DESIGNING AND IMPLEMENTING LEAN OPERATIONS MANAGEMENT PROCESS IN SME´S: AN ACTION RESEARCH STUDY

JONIS MAHMUTLLARI

A dissertation submitted in part requirement for the
Master of Business Administration (MBA)

Adam Smith Business School
University of Glasgow
August
2018

Abstract

Lean operations management is a popular concept which is gaining more importance and usage over the last decades in SME´s. SME´s can take advantage of benefits that Lean philosophy can bring to improve their operation processes, helping them to create more value for their customers and maintain competitiveness. Despite many researches on the subject, the empirical researches in designing and implementing lean operations management processes are limited.

This study uses action research methodology to design and implement lean practices in a Finnish small organisation. The study introduces the key elements of lean operations management that can be used for operations process improvement. The findings of the research present the benefits of lean operations management practices and how these practices help in improving working practices in SME´s. The study finds that lean practices can have a positive effect in improving the operation management processes resulting in reduction of waste, elimination of critical issues, enhanced operation and improved working practices.

The results of this action research can be used by manager of SME´s when planning to improve their existing operation processes and create lean operations management. In addition, the study contributes to the knowledge of how to design and implement lean operation management processes.

Key words

Action research, lean operations management, lean methodologies, lean implementation in SME´s, 5S, lean six sigma, layout design, just-in-time, Kanban.

University of Glasgow | College of Social Sciences

Declaration of Originality Form

This form **must** be completed and signed and submitted with all assignments.

Please complete the information below (using BLOCK CAPITALS).

Name ..... JONIS MAHMUTLLARI .....
Student Number .....
Course Name ..... MBA (MASTER OF BUSINESS ADMINISTRATION) .....
Assignment Number/Name ..... MBA DISSERTATION .....

An extract from the University's Statement on Plagiarism is provided overleaf. Please read carefully THEN read and sign the declaration below.

I confirm that this assignment is my own work and that I have:

Read and understood the guidance on plagiarism in the Undergraduate Handbook, including the University of Glasgow Statement on Plagiarism	X
Clearly referenced, in both the text and the bibliography or references, all sources used in the work	X
Fully referenced (including page numbers) and used inverted commas for all text quoted from books, journals, web etc.	X
Provided the sources for all tables, figures, data etc. that are not my own work	X
Not made use of the work of any other student(s) past or present without acknowledgement	X
Not sought or used the services of any professional agencies to produce this work	X
In addition, I understand that any false claim in respect of this work will result in disciplinary action in accordance with University regulations	X

DECLARATION:

I am aware of and understand the University's policy on plagiarism and I certify that this assignment is my own work, except where indicated by referencing, and that I have followed the good academic practices noted above

Signed ..... JONIS MAHMUTLLARI .....

Ethical Approval Document

University of Glasgow | College of Social Sciences

Ethics Committee for Non Clinical Research Involving Human Subjects

NOTIFICATION OF ETHICS APPLICATION OUTCOME – UG and PGT Applications

Application Type: New *(select as appropriate)* **Application Number:** CSS/BS/PG/2017-18/006

Applicant's Name: Jonis Mahmutllari **Project Title:** DESIGNING & IMPLEMENTING OPERATIONS MANAGEMENT PROCESS IN SME´S: A CASE STUDY OF SOVELLUSMESTARIT OY

Date Application Reviewed: 14 June 2018

APPLICATION OUTCOME

(A) Approved Subