but rather on eliminating waste.

Some other benefits mentioned are improvement of response time to customer demand, reduced inventories, reduced working capital requirements, simplicity and visual control, productivity improvement and operational benefits. Focusing on delivering better value to customers, doing more with less and ensuring that you do more with less without jeopardizing the safety, quality and stability of the organization are also goals for lean (Eaton, 2013)

One of the main premises of Lean is that, as products with similar features and price are offered by several companies due to the market demand and available technology, they begin to approach the state of commodity, once it has reached this state; differentiation becomes critical; this is one strategy that the manufacturer, as well as several actors in the network, can adopt (Usha & Ramakrishnan, 2014). If the manufacturer cannot achieve differentiation through quality, price or added technologies, then it's time to embrace different criteria. This is when the improved response time of certain manufacturers come into play. The fact that a specific manufacturer is able to satisfy the demand faster than the other competitors, while providing the same benefits as the others, it starts to be perceived as a competitive advantage and can be used by the company as leverage to attract more customers as stated by Hobbs (2004). Shorter manufacturing lead time usually allows a reduction in the amount of inventory carried with the goal to offset the changing customer demand.

The idea that Lean Manufacturing allows for reduction of working capital requirements is illustrated by Hobbs (2004) & Ruffa (2008) when mentioning the fact that, when companies are presented with customer demand that is expected to be satisfied within the lead time dictated by them, in order to satisfy said demand, manufacturing companies might incur in the practice of purchasing materials from suppliers well in advance in order to have the material available. This will cause variation that will increase working capital requirements; by reducing variation and errors by utilizing lean practices, the company frees resources that were tied to the company in order to correct the effects of variation and errors. Hobbs (2004) & Eaton (2008) also mention problems when dealing with manufacturing lead time being greater than customers' lead time; this might lead to customers waiting for the product, which is only valid when the manufacturer is the unique supplier, building WIP, which goes against Lean Ideology, or to send the products that have been produced in advance; again, going against Lean principles. The answer provided by Lean Ideology is that by reducing lead time and response time, Lean Manufacturing allows the manufacturer to reduce the working capital investment. Less space and less WIP usually means less infrastructure and, therefore, less working capital invested. The idea is explored by Cudney, Furterer & Dietrich (2013) when mentioning that the utilization of Lean systems will lead the companies to a reduction of the overall resources needed to perform the same operations and achieve the same goals.

Another tangible benefit of Lean Manufacturing is the simplicity and visual control capabilities it allows. A manager can inspect by walking around the shop floor and identify the possible bottlenecks and flawed operations, as well as the status of every piece that is being produced. (Cudney, Furterer, & Dietrich, 2013). Waste times are reduced, as well as controlling the consumption of materials to what's only needed. The same goes for the operational benefits of Lean Manufacturing, the streamlining of the processes, as well as the clear indications of what to do, when to do it and where to do it, allows the manufacturers to, if needed, change the sequence of production or add another step to change the product specifications in order to satisfy a specific customer demand (Cudney, Furterer, & Dietrich, 2013).

Nowadays, Lean Manufacturing is still in use; the only difference is that it is now supported by technologies and concepts such as MRP, MPRII, ERP, CRM, among others. This allows the manufacturers to have more control over the production times and schedules, as well as the orders and costs related to the production. Internet is also a tool that's allowing firms to share the information in an almost real time, allowing the manufacturers to only empower their lean capabilities and further increasing their responsiveness and flexibility, while at the same time, keeping a tighter control over the overall production (McDonald, Van Aken, & Rentes, 2002).

2.3.1 Eight wastes: the aim of Lean

As mentioned previously, the objective of Lean Manufacturing is to eliminate wastes throughout the production process; Chiarini (2013) mentions seven relevant wastes or NVA activities in the Lean Manufacturing philosophy. Such wastes are overproduction, inventory, motion, defectiveness, transportation, over processing and waiting. There is arguably another waste that was identified further in time and it is related to the unutilized talent or underutilization of employees' talents (Abdul Wahab, Mukhtar, & Sulaiman, 2013).

Any of these wastes becomes the aim of Lean tools since one of the main goals of the Lean ideology is the elimination of all wastes. As illustrated by Chiarini (2013), overproduction, encompasses the creation or manufacturing of an excessive amount of product manufactured either too early or too late to successfully meet the customer's demand. This type of waste is directly related to the all of the seven wastes. It is identified as the root cause of the rest of the wastes. Inventory waste, which involves any unnecessary raw material, WIP and finished products stored in any of the facilities of the firm. Having overproduction will eventually lead to an increase on inventory in any of the areas, therefore becoming a target of the Lean Ideology. The motion waste has to do with the unnecessary movement of the body or personnel, this will eventually lead to increased lead times and processing times. Defectiveness has to do with any non-conforming product that exists in the supply chain/network of the analysed company. While not all the defects are preventable, they can be dampened and their impact reduced. When any defect appears in the production, the company has several ways to respond to said defect. Either the manufacturer decides to discard the item, causing a loss of material and time, or fixing the defect, which will incur into over processing since the processing time needed to fix the problem was not conceived before said defect appeared. Transportation is defined as the unnecessary movement of inventory in the shop floor. This type of waste will cause both delays and, in some cases, the incurrence in motion wastes since the operators is forced to transport inventory to the required places. Over processing is also identified by Chiarini (2014) and it appears when a firm carries on manufacturing processes over a product that are not valued nor appreciated

by the consumer/customer. This not only forces the operators and machinery to work more than needed, but also can create a bottleneck which will imminently increase the unnecessary inventory waste. The last type of waste defined by Chiarini (2014) is the waiting waste. This waste is defined as the lost time that occurs in between each of the processing activities. This will increase the throughput time and the inventory waste in the form of Work In Progress.

Later in time, the unutilized or underutilized employees' talent was also identified as a waste since, in the end, the company has an asset that is not being fully utilized; therefore, wasting the employee's potential while being inefficient at the same time (Abdul Wahab, Mukhtar, & Sulaiman, 2013). Basically anything that causes the personnel to work more or less than he is supposed to can be classified as a waste of potential. Overwork most often translate into dealing with either fluctuating or a variation in demand. This includes the variety of products that concern the processes since each variation in itself increases workload; as well as product variation, which causes an increased need for machines to be calibrated or to use different sets of processes or tools (Taylor & Francis, 2012).

Another source of waste is having an uneven balance of workload with fluctuations over time. Having to deal with fluctuating demand, depending on where in the Supply Chain it takes place it is very susceptible to the Bullwhip effect and will, invariably, cause fluctuation and unbalance in the inventory as well as impacting the seven wastes (Chiarini, 2013). An uneven workload translates into uneven use of resources over time, be they material, tools or personnel. Theses variations are often dealt with maintaining inventory, causing several of the others and an increase use of storage which in manufacturing terms can be considered safe, but carries a higher cost.

As mentioned before, Lean Manufacturing ideology focuses on reducing the mentioned wastes while maximizing the value in the overall chain/network. The Lean Ideology is aided by VSM, among other tools, in order to achieve this. The reader is referred to the VSM section for further understanding of the tool.

2.4 Value Stream Mapping

To understand VSM one must first know what VS is. It can be defined as all the action and processes that are necessary to build a product and deliver it to the end user. As explained by Rother & Shook (2009) "*... all the actions (both value-creating and non-value-creating) currently required to bring a product through the main flows essential to every product: (1) the production flown from raw material into the arms of the customer, and (2) the design flow from concept to launch.*".

These processes include both VA and NVA processes and spans all the way from raw material to delivery of finished product to customer, often including more than one company that is needed in the process to know the complete VS. The VSM however should be broken down for all of these instances, mainly from company to company. The expression "door-to-door" is often used to describe that the VSM holistically follows a product within only one company, no matter where in the VS it is, from door-to-door of that facility (Rother & Shook, 2009). Teichgräber & Bucourt (2012) states that in the modern companies of today it is necessary to map your VA process, not only for the reduction of costs but also in order to stay competitive on the market. Since Lean is focused specifically on finding and eliminating wastes within a VS and VSM is one of the front tools used to do so, the reasoning for an easier to use of TVSM as requested by TC can be seen.

2.4.1 VSM

VSM is defined as a visualization tool that maps all the processes that are carried out within a company in order to bring a product to the market. As mentioned by Abdulmaleka et al., (2006) and Chibba et al., (2004), the mapping is done by including flow of information, material, and in some cases, capital in and out of the site as well as inventory storage and workplace process arrangements. This is done by identifying the processes and activities that are carried out within said company with the goal of distinguishing between processes and activities that are VA from those that are NVA (Chiarini, 2013). This leads to highlighting and identifying occurring wastes in the processes and activities (Jimmerson, Weber, & Sobek, 2005). The final intention of VSM is to remove, when possible, the identified waste within the analysed processes and activities (Rath, 2008).

A well performed VSM visualizes flow of material and information connected to a product through the company. Even if quick fixes and process optimization seem appealing to many companies, understanding the flow of the product is essential (Rother & Shook, 2009). This in order to avoid sub-optimization and to clearly see how all processes are connected and work for optimization as a whole inside of the company, not just optimizing a process within a department. This carries the idea that the companies, as well as the processes embedded within said companies work as a whole and not as isolated bodies or elements. This is achieved by the highlighting of the wastes throughout the whole company and visualizes how material and information flow are interlinked together. This in turn breaks paradigms between the participants and increases consensus within the firm. Similarly, Abdulmaleka & Rajgopal (2006) argue that the use of a VSM can be used as a base for decision making and evaluation upon future implementation and improvement projects. With the increased insights and understanding of the process intradepartmental connection as a whole, can help to create a better future state and enable and improve implementation processes (Teichgräber & Bucourt, 2012). Another point of view, as stated by McDonald et al., (2002) "*VSM creates a common basis for the production process, thus facilitating more thoughtful decisions to improve the value stream*".

2.4.2 VSM as a tool

As mentioned previously, the VSM is a valuable tool for visualization and greatly improves the success rate in the implementation of a Lean System as illustrated by Teichgräber & Bucourt (2012), and is in many cases, a necessary step before serious improvement and waste reduction projects can commence and be carried out successfully. As described by Rother & Shook (2009), VSM is *the most critical step* in order to create a sustainable progress for improvement. This is also emphasized by Teichgräber & Bucourt (2012), who state that VSM *"greatly assists in successfully implementing a Lean system"*. It is easy to make Lean implementation, kaizen workshops, *Muda* elimination and such, however, when not used in cohesion with a VSM, it is easy to get stuck and start sub optimizing and lose momentum, causing the Kaizen to fail (Spear, 2004).

2.4.3 VA, NVA and Necessary NVA activities

The difference between VA and NVA activities comes from a customer perspective and not from the companies involved in the product making; nonetheless, it is important to mention that sometimes, companies will have internal customers whose opinion should be taken into consideration. It is important to separate what the company views as VA steps in order to deliver a product and what is perceived as VA by a customer (Rother & Shook,

2009). Looking at processes from a customer perspective is imperative when defining waste inside the companies. The definition of value comes down to answering the question "For what are our customers willing to pay?" (Rother & Shook, 2009). As an example for NVA activities customers are not willing to pay for, but that the companies still must carry on, are the wastes described above, but also activities such as advertisement, overhead costs and administrative processes (Teichgräber & Bucourt, 2012). VA activities can be identified as those that are "hands on" the product, refining processing or changing the availability of the product in any way. These activities are the only ones the customer is viewing as VA, since at these processes; the product is being refined or changed in a way that would fit for the customer's specifications. Some other necessary activities for the company such as transportation, inspection or storage, in order to make a final product are not always seen as VA in the eyes of the customer. However, making the product available in a specific area i.e. a supermarket will be considered as valuable by some customers, since availability is what certain customers are willing to pay for (Lusch, Dunne, & Varver, 2011).

The processes that take place in a manufacturing company can be classified into three different categories. As described by Ishiwata (1991), Monden (1998), and Murman et al., (2002). These are: (1) VA (2) NVA, and (3) Necessary but Non-Value Adding, NNVA. The VA processes is explained as "…*Involve the conversion or processing of raw materials or semi-finished products through the use of manual labour.*" (Taylor, Taylor, & Brunt, 2001, p. 28). It encompasses anything that increases the product's value to the customer. The NVA is closely related to *Muda* as described above such as waiting, storage or unnecessary transportation. The NNVA are wastes that are necessary under the current production limitations and that cannot be altered without major changes. They can involve entire shop floor layout changes or altercations delivered from the supplier and may not be applicable to change due to resource constraints.

2.4.4 Elements of a standard VSM

The following are the natural steps when doing a VSM project according to, Cudney et al., (2013), Martin & Osterling (2013) and Rother & Shook (2009).

The first step is to figure out which products the VSM will be focusing on - **select the product or product family**. This can be done by doing a product matrix, matching products to the processes available and see which products share similar processes. These are then a product family and will be affected by the project collectively. Depending on the type of production, the amount of products in the family may vary and may even be singulars. Next step is to **define the boundaries**, a VSM can be conducted on different levels of scope, in rising order, process level, plant level, across multiple plants, across multiple companies. A standard thought in VSM is to follow a product from "door-to-door" i.e. plant level, but depending on the scope of the project it may vary. Performing a VSM across multiple companies means involving both suppliers and customers in your supply chain and can be a tremendous project whilst process level may only involve either a single process or otherwise department inside a plant.

Next step is to **walk the process,** it is recommended to start at the end of the process, for example the shipping area and work your way backwards all the way to raw material. This in order to simplify the visualization of the final product and to know what processes it goes through instead of starting following for example four raw materials parts which then combines further downstream into finished product. The product should be "touchable" to avoid confusion. The next natural step when doing the walk is to **identify tasks and**

flows of material and information between them this should visualize the connections between processes and how they are getting orders to produce work. Important in this step is to hold the hand of the product, show where, how and why it acts the way it does. If it's stopping at storage, being processed, waiting or transported. Next step is done simultaneously and asked at each process step: **gather data,** these involve cycle times, changeover times, batch sizes and personnel to name a few. These are important metrics to be used later on for recognizing bottlenecks and Kaizen improvements. When these metrics has been gathered it is time to **create the current state map** in terms of putting it on paper. This can be done simultaneously as the walk with pen and paper on the floor but may also take place in a conference room with the team putting it together. This is in order to fully **understand how the process currently operates**, important to realize here is that VSM aims to take a snapshot of reality precisely how it looks today. With this visualization and data gathered a higher understanding can be reached between departments and especially for people not directly involved in the processes on day to day basis. This can then be used to **analyse current conditions** in order to see where there is room for improvement. A note should be made that parts of the team involved in the project may already know parts of this steps, especially if they involve technicians or operators, but seeing it as a whole and how it is connected makes a difference in realizing the scope and see how it connects across the plant. Next is to **identify value adding and waste**, being VA and NVA as explained earlier. This step concludes the Current State Map (CSM).

The next steps is making a second map and visualize the ideal state, from the CSM visualize how the product would flow in a perfect state without any hinders, basically to **reconfigure processes to eliminate waste and maximize value.** Here there are no limitations, and the system should envisage the "perfect flow" of the product.

From the ideal state, the thought is "how to get there", in order to do this; **create a Future State Map** (FSM) with the help of the CSM and ideal state. The tools to do this lie in the multitudes and will not be further explained. The idea is to **design a Lean flow** that is possible with today's limitations. This already hints at the fact that achieving the ideal state may not be done in one event and may span over years and multitude of projects. However keeping the ideal state in mind helps figure out solutions of how to achieve the FSM and where to invest resources. Lastly is to **develop and track action plans**, here is the fruit of the labour, finding areas of improvement in order to come closer to the ideal state. These should be broken down into as small steps as is manageable, assign ownerships and delegate tasks.

2.4.5 Usage and diversity

The usage of VSM is further enhanced by authors who have used it successfully in the same industry as the case this paper is based upon, such as AR & al-Ashraf (2012), whom demonstrate the usage of VSM as a base for improvements in an Automobile production company. Its diversity can also be shown by Khurum, Petersen, & Gorschek (2014), who use VSM to map a non-physical production process. Another evidence of diversity is shown by Abdulmaleka & Rajgopal (2006), who apply Lean tools such as VSM with the help of a simulation, into a continuous process, where Lean hasn't had much breakthrough (Cook & Rogowski, 1996).

However, it is important to note that even when applying the tools and initiatives available, Lean manufacturing implementation might lead to a failure to realize and show benefits and concrete results. This might be caused by the fact that the implementation team might

be using the wrong tool to solve a particular problem, or using only one tool to solve all the problems, or be using all the tools in every single problem (Pavnaskar, Gershenson, & Jambekar, 2003).

2.4.6 Real cases examples

When having made a VSM it is not surprising to find many NVA activities within the processes. In the example of Teichgräber & Bucourt (2012), they measured that, out of 13 processes in their study, only two of these could be considered VA; six of the processes that were considered NVA were deemed as necessary in order for the processes to function. However, that leaves five processes deemed as pure waste and to be *Kaizened* away. In their case it turns out that only 1.92% of the time spent handling the product could be considered Value Adding. In another case of Seth et al., (2007), an excess of inventory within the VS totalling 244 days was discovered. These are just examples from real cases how VSM can be used to highlight and find waste not otherwise perceived within the VS.

2.4.7 VSM Benefits

It can be argued that, since VSM is a tool to draw a firm closer to attaining Lean practices, the benefits of using VSM are the same benefits that the company will experience when attaining Lean since, in the end, VSM is a mean to an end and not the end itself. However, there are particular benefits of using VSM over other tools in order to get closer to a Lean practice. One of the main benefits is that it offers a quick and easy way of holistically overview a product flow. This relates both to the material flow as well as the flow of information and how they connect to the processes inside the VS. Although, as illustrated by Abdulmaleka & Rajgopal (2006), the holistic perspective of VSM can also be considered a flaw, however it can also be seen as a benefit since it allows for the identification of general flaws that can be directly attacked in order to achieve less waste.

Another of the benefits is the universality of its applications, as supported by the argument provided by Rother & Shook (2009), when they say that whenever you have a product, you will have a VS. VSM can be done in the same way for different business activities and expanded either upstream or downstream. The challenge itself lies in exploiting the findings after applying VSM.

VSM also helps in the identification of gap areas and facilitate the Lean implementation for the production industry since it clearly highlights the areas that are incurring on the eight wastes defined by Lean and also sheds some light on possible alternatives to improve the performance of said areas (Singh, Garg, Sharma, & Grewal, 2010). Clarification of VA versus NVA towards the customer is identified as a benefit of VSM. These measurements can then be used as base for further improvement with Lean principles in mind. And more so, thanks to the holistic view, it limits sub optimization improvement processes to focus on the entire chain and not just individual processes (Rother & Shook, 2009).

AR & al-Ashraf (2012) argue that some potential benefits, other than the ones stated before, are the reduction of lead time in production and lowering the WIP inventory, both of which can be more related to the Lean practice and not particularly to the utilization of VSM as a tool.

Some other benefits identified are the transformation from a "firefighting" firm to a "problem solving" one, which will increase the communication across the organization and deal with problems identified at the root rather than at the surface. Another benefit is the con-

tinuous focus on eliminating an enormous amount of NVA activities or *kaizen* (Tyagi, Choudhary, Cai, & Yang, 2014). Throughout their paper, Tyagi et al., (2014) argue that VSM, when utilized correctly, will allow access to relevant, complete and correct amount of available knowledge without the need of escalation, which will improve the efficiency and effectiveness of individuals.

2.4.8 VSM Drawbacks

Just as the benefits, the drawbacks are intrinsically related to the issues that could appear when implementing Lean Manufacturing such as increasing material handling costs in order to achieve a JIT replenishment system, increased training costs and increased costs derived from the fact that some processes and layouts might need rearrangement.

VSM as a tool does not come without flaws; some were already mentioned in the problem statement. It can be argued that the VSM concept cannot be directly implemented into all industries and fields and used successfully, least not without some modification in some extent. This argument is strengthened by Bertolini, Braglia, Romagnoli, & Zammori (2013), when they argue for a weakness in one of its core concepts; even though VSM can be classified as a main tool for implementing Lean, it is limited in its usage by solemnly relaying on a pure pull system, making it not the most advantageous system for all different kinds of industry. We do not wish to argue against the core principles of VSM, merely highlight the fact that when adopting VSM it may not be directly transferable to the industry at hand least not without some modifications.

Another drawback, as identified by Abdulmaleka & Rajgopal (2006), is the fact that VSM is a tool that focuses on the holistic view of the processes. While this brings clarity and cohesion between the areas of the firm, the identification of the need to have a particular focus or directed efforts towards a specific area are impossible to glimpse through the utilization of VSM alone.

The fact that VSM has a structure set of symbols and methodology of usage is also a limitation and can be considered a drawback since, as explored by Abdulmaleka & Rajgopal (2006), it only offers a limited capability and, if the user wish to explore further or apply it on specific industries, then tailoring and customization is needed of the tool.

As is with any tool, personnel require specific training and knowledge in order to successfully use and implement said tools. Such is also the case of VSM and Lean as Chen et al., (2010) illustrates, smaller firms might not be able to use the tools, not to mention implement the findings, because they might have limited resources and, depending on the complexity of the processes to analyse, it might require a full time VSM and Lean expert to be working with the firm. As is the case with small and medium firms, the costs might offset the benefits of utilizing VSM as a tool (Chen, Li, & Shady, 2010).

One of the most important drawbacks of VSM is the fact that not only the training for it, but also using it to create the value maps, can be a time consuming task. If the processes are complex and complicated, the user might find herself or himself submerged in a redundant and time consuming task since, as is the case in companies with similar interchangeable products, their production processes tend to share common activities which need to be mapped and analysed individually as explained by Hobbs (2004).

2.5 Tailored VSM

Throughout the literature review, the authors of this thesis have found that, most of the efforts regarding the usage of VSM can fall in two categories than can be summarized into: 1) the company adapts the tool to fit in a better way to the company practices and policies; this is considered tool customization or adaptation. 2) The company adapts to the tool in order to attain the desired objectives; this falls into the category of standard VSM since the company is forced to change methods, processes and practices in order to achieve Lean Manufacturing (Martin & Osterling, 2013). There is no clear TVSM method in the literature as of the date of this thesis.

Abdulmaleka & Rajgopal (2006) and Bertolini et al., (2013) state that due to several industry barriers, as well as internal barriers in the firms such as lack of practice, lack of knowledge, and high costs, amongst others, firms have been forced to utilize suboptimal tools in order to achieve success. It is mentioned that some sort of tuning or customization of said tools is needed in order to fully capture the value and, furthermore, deliver finer results. This type of modifications falls into the category of tool adaptations as a form of TVSM.

For the purposes of this thesis, the authors state that a TVSM is defined as a VSM that contains any effort from the company to change the tool and adapt said tool to fit in a better manner to the company/industry practices, methods and policies.

2.5.1 TVSM Benefits and Drawbacks

As mentioned by Abdulmaleka & Rajgopal (2006), the strength of a TVSM approach lies in its user friendliness. It is fitted to match a certain lexicon that exists within an industry, therefore making it easier for users to relate and understand the VSM. It also allows the firm to analyse the processes and flows in a better way since it includes specifics such as valuable waiting time, and the fact that the tool can be applied in a way other than from "door to door" approach.

Another benefit of the tool is the fact that the output is closer to the companies' capabilities and competences, since the analysis is done within the firms/industry scope, allowing the firm to adopt approaches and methodologies that are closer to their reality. This is supported by Bertolini et al., (2013) when they mention that the utilization of VSM by allowing certain flexibility will allow the company to adopt a hybrid approach in regard to pull versus pull approach, contrary to what a standard VSM would dictate.

One of the cons that is easily identifiable is the fact that a TVSM requires first of all trained personnel, as well as investment from the company's part in the form of time and capital in order to manufacture and create the tool. Another drawback is the fact that when moving away from the original ideas of VSM, the company can lose a certain degree of its intention since, the reason for making a VSM is to visualize and understand the processes on a holistic in-depth level, but when tailoring it by making it more user friendly, a valuable part of the understanding is replaced in the shortcut.

3 Methodology

In this section, the authors will present the design, as well as the methods utilized in order to fulfil the Research Questions proposed on the introductory section. The reader is also provided with information about the research approach and the methodological choice. Lastly, the quality criteria taken into consideration for the data are discussed.

The reasoning of doing business research, as stated by Cooper & Schindler (2003), is to systematically inquire for the sole purpose of providing information that somehow may aid in the solving of managerial problems or in other ways help to make a decision due to a problem.

This chapter is based upon the research onion as presented by Saunders et al., (2012) which can be viewed in *Figure* 2.

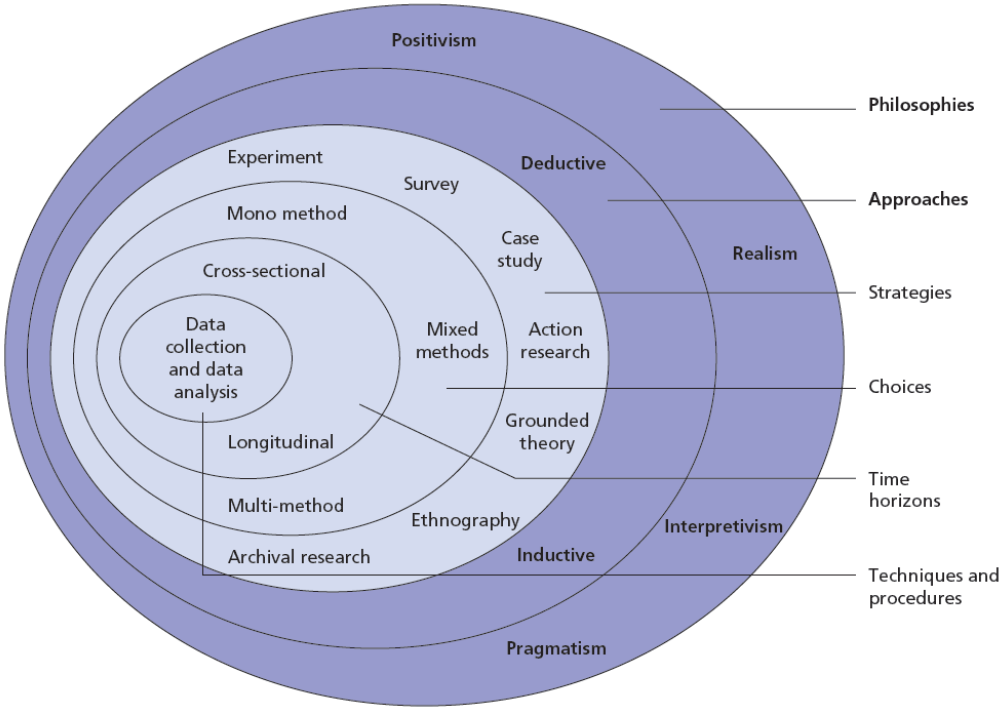

Figure 2 – Research onion – Saunders et al., (2012)

3.1 Philosophies

For the purposes of this thesis, the researchers were inclined to adopt the Interpretivism philosophy as Interpretivism states that researchers should understand and take into consideration the difference between humans in our role as social actors; it states that there exist a difference while researching humans and objects since humans have emotions, intentions and attitudes that can't be changed, measured nor modified (Saunders, Lewis, & Thornhill, 2012). The study took place in a business environment involving different management levels and how they interact and corresponds to each other further supports the selection of philosophy position. Additionally, the results of the paper can't be treated as

black or white facts, nor were trying to test any hypotheses, but rather as an interpretation and collections of different views and opinions given at a specific time.

3.2 Research approach

According to Saunders et al., (2012), there are two possible approaches when conducting a study, the deductive and the inductive approach. The deductive approach suggests that the research design is based on a frame of reference or tentative idea; meanwhile, the inductive approach suggests that, first comes the collection of data and information, and, after the completion of a rigorous analysis, the authors or researchers comes up with a theory that explains the analysed phenomenon.

There is a third approach mentioned by Peirce (2012) as abductive approach. This approach is characterized by a combination of the aforementioned approaches. With this, the research and analysis of empirical facts is combined with the research on previous literature. It is also explained by Saunders et al., (2012), that when the researches focus on collecting data to explore a specific phenomenon and then proceed to identify themes and patterns in order to generate a new theory or modify an existing one, the researchers are utilizing an abductive approach. The concepts are summarized on *Table 1* for an easier reference to the reader (Saunders, Lewis, & Thornhill, 2012).

For the purposes of this thesis, the authors have concluded that the best approach to utilize is the abductive approach since the research started with a thorough review of the existing literature in the topics of Lean Manufacturing and, particularly, VSM as a tool to bring companies closer to a Lean practice. Further in this thesis, the authors research the perceived impact of utilizing a company TVSM against the impact of using a standard one. The authors intended to see how the findings would be related to existing literature.

In addition to the mentioned approach, a research might have a descriptive, explanatory or exploratory purpose, as illustrated by Saunders et al., (2012), which will influence the research and study as well. The purpose of descriptive studies is to gain an accurate profile of events, persons or situations in particular.

The authors are inclined to conduct their study within the field of exploratory research, as the purpose is to gain insights and investigate the perceived impacts of utilizing a company TVSM versus a standard one, as well as finding the most common challenges and difficulties from utilizing a TVSM in place of a standard VSM. By the literature, the authors found little arguments for or against the need and usage of a TVSM document to be used in a specific product family within a multitude of sites both nationally and internationally. It is therefore the authors hope to beginning to bridge this gap by contributing the answers from the aforementioned questions. Also, the authors hope to reach an understanding upon the reasoning of the company from the given case as to what led them to the initiative of constructing a tailored document. By exploring the usage of a company TVSM in a manufacturing company, and stressing its perceived benefits, as well as the perceived challenges of using TVSM, this research can provide an understanding of the real situations in modern companies, whereas it does not seek to explain the situations nor aims to describe the situation in full detail.

Table 1 – Deduction, Induction & Abduction - Saunders et al., (2010)

	Deduction	Induction	Abduction
Logic	When the Premises are true, the conclusion mist also be true	Known premises are used to generate untested conclusions	Known premises are used to generate testable conclusions
Generalisability	Generalising from the general to the specific	Generalising from the specific to the general	Generalising from the interactions between the specific and the general
Use of data	Data collection is used to evaluate propositions or hypotheses related to an existing theory	Data collection is used to explore a phenomenon, identify themes and patterns and create a conceptual framework	Data collection is used to explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth

3.3 Research Method

For this paper, the case study approach has been chosen; this due to the fact that the problems stem from a real life issue and is given as a real problem from the firm. Much like Robson (2002) puts it: *"A strategy for doing research, which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence*", leads us to conclude that it fits well to the purposes of the thesis. Another evidence of the usage of the case method is given by Yin (2003) who argues for that research questions that have their base in "how" and "why" go by an explanatory nature and are preferably answered by making use of experiments, histories or case studies (Yin, 2003). Also the purpose relates to reaching an understanding of the managerial and organizational processes, which fits well into a qualitative case study (Remenyi, Williams, Money, & Swartz, 1998).

There are two types of case studies, single and multiple case studies. Riley et al., (2000) explains the criteria as to which one to choose is firstly what the reason for the choice of the subject is and secondly how much external validity is necessary. This study will rely on a single case study; it can be argued that external validity could be beneficial to the purpose, this in order to compare between other firms and if they have encountered similar problems. However, as stated by Yin (2003) that multiple case studies are resource and time extensive, and may not be applicable to conduct if the case is unique. It may be arguable that the problem given by TC may not be unique in the industry or other firms; however due to limitations, a multiple case study is not applicable, but may serve as a ground for future research instead.

For the purpose, as well as the needs of the research study, the authors decided to take a multi-method approach making interviews as well as observation as the primary data collection tools. This is further supported by the argument given by Saunders et al., (2012), that states that participant observations is a qualitative data collection technique that allows the observer to discover the meaning of people's actions.

3.3.1 Time Horizon

In regards to the time horizon, the authors elected the cross-sectional one, in place of a longitudinal study. This particular study does not aim into explaining or exploring the perceived benefits and the identified challenges throughout a time frame, it focuses on the identification of said benefits, challenges and difficulties. It aims to capture the status-quo of the company related to the utilization of a standardized VSM and a company TVSM.

3.4 Data collection

Due to the exploratory nature of this paper, based on data gathered from participants of the project through interviews, this paper relies solemnly on a qualitative method. The data is mostly insubstantial and gathered in the forms of words and thereafter interpreted by the researcher or interviewer. This method is best used to gather such things that cannot be expressed solemnly through numbers (Saunders, Lewis, & Thornhill, 2012).

The authors based the research mostly from primary data. Secondary data is used in order to fulfil and complement the research, as well as to provide the reader with a deeper understanding of the topics, challenges and problems detected during said research.

3.4.1 Ethics in the data collection

It is the particular case of this thesis that the authors and the firm included in the case study, agreed upon confidentiality and secrecy terms; therefore, making the authors take extra care into how the information was collected, analysed and presented. As mentioned by Saunders et al., (2012), the data collection stage is associated with a range of ethical issues. The fact that people and firms in general accepted to be part of the research, doesn't mean that they should provide all the information they have. Individuals and firms have the right to withdraw or decline to take part in a particular aspect of the research. Regarding these points it is important to state that all the participants, as well as the firm itself was informed about the data that would be collected and how could it be collected. The observations carried out by one of the researchers was mentioned to the people involved in order for them to be aware that any behaviour related to the research could be documented and furthermore presented in this paper.

Saunders et al., (2012) also mention the fact that information should be collected and presented in an objective way. The authors assured that all the information presented here was reviewed with the pertinent participants, as well as thoroughly read and documented in order to avoid subjectivity in the collection of data. The authors also ensured that the data presented in this paper was real and nothing included in this paper was fabricated for any purposes.

Anonymity and confidentiality was conceded to those who asked the researches to include neither their names nor positions. These promises were kept during the research and also during the writing and presentation of this paper.

It is important to note that the authors went one step ahead and ensuring that complete anonymity and confidentiality was kept for individuals and the firm involved; therefore, the reader will be presented with generic names and no sensitive data will be presented.

3.5 Primary data

Due to the opportunity given by TC to the authors, the focus was to obtain data directly from the source and for the purposes of this particular research. The authors carried on interviews and participant observation as the way to collect the data that would be further analysed and utilized to fulfil the research questions.

Since one of the researches also conducted an internship as the TC, observations were used to collect data. As Wisker (2001, p. 178) puts it: "(…*) enables to capture what people actually do rather than what they say they do.*"; this helped the authors to select the participant observation method. During the employment, the researcher was able to attend meetings and have regular sessions with managers on different levels regarding Lean projects and the usage of VSM as a tool to achieve them. The limitation of these observations was that it surrounded mainly the mid and upper level management and granted limited access to the actual implementation personnel of the TVSM. The authors bridged this through visits to other sites and interviews with different personnel on three different sites in total, including Central.

3.5.1 Interviews

The primary data was collected through the use of interviews as the favoured choice of data collection. As stated by Yin (2003), interviews are the most important source of information in case studies and should be guided more by conversations rather than by structured questions.

Sampling selection was limited due to the case but due to the researches participation, the sampling was made with the snowball sampling, as explained in Saunders et al., (2012). The first interviewee was the closest contact to the researcher who in turn suggested people involved in the VSM projects both locally and on other sites. These people in turn were asked of other possible candidates. Saturation was met when participants referred back to each other or when suggested people were not available or interested.

For this study, the data collection was a combination of focused and open-ended questions described by Yin (2003), as the same as described by Hughes (2002) as "interview guide approach" and "informal conversation". The former of both methods means to prepare a set of questions beforehand to be used during the interview. Whilst the latter's allows to not only stick to facts but also ask on a personal level about opinions around the matter. It also allows for some freedom during the interviews to dive deeper into a topic that arises that may be outside the preordained questions set for the interview.

The benefit of using these methods is that with an interview guide, it makes the data collection systematic, comprehensive and reproducible (Hughes, 2002). Whilst on the other hand, information may be lost and areas may not be explored if not already thought of by the researcher. Whilst in the case with the informal conversational approach and open ended questions interviews, is said to increase salience and understanding of the topic. However this approach also comes with a flaw, that depending on who you are interviewing, you get the problem of "different information will be collected from different people with different questions" (Hughes, 2002). For this paper, a pre-set of questions was used at the beginning of the interviews but remained open-ended. During the interviews the researcher

was allowed to address topics and areas not pre-ordained and also ask the interviewees about the specific opinions in the matter, leading to a combination of both the focused and open-ended interview style.

The interviews were recorded with the permission from the interviewees and later disposed of due to the secrecy factor involved. The interviews were only allowed for research purposes by the authors as per signed agreement. During the interviews notes were also taken in order to highlight specific topics and the recordings maintained a state of reliance as to that no information would be lost during the process. Table 2 depicts a summary of the interviews that were conducted, as well as duration, location, and interviewee involved.

Interview Number	TC Location	Interviewee	Interview Date	Type of Interview	Duration (min)
1	Central	PL1	03/24/2015	Face to Face	21
2	Plant A	PL2	03/30/2015	Telephone	36
3	Plant B	PL3	04/01/2015	Telephone	27
4	Central	TM	04/07/2015	Face to Face	31
5	Central	TL	04/21/2015	Telephone	28

Table 2 – Interview Information

3.5.2 Observation

In order to achieve the results desired, the researchers incurred in participant observation identified as Participant-as-observer. In this type of observation, both the purpose and the identity of the researcher are revealed to the group; moreover, the researcher takes part in the day to day activities and operations being carried out on the object of the research (Saunders, Lewis, & Thornhill, 2012).

The benefit of using this method is the fact that the participant becomes part of the environment and creates relationships and connections with the people carrying out the operations; this leads the researcher to discover certain patterns and themes that would not show when using other data collection techniques (Reason & Bradbury, 2014); it also gives the participant the opportunity to attain an insider's point of view (Jorgensen, 1989).

The objective of incurring into observation was to identify benefits, as well as challenges arising from utilizing company TVSM vs. a standard VSM. As suggested by Jorgensen (1989), the author that incurred into this type of research kept a journal in order to record the findings and track any behaviour or remarks that appeared during his laboured hours, fitting the style of primary and secondary observations. The researcher attended management meetings concerning the productivity and efficiency on different plants under the care of Central plant. Participants on the meetings were involved in improvements projects as projects leaders or carrying a support function, as well as top to middle managers in charge of different departments touched by the projects. Also studies were conducted informally between the researcher and participants individually on some occasions in order to deepen understanding of more specific topics. As was the case with the interviews, no personal information or sensitive information was recorded and the anonymity and confiden-

tiality of the observed participants was kept while at the same all involved was informed that research was taken place.

3.6 Secondary Data

Documents already existing at the TC that had been made for VSM training purposes were investigated. As put by Zikmund (2000), one of the main benefits of secondary data is that it is faster to collect and already existing. This was done to validate against current literature in the field, and how VSM practices currently was taken place. This to be able to make a comparison of existing VSM practices to a tailored approach. Although secondary data can be easily come by, one must keep vigilance of validity in time and to keep in mind upon analysis that secondary data was made with another purpose then to solve the current study (Yin, 2003); (Zikmund, 2000).

3.6.1 Criteria to select secondary data

Out of the training documents available, 28 of these were studied in more detail. Project leader 1 directed towards the company intranet where all documents were, mostly in the form of power point presentations. These had been made for training purposes by local staff at Central to be used in VSM projects, most of the documents were made circa 18 months prior to this study.

It is important to note that the search criteria for secondary data was mainly that given by Project leader 1, this due to the reason of finding the documents that were either known to exist or actively used on sites. Since more documents were found than the ones examined it was valuable to put emphasis on documents that the managers in charge knew existed.

3.7 Data Analysis

Regarding the data analysis, the authors of this thesis conducted a series of semi-structured interviews with different key actors in the company (Saunders, Lewis, & Thornhill, 2012). Similar question were asked to the interviewees, depending on their previous responses, some questions were altered and added in order to cover for new areas discovered during the process. The interviews were conducted on several sites owned by the company, but all of them encompassing the same products. After the interviews were carried on, due to confidentiality issues, the transcriptions and recordings were disposed, previous to disposition, the documents were reviewed with the interviewees in order to validate that the information and ideas had been correctly imprinted in the text.

When carrying on the interviews, the authors started by introducing themselves and further explaining the purpose of their interview and the research itself. After the interviews were conducted, the authors listened to the recordings and transcribed the interviews paying close attention to the answers given by the participants. Furthermore, the text was reviewed with the participants in order to validate the answers, as well as the opinions expressed in said interviews. As long as the interviewees agreed on the content and opinions imprinted in the texts, the authors considered the texts to be qualified to be used for the research purposes. See appendix 1 for interview questions.

For the purpose of the creation of the empirical findings section, the authors assessed and read each transcript and identified similar answers that could be coded, following both the thematic analysis and coding methodologies proposed by Roulston (2010), taking into consideration commonality between the answers, pre-established codes such as “actual state

VSM", "future state VSM", "training needs", etc. After the individual assessment, theming and coding, the authors met in order to cross-check the identified data, themes and codes that was identified, as well as considering the possibility of recoding or re-theming certain data under different codes or themes that were identified during the individual assessment.

After the initial coding was done, certain areas stood out through all plants and was decided that, for the ease of understanding, these areas were implemented into the empirical section as minor headlines. These came down to "Ownership" "Training" "Initiative" "Usage" and "Knowledge". These were the first level of themes during the analysis and later used to structure the empirical data section as seen in chapter 4. An example of the coding is provided in Appendix 2.

The final codes utilized by the authors reflected the challenges, the general impacts, as well as problems that arise when utilizing a company TVSM. They further reflect the reasons behind TC choosing to use a company TVSM in lieu of a standard one. Additional to the data collected via the interviews and later coded, the authors identified challenges, problems and impacts of using a company TVSM, by participant observation.

In line with the purpose, the authors embraced this analysis in order to gain a deeper understanding of the reasons and challenges, as well as the benefits of utilizing a company TVSM in place of a standardized one. This kind of analysis also provided, according to the authors' opinion, a more objective perspective since the findings come directly from the source.

3.8 Quality Criteria

The present thesis is based under the qualitative study premises. The data was obtained mainly by semi-structured interviews, but also observations, as well as the use of secondary data was recurred in order to enrich the work presented. However, there are some limitations regarding these methods. As mentioned by Saunders et al., (2012), a matter of great importance in scientific research is the research process and its findings to stand up to the scrutiny. It is also mentioned that one of the goals are to reduce the probability of error in the research being carried out. In order to diminish mistakes, as well as to provide a value to the research and surpass the mentioned limitations, the authors applied the specified quality criteria.

3.8.1 Transferability, Dependability and Credibility

In this regard, Lincoln & Guba (1985) propose new names for versions of criteria that recognize the nature of qualitative research such as dependability for reliability, credibility for internal validity and transferability for external validity. The authors used these concepts coined by Lincoln and Guba for the purposes of quality criteria's.

Regarding dependability, Saunders et al., (2012 p, 156) & Lincoln & Guba (1985), mention "*Dependability refers to the extent to which your data collection techniques or analysis procedures will yield consistent findings*". To be sure of this, Easterby et al., (2008 p. 109) give three questions to answer: (1) Will the measures yield the same results on other occasions? (2) Will similar observations be reached by other observers? (3) Is there transparency in how sense was made from the raw data? To these are added threats to dependability. Robson (2002) states four threats to investigate. (1) Subject or participant error – where the people the data are generated from is somehow influenced in any way, for example time. That if the study were to be conducted at another date, the data yield would be different. (2) Subject or participant

bias – meaning that the interviewees may only give answers they think are needed, or right, for the study or in other ways pressured into giving certain answers that may not be their own. (3) Observer error – for example the data were collected differently by the researchers. (4) Observer bias – meaning that the data collected were interpreted differently.

The data collections were obtained foremost by interviews. As mentioned, the interviewees were granted anonymity. In some cases multiple interviews were also conducted over a period of time, this was to increase the dependability of the answers given. As for the observer bias and error, due to geographical constraints, the same researcher conducted all interviews, although the analysis of the data was done together and discussed as the analysis progressed. As Saunders et al., (2012) states, observer bias cannot be avoided, just to be aware and in control of it. For this paper a version of informant verification was done, after observing certain aspects that brought questions to mind how they could be interpreted, these were written down for further confirmation. Said confirmation was done either by informal discussions with projects leaders or managers involved as well as through interview questions. After discussing between the researchers, a topic open for interpretation that was deemed valuable enough was made into an interview question and asked at each interview henceforth in order to collect more views from other participants and avoid researcher interpretation bias.

As for Easterby's & Robson's questions, full dependability cannot be given. This due to time constraints derived from period of time of the study and the case in itself. If this study is performed at another company, or even the same as the case, it cannot be guaranteed that the same conclusions will arise since companies have similar resources, but never the same. In this case, it should also be considered that internal factors such as the company changing over time, could lead to the company TVSM to be viewed differently in the future. There are also external factors that tie this particular study in this particular time frame. Sustainability regulations and overall governmental initiatives could, and most assuredly will, change the results of this project, as well as the way it has been conducted.

Regarding to validity, Wisker (2001, p. 322) formulates validity of a research paper the following "*If the methods, approaches and techniques match with the research issues then the findings are likely to be valid*" which relates to if the data collected is true to the questions they are supposed to answer and meet the requirements set for the chosen methods. External validity, or transferability (Lincoln & Guba, 1985), means to question to which extent the results are generalizable or transferable. Yin (2003) highlights that single case studies do have problems with these issues due to the sample size. Internal validity, or credibility as mentioned by Lincoln & Guba (1985), refer to how well the design of the study has been, for example which data was collected and which data was not; in regards to this, multiple sources of information were used in data collection to confirm authenticity. All information analysed was cross checked with the management of TC to serve two purposes. Both that secrecy had been ensured and to validate that the data collected had been correctly understood by the researchers. Transferability is hard to prove due to the single case nature of the paper; however the methodology used can be generalized to be used in other case studies. In addition to this, the authors also resorted to credibility to ensure the quality of the paper. As defined by Lincoln and Guba (1985), credibility deals with how the authors of a research can establish confidence in the truth of the findings of said research, taking into consideration the context in which the research was carried out. The authors tried to establish a correlation between variables; in this case, the existing relation between a company TVSM and the benefits and challenges that arise on the utilization of said VSM in order to establish

credibility in the paper; this is further supported by Saunders et al., (2010), who define that credibility is established when the research demonstrate a causal relationship between variables.

3.9 Choices of study

The single case study method therefore served as the base of investigation throughout this paper. Using multiple sources as evidence, these contained primarily of interviews but also documentation and participant observation. The interviews were conducted along the chain of command in the firm, including a head manager, who had ordered the TVSM, a project manager in charge, a project leader and finally the end users in different plants owned by TC. This was done in order to get a thorough picture from both ends, both managerial decisions as well as the impact of it by the people who will use the product.

4 Empirical study

In this chapter the empirical data collected by semi-structured interviews, aided by participant observation, is presented. Personnel at the managerial level working at three different plants have been interviewed in order to fulfil the research questions. One of the sites is the headquarters of the company whilst the other two is branches on other geographical locations. The authors focus on the perceived problems and benefits of utilizing VSM as a tool on how they are using it to this date in order to explore the perceived benefits, problems and challenges of utilizing a company TVSM in lieu of a standard VSM approach.

The Case

While operating internationally, a document pertaining a structured and tailored approach, adapted to their specific needs and production characteristics, around their local sites on how to make a VSM was asked for. The case, as given by the company, sees a problem of adapting VSM into sites due to resources constraints such as time, training, skills and knowledge. As it is right now, a site owned by the company is to undergo structural changes and will then implement new processes that will require a restructuring of the current layout as well as the resources allocated to said processes. The restructuring of the firm will begin with the development and implementation of a VSM. These changes can lead to uncertainty and potential risk of increased losses; said changes are derived from the fact that little understanding of how a VSM should or could be conducted. A company TVSM specific to the tire production should help the site to best plan and cope with the required changes.

4.1 Findings at Central

Central is considered the headquarters of the other plants. From here directives and goals is sent out to other sites in terms of production and training. They do maintain some level of production as a support function to the other sites, but its main purpose is administrative, and the setting of KPI's to other sites. The company consists of approximately 2000 employees. The views stated here span over several plants and offer a more general and holistic view since Central often visits several sites each year in order to support different projects. On this site, three participants were interviewed, a Project leader (PL1) a Team leader (TL) and the Team Manager (TM). The PL1 is in charge of visiting sites and supporting in the making of VSM's globally when improvement projects are made locally and also possesses expertise knowledge and training of VSM. The TL is also involved in improvement projects but more on a macro and managerial level and has received general training and possesses some knowledge of VSM. The TM is the manager of PL1 and TL and is mainly overseeing projects globally and goal setting on a higher macro level. Knows and is trained to some extent in VSM.

The interviewee's opinions often flows together on many subjects and is therefore only highlighted in particular when something stands out from among the rest.

4.1.1 Benefits

According to the interviews, the utilization of VSM bring benefits such as the ability to establish a series of steps for the plant to follow in order to accomplish all the goals dictated by Central; furthermore, it allows the plant to identify areas of opportunity when they compare the actual state to the desired state.

Another mentioned benefit is that it gives a quick and easy way when going to a new site to help understand the processes there, and more specifically, how they are working and interacting with other connected processes. It is the fastest way to date to help understand how they are working locally. This is beneficial for Central who often goes to new sites to support improvements projects. Even so, all the plants more or less produce the same product range, however all plants do so differently. This is derived from the fact that some plants may be older or has space constraints, to name a few; this has led them to developing uniquely.

VSM is used in its more traditional sense as a base for improvement on how to move towards the future state in terms of what is needed in resources that is not there today. It also helps set benchmarks and goals for upcoming projects. PL1 really points out the benefits a VSM bring in terms of a strategically planning tool. The TM says that the main reason it is used is to identify improvement areas, to show the flows, material and information.

4.1.2 Challenges

Usage: In regards to the problems that arise when using VSM's from a Central perspective, the PL1 stated that in some sites, employees in general have no lean background; furthermore, the concept of VSM overall seems to be alien to the plant's employees and workers. There also exist a population in plants that have never seen a VSM, moreover, they ignore how to create a VSM, how to follow it, and fail to realize the benefits of having the tools and exploiting them.

Another point mentioned is the fact that the VSM is used for visualization and to show the processes of the status quo, but when trying to move to FSM using the tool for improvements that has not been done too often says TL. Although TL makes clear that he is seldom involved in detail in the projects. TL's experience on sites usage on VSM stems more from audits carried on in the firm. In TL's own experience, the VSM seems pretty difficult to use for the very little results you get out of it; put it simply, the effectiveness and efficiency of the tool seems trivial, stating that there are other tools that will show and help more with less effort then VSM.

Other problems have involved making a VSM for people where the knowledge brings nothing new to the participants, making the project "dull and obsolete" in the words of TM; he also states that in these cases, VSM may not have been the right tool for the problem, not necessarily that it has been used wrongly.

Another challenge is how often a VSM is being used on sites. As Central have a holistic view of many different sites, they see that some do not use VSM at all, while some sites perform one maybe once a year. There is a desire from Central that the tool is used at least annually, for example at the end of each year to lay out strategies for upcoming projects, as stated by PL1. The TM confirms that it is not a regular event; the utilization of the tool is rather triggered on demand. Another point to consider is the fact that when the tool is indeed used, it is mostly used on a specific area instead of whole plants. TM states that making a VSM for a whole plant only makes sense when there is a need to identify bottlenecks, de-bottlenecking or looking at overall Takt time, to reach a higher throughput. Focusing on areas makes more sense because a lot of the processes are not interconnected, but rather separate activities, without a fixed transportation system between them as put by TM.

It is the opinion of the interviewees that focusing on plant areas normally brings more benefits, increasing efficiency is more valued at TC since Work In Progress and throughput, which accordingly to TM is one of VSM's focus points, is generally not a big issue but rather efficiency and setup-times. The emphasis on focusing on areas rather than plant level is further strengthened by the TM saying that bottlenecks and a capacity issues are generally already known facts by the Industrial Engineer (IE). When trying to look in-depth on "how can I reduce losses in that area" for example, then utilizing VSM makes more sense, says TM, since this level of depth is not visible on a macro level.

Currently, it is the most common practice for Central to come and use VSM on different sites; however, it is the future plan to educate and train certain departments who deal with local improvements at each site to effectively and efficiently use and maintain VSM on their own, without Central's involvement, as mentioned by PL1. There is also an initiative to develop demand for improvement on sites, teaching said sites how to use it in order to help plants see the need for improvement as well as the benefits of VSM, and the initiation of improvement projects by themselves, states TM. Currently many projects are initiated by Central only, and it's the interviewees' opinion that VSM, along with other Lean tools, can help create the willingness for change.

Training: Touching upon the topic of training, it was mentioned that most of the training material is only available to a certain population; furthermore, the training materials are purely theoretical and illustrate unrelated examples and issues existing in other industries that cannot be transferred to the tire industry in particular, says both TL and PL1. Another issue related to training material is the fact that operators and managers alike find the theoretical information at times too hard to relate too and understand; for example many books instructing Lean and VSM use another type of measurement different than the one used in the tire industry; so whilst textbooks examples talk about parts, number, articles or days of inventory, TC deals in "cassettes". This is purely an example, but it is enough to undermine the trust for the current training and not make it relatable for them. This correlates directly to the low spread of education in Lean tools at the sites, the theory is too difficult to understand and not being able to connect with the material shown causes disinterest and confusion on how this is supposed to be used by themselves. PL1 states "*it is hard to apply the textbook training to operators who 'need to go back to school' and not being able to connect to the material*".

It is desired that training partakes annually with real life examples so that people in TC can relate to a simplified theory in an interactive manner; this in order to make a non-Lean specialist able to understand and relate to the training.

In regards to challenges, the inability to standardize the knowledge and tools throughout the plants was mentioned; this is related to the fact that some departments in the plant hire external consultants to create VSM's. This department then proceeds to create a series of steps and strategies to follow in order to fulfil the department's goals and objectives. The fact that the creation of steps and strategies occurs in such an isolated manner causes inconsistency between the documents that exist throughout the plant and those between Central and the plant. The main challenge, as pointed out PL1, is to create a tool that can be used by several departments, if not all, belonging to the plant. The main goal is to have a training made for operators, planners or anyone who is going to be involved in the VSM project to be able to run an annual VSM event by them on a local level without Centrals involvement says PL1.

Knowledge: Another issue that appears in the plants is the underutilization of the tool. It was mentioned by PL1 that plants are not able to fulfil the goals and follow the strategies dictated by Central since, most of the time, a series of steps stated are derived from the VSM; and since some employees are not used to using the tool, they completely miss the steps dictated by Central. A common practice by Central is to come to a site and teach the owners of the projects how to use VSM to set strategies; however, due to a low level of Lean education overall in the sites, it becomes problematic to handover the project; this further causes the new owners to not utilize the tool to its full potential. It is common, as mentioned by Central's interviewees, that many plants have experience and know how to make a CSM but fail to move forward from that point because the lack of knowledge and experience. This further cause the project to not yield as many benefits as it could. The sub optimization and sub utilization of the tool is directly correlated to the lack of Lean education on sites. It was mentioned that the most common issue from Central's point of view is the inability for sites to move towards a FSM even when the CSM has been correctly and successfully done. As all interviewee's states, Lean is a fairly new concept, and TC is a traditional business where many have never even seen a VSM. Although some plants have been using Lean for some time, many are just starting with its introduction. Another point mentioned by Central is that often, certain sites still see the traditional way of working as the optimal and correct way of achieving results; this causes a silo mentality and departmental thinking.

Initiative: Another challenge is the fact that, most of the time, the initiator of the VSM process is Central, leaving the plant unprepared to start or stop the process. This enhances the dependence of plants towards Central, which goes against the goals established by Central itself. The manager of the area that is being mapped is always involved in the projects; nonetheless, looking at it in terms of reactiveness and initiation, it's not always the owner of the process, but rather Central who takes charge and leads in the background. This is done by Central as it sees performance issues as a reason to initiate a VSM project in order to start the improvement process. Nowadays, this is standard procedure in order to ensure overall quality among sites; this is caused by the fact that Lean initiatives are still considered new in many plants. As stated by PL1 "*the need is there, even if it is not always acknowledged by local sites"*. One point to consider is the fact that the plants that already have established Lean tools, carry on the initiation process on their own without any of Central's involvement.

Ownership: Indivertibly Central is somewhat the owner due to higher knowledge and knowing how to use it properly. This is not the case in every project; however it is worth mentioning that it occurs in some cases. It is the opinion from all interviewee's that the owners should always be the local project managers depending on the level and scope of the project; however, it is the desire from Central that their involvement is purely a moderating role.

4.2 Findings plant A

Plant A is a manufacturing production site; it produces, unlike Central, the whole product range from raw materials to finished products and supplies directly to distributors or wholesalers. The plant consists of approximately 2000 employees with its main focus on production. Central also supports this site, to some extent, with material for further processing but mostly with goal setting and KPI's. One Project leader (PL2) was interviewed here. Two more people were also asked to be interviewed; however, after contact with them, they themselves deemed that they had little to no knowledge to add regarding

VSM's, even after the researcher assured that current knowledge, even if little to none would also be beneficial for the study. Their answers were used to emphasize the current knowledge within the plant since they both represented two different departments away from the PL2. Saturation was deemed to have been met as no other applicants could be found.

4.2.1 Benefits

VSM is seen as a visualization tool in order to identify problems regarding everyday processes and also in order to clarify the flows; it is then being used as a base for further improvement. It not only helps with identifying problems, but also brings people together from many different departments that don't often work together, building and strengthening bonds between departments.

VSM's is as beneficial in offices as well as production, and seen as equally valuable. Experience states that it should be done on the closest level as possible to the processes and be as concrete as it can be, the more detailed you can make the map the more you will gain from it, as stated by PL2

4.2.2 Challenges

Usage: it was mentioned by PL2 that VSM as a tool is not broadly used at the moment, but there is a desire to use it in certain processes in order to identify current problems. Currently, there is an "idea box" in operation. The thought is that operators can drop suggestions into it when they come up with an improvement, and although in theory it is a benefitting system, the support surrounding it is less structured and organized. This problem is recognized by multiple levels in the site however no one seems to be responsible for processing the ideas. Another problem that is linked to the fact that there is no responsible is that operators see that their ideas are not being taken seriously or that the process takes months or even years, losing the momentum and diminishes the morale for further ideas. The responsibility problem stems from the heavy workload that exists and leaves little to no time for improvement work, as well as failing to see the benefits of operators' involvement.

Another problem is the existing company culture, where improvement projects are seen as more work to be done where there already is enough, instead of being viewed as an opportunity for improvement. This, according to the interview, comes from a lack of understanding of how VSM and other Lean tools can benefit their work in the long run. There is also no realization that working with smaller improvement suggestions could be beneficial and empowering for workers, causing no real sense of urgency.

Operators and workers rarely have an initiative regarding to the start and use of VSM in their everyday activities, whilst the upper management doesn't really understand it and, therefore, doesn't really see a need for it. The real usage comes from the middle management level since they are the ones that have both the training and experience, whilst seeing the benefits of using it to handle reoccurring problems in the production. One issue that came up was to make sure to make the map on such a level that it will be beneficial; the more detailed the map can be made, the more benefit will come of it. PL2 states: *"If used on a higher level it is much harder to relate it to the processes that you wish to improve"*.

Training: Training is individual and not standardized coming from the company itself. It seems more likely that managers trained in the topics of Lean and VSM have gotten the

knowledge and experience from previous employments rather than receiving it in TC. This is enforced by the fact that, when asked, the interviewee stated she has not experienced any kind of standard Lean education training from the company but she has received such training from previous employments. It was also mentioned by PL2 that some employees are trained in the usage of Lean tools, but it seems that it's mostly since it "makes sense" rather than coming as an initiative from the managers' own ideas.

Lack of training has been deemed by PL2 the biggest issue around the site. If there are problems around that could be solved with the help of VSM, people fail to realize that VSM could be beneficial and helpful. Moreover, many of them do not seem to know of the existence of the tool and how could it be used to solve their issues; on top of that, in some cases even when they are aware of the tool, most often they do not know who to turn to for guidance in regards to said tool.

The culture at the site leans more toward putting out fires; "we do not have time for that" or "we have other problems to solve", rather than going to the root cause and fixing the problem at the source. The reasons behind this are multi-faceted, the industry in itself is a traditional one and many workers and operators on the sites have been working there for a long time. Moreover, everybody knows the processes by heart and carry them on in a traditional way, this has caused them to stop making them better; this again, is in line with the thinking of "this is how we always has done it". A note should be said here that this is a generalization, because there is still the suggestion box as mentioned above; however, with a lack of empowerment, and the fact that ideas are not really heard nor validated, operators have been accustomed to the fact that no actions are taken in regards to their ideas; to put it in the interviewees words: *"(they say) no one listens and nothing happens, so why make an effort*".

Knowledge: The site has a department that works with projects on the site in terms of improvement, IE; one of the goals set by Central toward this department is that VSM projects are one of its responsibilities. However when asked about how many are trained in the matter, it came out that there was little to none who were either using it, had training in it, or were experienced users in any VSM methods. A note is to be made that this applies only to the general population in and around departments, there are some people who have more experience, although in a generalization of the overall knowledge, it was considered low by PL2.

The training that exists today was deemed by PL2 as not beneficial; however, PL2 have had previous knowledge and training in both Lean and VSM since before. It was agreed that several people should be trained in both Lean and VSM and, as is the case with the site, of over 2000 people, only a handful is experienced in Lean tools and was deemed not optimal for success. It is PL2's opinion that the training should be more spread out.

In order to make training successful, a different set of materials is needed in order to set a standard overall. A suggestion, as mentioned by PL2, was for Central to provide standardized material which can be used at all sites, stating how it should be done, but allowing room for local changes. Another point mentioned was a "train-the-trainer" method and to have a mentor who specializes in VSM who would be the person to go. The training would be carried on demand instead of having a clear interval such as once a year for example. PL2 mentioned that they rather prefer to know who to go to for help and receive training when needed in order to keep the knowledge fresh and up to date.

Initiative: It was mentioned by the interviewee that, the initiation of the VSM projects should come either from the owner of the process or the department level it is positioned in, and should involve an operator or anyone who is connected to the process. *"It should come from someone who feels the pain of process"*.

Ownership: It is the opinion of PL2 that the site involved has no historical precedent regarding many VSM's in order to answer this efficiently. PL2 stated that most VSM work would go through the people in the department that support or is involved in the VSM process. Similar to Central's opinion of depending on where the VSM is to be done, the local site owns the process with support of the local improvement department. Central as mentioned is to carry a support, in order to not be forced to depend on Central to make the VSM projects happen.

4.3 Findings plant B

Plant B is a site with approximately 5000 employees supported in some extents by Central regarding goals, improvement projects and KPI's. This site deals with bulky and expensive products with high complexity and big batch sizes, making inventory a reoccurring challenge. Here, Project leader 3 (PL3) was interviewed. Due to language constraints, no further interviews were possible but saturation was deemed to be met since PL3 was the person in charge of VSM execution and creation in the plant. PL3 is trained and possesses expert knowledge regarding VSM's.

4.3.1 Benefits

VSM is used as a base when the plant wishes to improve a process on the site; PL3 mentioned that it helps having a visualization of the process and then use this for finding potentials for improvement. For this site, VSM has been deemed as the most suitable tool to deal with problems surrounding stock, inventory and WIP. The VSM is updated monthly or bi-monthly in order to notice changes and differences from previous updates. These are then analysed and compared to current order stock and used for production changes. PL3 stated that the tool is actively used as it gives a quick overview of the entire inventory at each process in the entire plant. The map that has been made is very extensive and complex as it shows the entire factory and is mainly used by IE and trained operators. A point to take into consideration in this plant is the fact that some reservations as to who can use it; due to the complexity, it may be hard for personnel not specifically trained in VSM to use and fully understand the tool. An advantage in this plant is that some of the data is gathered and updated electronically for easier maintenance.

With VSM as a base for visualization and identification together with sequencing, they have been able to halve the stock in certain products, saving on both space and tied up capital.

Another sublime benefit is the understanding of the tool, after VSM projects have been conducted and connections between departments have been made, recognition may come. This means that the plant uses VSM to actually help them recognize benefits by themselves and then start to see the potentials for improvements and increasing learning how to use the tool. This is more referred to other departments than IE who uses it more often and is trained in VSM.

4.3.2 Challenges

Usage: Improvement tools have been used for a longer period of time, since ten years and back, with VSM being introduced about five years ago. Due to the experiences with other tools, VSM has not been deemed as beneficial as in other sites; this is due to the already extensive previous works in terms of improvement projects; nonetheless, the tool is being used for visualization purposes.

Mainly it is the local IE that uses VSM and other tools; the projects are then presented to the management in a workshop. Then, a team is formed consisting of operators, technicians and the closest supplier and customer of the involved process. VSM is then used to visualize the flow and to highlight and explain what are VA and NVA currently in the process.

The main challenge the site has is updating the information on the VSM; due to high complexity, there are a lot of cycle times and keeping these up to date is challenging for the plant in question; on top of that, articles in the inventory are always changing; this adds another layer of complexity to the already complex VSM.

A challenge is stock taking, since the processes and the plant are huge; this leads to the VSM map being the same; furthermore, working with it is not always easy. PL3 mentioned that there is a preference for automatized updates electronically; however such is not always the case.

Another cause for concern, as highlighted by PL3, *"it is worth emphasizing that VSM may be used to identify problems, it will not solve them"*. Some people seem to have understood it wrongly and perceive VSM as a tool that will solve all of their problems just by using it.

Training: A local VSM training has been created, which is being used currently in office settings. It shows and explains step by step how a VSM is to be done, as well as benefits of it and how to use it properly. The goal of the training is to make everyone involved in VSM projects take this training or, at the very least, that the training is to take place before a VSM project starts. Some other points mentioned by PL3 is that the most valuable training is learning by doing; a new training is only done if there are new people involved to show how it is done. After time progresses, it is not so critical to train often; it is preferred to have more training in the beginning, and then working through questions that come up along the way.

On a separate note, a wish for sharing training programs and see how other sites are doing came up; it was mentioned by PL3 that there is a motivation to work with people from other sites, share ideas, learn from each other and from everyone's experiences.

Knowledge: The local level is seen as high in both VSM and other Lean tools across multiple levels of the site; this is due to a lot of the tools being interactive in everyday processes. The challenge says PL3 is to standardize the level of education across the plants

Overall, education level is seen as high and other Lean tools like 5S, SMED, Kanban and the like are used on a daily base by operators, as well as in management levels.

Initiative: VSM projects come almost exclusively from the department in charge of improvements; however, the motivations and orders come from top management.

Ownership: Depending on the project, there is always one responsible for that process, like a department or process manager who is then involved in the project; However, IE is always involved but not necessarily driving the project forward; they carry more a support function.

4.4 Tailored VSM

The following segment is comprised by the statements from all the interviewees, regardless of site, collected thoughts on a company TVSM.

When talking about a company TVSM, the first benefit was mentioned to be useable by anyone without a deep knowledge of the tool. The ability to have examples and issues that can be related only to the tire industry will motivate workers to actively seek for areas to develop and improve. One point was made very clear; the presentation of the TVSM needs to be short, clear and be able to offer examples that can be related to the industry in order to make people understand and connect to it.

The idea of continuous performance improvement was mentioned as a benefit of having a company TVSM since, when getting rid of the unnecessary elements of a standard VSM, the operators, managers and employees in general can focus more easily and effectively on searching and finding problems, as well as establishing a series of steps and strategies to follow in order to effectively fulfil the goals dictated by Central; moreover, it can transform the plant into a "performance improvement initiative creator" since the improvements carried on here can most assuredly be used and implemented in other plants.

The empowerment of the plant was also mentioned, having an easier to use TVSM will allow the plant to operate and generate improvements independently of Central. It was stated to be beneficial to have a "booklet" to fall back upon, a checklist in order to review if something has been forgotten in a certain step, and to have all the symbols and technical terms explained together with templates in the paper; but also how to execute a successful project meeting and manage a workshop.

4.4.1 Challenges

One of the topics mentioned during the interviews, was the fact that, due to the existing company culture, it is hard to convince Central and the plants in general to have training sessions at least once a year in order to either refresh the knowledge, or introduce people to the concepts. This is related to another point mentioned by the interviewees regarding convincing employees of the benefits of "going back to school" in order for them to maintain competitiveness in the industry. It was mentioned that, most of the operators would resist change or deem the training too time consuming of a task; this, linked to the fact that they are working under an already tight schedule, leads to employees increasing their resistance against learning the new tools or refreshing the knowledge on the existing ones.

Creating a TVSM that includes only the concepts and examples related to the tire industry was also mentioned by the interviewees as a major challenge, since experienced personnel are needed, as well as time windows available in order to develop the mentioned tools. This is also linked to the challenge mentioned above; the lack of time is a persistent situation that has impact on the rest of the tasks.

Another idea was the fact that clarifying the ownership of the TVSM process would be complicated since, nowadays, the initiation, as well as the follow up and executions lays of-

ten in the hands of Central. And it was mentioned before, one of the objectives of Central is to delegate the ownership to the respective plants, but the lack of confidence in the capability or knowledge of the employees in different plans forces Central to still be a major role during the VSM process.

An interesting note stated by TM was that he did not see the need for a company TVSM. Stating that there is the risk when there is a template or pre-filled information, that shortcuts will cause information and learning loss. For example, letting people just "fill in the blanks" could miss deeper analysis. One of the main purposes of a VSM is that is a development exercise, it requires that the people involved understand the definition of value, as well as the steps needed in order to leverage said value and the firms capabilities. Finding connections and looking beyond the status quo is what is important.

The final thought regarding TVSM mentioned by the interviewees is the fact that such a tool would require constant development and improvement, year by year, the issues, needs and benefits will differ from each other; moreover, training on the updated TVSM would require further training and clarification, not to mention dedicated personnel and commitment from all the employees involved.

4.4.2 TC's view of a TVSM approach

The following are a series of steps on how TC usually carries out a VSM project. These steps have been gathered by observation and to some extent informal interviews and formulates how a TVSM project is wished to progress.

In comparison to the standard VSM approach, TC wishes to have a more extensive detailed document on how to perform a VSM. The standard VSM approach deals mainly in how to execute a VSM per se. Whilst TC wishes to fill the information gaps between the steps in standard VSM more extensively and at the same time increase the information needed to fulfil each step in order to cover for low Lean knowledge.

A VSM project in TC normally starts due to a process not fulfilling its goals or a need to improve efficiency or decrease of waste. Starting with **need for improvement**, after this has been established which process and at which plant it is located at, is to **identify owner**, a note should be made that VSM's projects often occur on a process level exclusively. A natural limitation occurs here as the **definition of the scope** of the project is made simultaneously. This leads to assigning the owner of the project as the director to move things forward and is in charge of **collecting KPI's**, these can be related to the standard VSM data box that is being used. However, depending on the project, some KPI's may not be needed and collecting the right ones depends on the project. For example a project focusing on increasing efficiency rates of a process, scrap rates may not be needed to the same degree as cycle and setup times.

The owner or Central, depending on the need for knowledge and expertise, then **formulates a project team**. The participants that should be involved in the project are the owner of the process, technicians who possess expert technical knowledge, a scheduler who arranges material flow, the owners up and down streams of the connected processes, and a PL from Central if needed. Depending on the scope of the project, management or operators may also be involved. **Arranging the project** after the participants have been decided, a place and time to work in and to kick-start the project and also inviting all the participants.

When all is gathered, do the **Gemba walk** which is to go to the process on the site whilst all the participants have been assigned certain roles to fulfil during the walk, some may count inventory others may take times, all in order to **identify the process and its flows.** Completed, they go back to the meeting room and **construct a current state map** with all the information gathered. This is then used as a base to **construct the future state map** which is made by **analysing the current state**, **identify VA and NVA** in order to **find points to be improved**; these points differ depending on the scope of the project and its focus. Just like in a standard VSM the tools involved in finding improvements is legion and will not be developed further in this paper. The tools used in both finding the points as well as the execution of them differ depending of the project and skill knowledge of participants. The findings are then **assigned owners of improvement** and broken down into a series of manageable steps and **developed into a timeline** in order to ensure completion. The owner of the project then proceeds with **follow ups** of the development of improvements points to make sure things are progressing. An optional event later in the future is **comparison of KPI's** between the first VSM project and a second one to see if the project was successful.

In order to perform the steps described above TC wishes to have standardized training documents written with the TC culture and company language in mind. This allows for all members to receive training in TC's TVSM in order to conduct it thoroughly.

More information was gathered through observation regarding in-depth steps on how TC wished to conduct VSM projects; however they were deemed to small and out of context if brought up separately and will instead be emphasized in the analysis where appropriate.

5 Analysis

In this chapter the authors consolidate the empirical findings and proceed to integrate them with previous research and efforts regarding VSM and TVSM. The perceived benefits, as well as the problems and challenges of utilizing a TVM in lieu of a VSM are investigated from the firm's point of view.

In order to facilitate the understanding, as well as ensuring the that the red thread is followed through this section, the definitions of what VSM and TVSM requires to change in order to be successful, as stated by the researchers in the literature review part, should be mentioned. The researchers found that, in order for a VSM to be successful, the company has to adapt to the tool, whereas TVSM requires the tool to be adapted to the company.

The following sections will highlight and argue for the strengths, differences and challenges when dealing the different types of VSM's and how they could affect TC with the results found in the empirical section.

5.1 TVSM

As mentioned in "The Case" section, a TVSM was asked for in order to cope with the difficulties of implementing a standard VSM due to lack of knowledge, time and resources to achieve goals successfully and in a cost effective manner, as well as to comply with the needs specific to both the industry and the firm.

Throughout the interviews and observations, the researchers found that the perceived benefits, as mentioned by the interviewees stated in the empirical findings section, included the ability to be used by almost anyone without deep knowledge and understanding of the tools. This not only empowers the employees, liberating both Central and management in the areas from workload, but also effectively dampers the fear barrier against the tool. This goes in line with the argument stated by Chen *et al.,* (2010); saying that smaller companies or plants, such as the sites given in the case, find having full time lean staff to be expensive and inhibits them from implementing and maintaining Lean projects; this is further supported by Rother & Shook (2009), who says that in order to be successful at making VSM projects and moving from current to future state, firms need someone experienced in the matters of VSM in order to overcome the high learning curve.

Presenting employees with the ability to reduce the learning curve, as well as the time frame needed to learn and utilize the tool is one of the major benefits identified. These arguments are linked further with another benefit mentioned by the interviewees in different plants; having a series of examples and issues that can be related to the tire industry will motivate employees to actively seek for areas to develop and improve. This, in the interviewees' opinion, can further receive a boost from the fact that having a presentation and/or interactive and dynamic material will allow not only to reach a broader population, allowing the training to be more effective and efficient, but also will make making the tool more readily available and shortening the training time needed. This will require both tool standardization as well as a continuous and recurrent training. This, according to Chen et al., (2010), both increasing chance of successful implementation and reduces the learning curve of said tool. However, one of the challenges mentioned during the interviews regarding TVSM was the fact that, not only does the company have a "resistant to change" culture, but also they seem to believe that the actual practices are the correct ones and both effective and efficient since the idea of "that's the way we've always done" prevails; on top of this, the lack of time and disposition to "go back to school" and re-learn the concepts would prove a

tough barrier to overcome. This would render the benefit invalid since, even when the learning curve is reduced and the tool is more readily available to a broader population, training and education is needed in order to change the culture and position of the firm to a more open environment that is ready and open for change.

Another benefit identified during the interviews is the fact that, when getting rid of unnecessary elements in a VSM, the employees involved could turn their attention into efficiently and effectively searching and finding problems that can be solved with the help of the tool. It also would allow establishing a series of steps and strategies to follow in order to fulfil the goals dictated by Central. This would allow the plants to be transformed into performance improvement initiative creators; this is because the findings can be transformed into best practices due to similarities in between the plants. This can be linked to the fact that the tool would empower plants, allowing the involved teams in every plant to effectively apply the tool to solve problems and find areas for improvement. This is supported by Tyagi et al., (2014) when they mention that, a proper tool will empower the employees and transform the firm from a "firefighting" firm to a "problem solving" firm and; further in time, "problem seeking" firm.

However, in order to achieve this state, first the tools need to be created and then implemented. This in itself was mentioned as a major challenge for the firm since; first of all, some plants call external consultants to create the VSM documents. Moreover, in the majority of the time, the developed tools are based on one plant only, rendering them hard to implement or even compare within plants. Moreover, plant B in particular; declared that they already working under a tight schedule, disabling them on matters of time flexibility. As mentioned by Abdulmaleka & Rajgopal (2006), developing the tools, particular to a firm or industry, grant great benefits and rewards; however, achieving said tools also requires investment in the form of time and effort; both resources are almost non-existent across the plants. This might be caused by the firm's culture, as well as lack of support from middle and top management; this point is further strengthened by the statement Hobbs (2004) makes regarding tools and training; the creation, development, training and execution of VSM tools can be a time consuming task; if the firm is not able or unwilling to invest in the tool, most of the projects are doomed to failure.

On another topic, the fact that the results of successful implementations are shared by the firm, allows for a boost of morale in the involved teams, as well as creating a best practices base that can effectively be applied to several plants due to their similarities in production lines, methods and composition. This can be related to what Bertolini et al., (2013) mentions in regards to the utilization of a VSM; allowing certain flexibility in the tool, will permit the company to adopt specific practices and approaches that are closer to the plants reality. Said practices and approaches would then become the best practice compendium to resort to when dealing with similar issues across multiple sites.

A surprising discovery was the statement by TM when he declared that the company is not in need of a TVSM; accordingly there is the risk that employees with little to no knowledge of the tools will simply "fill in the blanks", taking shortcuts where a deeper analysis is needed and risking information and learning loss. This is contradictory to what Chen et al., (2010) and Rother & Shook (2009) state when dealing with learning curve and successful implementation. If information and learning loss is to occur, not only the project will be a failure in itself, but also the time and resources invested in the creation and training of the tool will go to waste, effectively increasing the learning curve, as well as decreasing the suc-

cess rate and defeating the point of having a tool that's easier to use and requires less knowledge from the users. This led the researchers to further explore if the idea of a TVSM is the perfect fit for the firm; the analysis of the perception of VSM will be presented in the next section.

5.2 VSM

When dealing with the benefits, as well as the challenges regarding VSM in TC, it is important to note that said results are "real" since the tool, concepts, methods and strategies surrounding VSM are either known or implemented in some way. These findings will be compared with the theoretical benefits, as well as the challenges found in the literature in order to find the gaps existing in the firm and get a deeper understanding of the firm's needs.

Central was identified as the plant that uses VSM the most. Some of the benefits directly related to the usage of the tool encompass the ability to establish a series of steps that allow the plants in general to accomplish the goals dictated by Central. At the same time, the utilization of the tool, as mention by PL1, allows for further identification of areas of opportunity when comparing the CSM against FSM; these are identified in the VSM literature by Abdulmaleka & Rajgopal (2006), as well as Singh et al., (2010) when they mention that VSM can be used not only to identify and reduce wastes, but can also be utilized to improve the performance of the areas involved in the analysis when detecting Mura, Muri and Muda, in both production and administrative processes. This goes in line with what was stated by PL1 saying that the tool allows the teams to define a set of benchmarks for upcoming projects; not only that, but it was praised by PL2 as a tool used for strategic planning. Even though the interviewees stated that there existed no culture of continuous performance improvement.

Another cited benefit by PL1 and PL2 is the fact that, VSM being a standard document, allows Centrals personnel visiting different plants to understand the processes and tasks being carried in said plants. It was also deemed the best tool up to date in order to understand how each plant works locally. One contradiction here however, is the existence of VSM silos created by local teams and projects. This, as cited by PL1 and PL2, causes several documents to exist and a disparity between the documents existing in the plant and the one that is presented to Central. Tyagi et al., (2014) mention that, when VSM is utilized correctly, it allows access to relevant, complete and correct amount of available knowledge, processes and operations, without the need for escalation, while this is partially true in the case of TC, due to the existence of standardized documents that allow several actors to understand the intricacies of the different plants. However, the fact that said documents show a different version of the truth to the same actors, defeats the purpose that Tyagi et al., (2014) mention as VSM knowledge sharing will improve efficiency and effectiveness of individuals and plants. In the case of TC, the time spent on standardizing the documents far surpasses the time saved trying to understand the peculiarities of the plants when reading the existing VSM documents.

The previous point is only worsened since, as mentioned by the interviewees, there is a general lack of knowledge and Lean background; to the point of having certain employees and groups that have never seen a VSM nor knows how to use or follow it. This inevitably causes the team and personnel in general to fail to realize the benefits the tool could bring; this also causes underutilization of the tool and personnel itself similar to eight waste of Lean. Even when not included in the traditional VSM literature, it was identified, as men-

tioned by Abdul et al., (2013), as sub utilization of potential capabilities. This is also linked to another problem mentioned by PL1 regarding the inability of the plants personnel to go from CSM to FSM; this was further proven by the fact that, the majority of the education comes from previous experiences and employers. These issues could be fixed by offering continuous training and education to the employees from TC's part; however, the general idea towards VSM is that it's hard to use and harder to implement tool. It yields very little results in comparison to the big amounts of effort required for it to work, as mentioned by TL. One of the biggest challenges that appears throughout the interviews is the fact that there is a strong "resistance to change" culture and a fear or repulsion to do the things in new ways; a change in the culture is first needed in order for TC to accept willingly and effectively the education required to fulfil the VSM goals successfully. It is a grinding and tedious process that requires both high amounts of energy and time (Hobbs, 2004). This goal will be impossible to accomplish if the top and mid management levels doesn't support the cause; as can be argued is with the case in TC. There is little to no involvement from middle and top management in certain plants regarding VSM projects, mainly as it seems due to that working on improvements has not been given enough priority and failure to see the benefits of working on them.

Abdulmaleka & Rajgopal (2006) point out that one of the biggest drawbacks of utilizing VSM is that the tool focuses on capturing the value of the mapped activities only holistically; this means that when a thorough analysis of the operations and tasks is required, VSM is deemed as a suboptimal tool to utilize; such is the case in TC, as mentioned by TM. It was pointed out that in some cases, it is not that the employees have no knowledge of the tool or that the tools is being used wrongly, but rather than the tool used is the wrong one. This is further exemplified when he mentions that some of the issues are already identified by the IE in turn or by the employees themselves; therefore, when utilizing the tool, the teams fall into a redundant and repetitive process that yields no new discoveries. Moreover, due to the holistic capabilities of VSM, some details and particularities of the processes in certain plants are lost.

Another challenge identified by the researcher that's not directly related to VSM, but certainly has some impact on the implementation and execution of VSM projects is the fact that there exist a lack of confidence from Central's part in regards to the existing VSM knowledge in other plants. This indirectly causes Central to take the leader and support role in regards to the projects. Chen *et al.,* (2010) touches upon the topic of difficulties having full time lean personnel in smaller firms or plants; also Rother & Shook (2009), mention that there is a need of someone with VSM experience in each plant in order to ensure success. By taking this points into consideration, the researchers observed that, the fact that Central takes on the role of leader, coupled with the fact that little to no training exist for the plant, leads to Central being unable to empower the plants' employees in order for them to not only take a leading role, but also take ownership of the VSM projects overall. This phenomenon causes a circle where Central will keep on being the leading role as long as no empowerment and education occurs and the knowledge is transferred to the plants' respective teams.

The previous point is worsened by the fact that the training material is available to only a selected population; moreover, most of the employees find it hard to grasp and understand the concepts due to the lack of relatable examples and concepts existing in the tire industry. On top of that, training occurs rarely and it's not consistent throughout all the analysed

plants. The fact that some personalization and customization of the material is needed hints towards the need of a TVSM.

5.3 TC's VSM Approach, a non – standard approach

In Table 3, the authors present a comparison that was derived from observations regarding the features that a TVSM should include in order to satisfy TC's needs and wishes, and a standard VSM that was found throughout a review of the literature.

	TC's VSM		Standard VSM
1	Need for improvement	**1**	Select a product of product family
2	Identify owner	**2**	Define the boundaries
3	Definition of scope	**3**	Walk the process
4	Collect KPI's	**4**	Identify processes and flows
5	Formulate team	**5**	Gather data
6	Arrange the project	**6**	Create the CSM
7	Gemba walk	**7**	Understand how the process currently operates
8	Identify process and its flows	**8**	Analyse current condition
9	Construct CSM	**9**	Identify value adding and waste
10	Construct FSM	**10**	Reconfigure processes to eliminate waste and maximize value
11	Analyse CSM	**11**	Create a FSM
12	Identify VA and NVA	**12**	Design a lean flow
13	Find improvement points	**13**	Develop and track action plans
14	Assign owners of improvement		
15	Develop timeline		
16	Follow up		
17	Comparison of KPI's		

Table 3 – Comparison of TC's TVSM and Standard VSM

Analysing TC's way of carrying on a VSM project, it can be seen that there exists a tendency to adapt and modify the standard practices, in order to have a better fit to the firm. Looking at step one between standard and TC's version, the first things noticed was differences of the initiation a VSM project. A standard approach goes directly into choosing a product or family that is to be improved. In TC's version, the need for change initiates

when there is a problem in production, not just for making an improvement project. If the assumption is made that even in the Standard version there is some underlying need for change before the project starts, their focuses differ greatly. While in Standard VSM training there is the emphasis on focusing on flows and improving the door-to-door function of the processes involved in the product family, in TC's version there is the focus of looking only at specific processes and most often also with specific purposes in mind, like decreasing scrap or to increase efficiency. This differs greatly from a standard VSM approach and it's mentioned by Rother & Shook (2009) that in the Standard VSM the norm is looking at more than one process at a time. Although viewing at the process level is not uncommon in standard VSM, it is albeit exclusive in TC's version. TC's TM stated that focusing on the entire flow makes little sense and bring little benefits if the purpose is not to increase overall throughput or de-bottlenecking. From this, the authors can derive that TC uses VSM's very differently from how it is originally taught. They have adapted a system they feel is of most benefit to them, seeing as the book examples are not fitting to their industry. This confirms the premise that the authors identified and established; the standard version of the VSM, in general, can't be fit entirely to the tire industry or to TC itself.

Looking further at Table 3, the TC's version steps 2-6 take place before the standard version even starts step 3, with the only thing in common being the definition of scope/boundaries. One interesting thing here, as seen in step 4 in TC's version, is the collection of KPI's like cycle times, setups, and downtime that are being gathered by the Standard version in step 5 which happens normally during the walking of the process. Through observation it was learnt that this is in order to keep the project going smoothly and not to waste time and complicate things during the walk collecting data that could have been collected beforehand.

Steps 7-13 in TC's version follow the same as in the Standard steps 3-13. What can be seen though is that in the standard step 13, the TC's version takes up steps 14-15 involving a more detailed project management steps of how to ensure that the steps are done and by whom. This concludes an overview of the steps comparison; however, with the help of observation, the authors also identified that more in depth information is wanted by TC especially in steps 10-13. These are similar in nature to standard VSM steps 8-12. As seen in the empirical findings there is an overall low VSM knowledge around sites other than Central; plant A as an example, and Plant B as the exception to the rule. Even though the steps are similar, the content of them differ. In Rother & Shook (2009, p.50) the way to reach a FSM is described as that the following eight questions should be answered: 1 – What is the Takt time? 2 – Will you build to a finished goods supermarket from which the customer pulls or directly shipping? 3 – Where can you use continuous flow processing? 4 – Where will you need to use supermarket pull systems? 5 – At what single point in the production chain will you schedule production? 6 – How will you level production mix? 7 – What increment of work will you consistently release? 8 – What process improvements will be necessary?

The following section will look more closely on the different questions and if and how they apply to TC. Question 1 is deemed unnecessary as Takt is not a focus, as mention in empirical, setup times and complicated processes makes this obsolete. Question 2 may apply to some extent, considering that the next process is viewed as a customer. Question 3 applies and should be strived for. Question 4 is similar to Question 2 in TC's case. Question 5 applies. Question 6 applies but is hindered somewhat due to machinery setups and mechanical processes and a note should be taken that Standard VSM teaches this to be done at the pacemaker process which not necessarily is the case with TC. Question 7 is similarly at-

tached to the pacemaker process in Standard VSM but applies also to TC even though most projects are only performed at a single process level. Question 8 applies without exception.

Out of the eight questions, six of them applies to TC's view, although it is arguable since question 5-7 applies to the pacemaker process indicates that they may not fit uncompromised. The problem lays in the way they are applied, the Standard VSM training gives some knowledge how to address each question respectively. However taking into consideration that the projects conducted at TC are time limited as well as knowledge limited, the steps are too complicated to learn and to achieve even if they apply. This leads to the researchers to conclude that, due to the particularities of the firm, such as knowledge level, training, experience, amongst other. On top of the firm's processes, the utilization of a non-standard VSM fits in a better manner to TC's needs. It was deducted that TC's could tailor surrounding/supporting areas, instead of tailoring the tool itself, in order to have more successful VSM projects.

The identified surrounding areas that can be tailored include, but are not limited to, training materials, actors such as: owners of the processes, leaders, initiators, VSM experts, the order in which steps are carried out, the scope and objectives of the VSM being used both in production and management areas and KPI's amongst others. In the case of TC, a focus on three major surrounding areas could be identified such as, the scope of the VSM, the definition and measurement of KPI's and the creation and utilization of training materials.

Due to the nature and characteristics of the industry, and particularly the firm, the scope of the VSM project will change depending on the actor that functions as an initiator. The fact that the different plants produce different components, as well as having differences in the machinery and processes to accomplish said production, leads to the scope of the VSM itself to be dynamic, in order to have a better fit in each and every one of the involved plants. Such situations were evident when analysing the empirical data gathered from the different plants involved in this study. The existence of similar products but specific procedures, as well as the existence of a difference in both training and knowledge, caused each plant to have a different scope of the VSM projects. Moreover, the standard VSM scope, as mentioned by Cudney et al., (2013), Martin & Osterling (2013) and Rother & Shook (2009), tends to be on the "door to door" approach, as well as encompassing the whole process. The methods utilized by TC differ greatly from what's dictated by the mentioned authors. This leads to concluding that this is one of the major areas where TC could benefit from the adaption of one of the areas surrounding VSM.

Another major area identified is the definition, as well as measurement of KPI's in the VSM projects being carried out at TC. According to the Standard VSM procedure and guidelines, the KPI's should be focused on reducing waste, as well as identifying and measuring VA and NVA activities and tasks. In TC's case, the definition and establishment of said KPI's stems from objectives stated by the initiator of the projects, instead of focusing on reducing waste related to VA and NVA activities. This is connected to what Ishiwata, (1991), Monden (1998), and Murman et al., (2002) define as VA, NVA and NNVA. TC's KPI's are more in line with what's valuable and important for the firm instead of focusing on what the Standard VSM dictates.

The last major area where tailoring can come into play as identified is the creation and utilization of training and education materials. As was found during observations and interviews, the lack of relatable information made VSM not only difficult to understand and ap-

ply, but sometimes impossible to visualize in TC's processes. The personalization of materials, as asked by TC, will allow the knowledge to create a cascade effect. This will allow the employees in general to close the gap between Central and the sites in regards to knowledge and training; not only that, but will make the training process easier and, overall, more efficient and effective. This is related to what Ishiwata (1991), Monden (1998), and Murman et al., (2002) define as valuable, the peculiarity here is that value is being perceived as a managerial measurement instead of a production measurement, as stated in the standard VSM literature by Cudney et al., (2013), Martin & Osterling (2013) and Rother & Shook (2009).

6 Conclusion and Suggestions for Further Research

6.1 Conclusion

Which are the benefits and challenges that arise when using a company TVSM, compared to a standard VSM?

Benefits: One of the most endorsed benefits the authors have seen is the increased ease of use in the making of a VSM project. A TVSM would ensure to reach a broader audience that possess low or no previous knowledge in VSM's enabling to still achieve high end result. The adapted training materials would help ease the resistance for change as the tool can be understood and applied to a scenario that employees are familiar with. This would increase empowerment not having to rely on other departments, sites or external firms in order to be able to perform a VSM project as well as increasing the initiative for change. The decreased learning curve would mean that the company would spend less time training personnel and in its stead increasing results as well as spending fewer resources. These results can then be shared across multiple sites due to its standardised methodology and company language furthering successful endeavours.

Challenges: The TVSM does not come without its problems. The first requirement needed in order to begin making a TVSM is first and foremost expert knowledge in the making of standard VSM's. To add to this comes also the requirement to possess in depth and extensive knowledge of the company processes as well as a clear understanding of the company culture. This hints at the fact that in order to be successful at TVSM the company already needs to be achieved in Standard VSM. Since such detailed and explicit knowledge is required it could be argued that external partners may not be beneficial.

This approach also require a bigger short term investment than a Standard approach in resources in the terms of that one already trained in Standard VSM then further needs increased knowledge in order to make a TVSM. Also just like a Standard approach to VSM projects, the knowledge and trainings needs to be kept updated, the TVSM in more detail than a standard as the company changes throughout the years whilst a Standard approach trainings is already existing through many established authors. This hints at that there is no benefit between the two in terms of upkeep, TVSM can also argued to require more resources over time to maintain as well as someone in charge who possesses and updates the knowledge, forcing the company to rely on a set of a few internal experts.

What are the reasons for TC to opt for a tailored approach instead of a standard approach? And how can these reasons be applied to other companies?

Making a TVSM requires some crucial prerequisites before it can be applied. First is that trained staff is needed who both possess expert knowledge in VSM as well as in the company. Secondly there needs to be urgency for change due to unfulfilled VSM projects that are being underutilized, whilst at the same time having full managerial support.

As for the reasons why TC should choose a TVSM, the authors can conclude that attaining the benefits displayed in the previous question are TC's main reasons. These come naturally since the research is based on its case and the findings stems directly from them. However, the main reason for TC is to avoid the costs related to implementing a standard VSM. Worth to highlight here is that one criteria stand out above the rest, that there has to be a

need for standardized work across multiple sites or departments for TVSM to be fully beneficial.

The valuable lesson is when trying to extend the reasons to other companies that might find themselves in the same situation as TC, as stated in the analysis part. It can be argued that said companies might find it beneficial to incur in a TVSM in order to avoid the costs of implementing a standard VSM; such costs include training and education expenses, hiring expenses, in the case that the company has no Sensei to fall back on and standardization of all documents existent in the firm amongst others. It might be very well understood as a company reengineering process, which will cost both time and resources that the company might not have. A good alternative would be to incur in the mentioned TVSM, choosing the parts of a Standard VSM that is deemed necessary in to reach stated goals by the company in question and tailoring it to its needs.

When is it appropriate and viable to adapt a VSM?

Implementing a tailored approach is viable, as identified, when there is an existence of different plant or different departments in which a knowledge/experience gap can be observed. Moreover, a firm that deals with a "developing lean practice", as is the case with TC, being a company that introduced lean and VSM recently in some plants, might find it useful to resort to a tailored approach instead of opting for an implementation of a standard VSM, which will force the firm to change the culture, practices and processes of the firm in order to comply with the standard methodology. The tailored approach could include changing the surrounding areas, as mentioned in the analysis. Another point to take into consideration when dealing with a tailored approach is the fact that, a company with a low level of knowledge, as in the case of TC when observing the fact that little to no VSM sensei exist in the firm, might benefit by the existence of tailored training material.

6.2 Suggestions for Further Research

A point to take into consideration is the fact that the research conducted was based on a single case study which is arguably not enough to draw solid conclusions that could be extended to other firms and other industries; it is therefore a suggestion to incur on similar researches in other industries in order to better understand the phenomenon of TVSM

Further research is needed in regards to TVSM and the creation of a new tool since in this research; the creation and implementation phases were not covered. A longitudinal time horizon; including the creation and implementation of said tool, is suggested since it will allow to observe the impact and evolution of the tool in a real case scenario.

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Appendix 1 – Interview Template

Participant (P): Date:

Interviewer (I): Duration:

Introduction
Before we start, I would like to tell you that, in order to protect your identity and keep the confidentiality that we agreed upon, names nor specific positions will be mentioned during the interview and will not appear in the written document. The interview is planned to last between 45 minutes to 1 hour and 15 minutes on average. Do you have any comments or questions before we start? (write down the comments on the comment are specified below) Shall we begin?

1. **How are you using VSM today?**
2. **Who owns the VSM?**
3. **Who initiates the VSM and why?**
4. **Have they any experience with VSM?**
5. **What are the issues with VSM on sites (if any)?**
6. **How long have you been using lean?**
7. **How often is the VSM used today?**
8. **Who is using them?**
    a. **On what level is VSM most often being used at? Why?**
9. **Is Central always the initiator of the VSM process?**
    a. **When does Central compared to local initiate?**
    b. **Is it always needed that Central functions as initiator?**
10. **What have been the issues with how VSM is used today?**
11. **Does anyone involved possess Lean knowledge/background?**
12. **How do you measure success?**
13. **Do you have any existing VSM training?**
14. **Who should be trained?**
15. **What is needed in the training today?**
16. **How often do people need to be involved in this training?**
17. **What is needed to have a company tailored VSM?**
    a. **How do you reach that point?**
    b. **What points should be considered?**
18. **How will the document be used in the future?**

Comments:

Appendix 2 – Theming and Coding

Participant (P): Project Leader A
Interviewer (I): Robert Lindhe-Rahr

Date: 02 – 03 - 2015
Duration: 45 minutes

Introduction
Before we start, I would like to tell you that, in order to protect your identity and keep the confidentiality that we agreed upon, names nor specific positions will be mentioned during the interview and will not appear in the written document. The interview is planned to last between 45 minutes to 1 hour and 15 minutes on average. Do you have any comments or questions before we start? (write down the comments on the comment are specified below) Shall we begin?

Interview	**Codes:**
I: How are you using VSM today?	
P: When I go to a plant, I (coming from the Central plant) don't necessarily know the inputs and outputs of said plants right away, I use VSM as a tool to map out their processes and create a picture of the current state, and then, with the future state team, we create a map for the next six months to support the plant, what are their needs and what are their goals. And then identify what is needed to accomplish those goals	**Identify current state** **Establish goals** **Identify needs**
I: Do you go to several plants and follow this method?	
P: Yes, the plants I visit are located worldwide and we try to apply the same methodology and methods to achieve the goals established by Central.	**Worldwide plants**
I: Are you considered the owner of the VSM regarding the creation and follow up of said VSM?	
P: Not really, I moderate the VSM and then show them how to use it, the owner of the VSM, the person in charge of creating and executing the VSM is dictated by the scope of the VSM. It can be the department.	**Methodology** **Roles/Actors**

(… The interview continues but this Appendix is just for illustrational purposes)

This colour identifies Challenges

Comments:

- Complete anonymity desired
- Willing to more interviews to "bounce" the topic
- Will give opinion based only on the participant plant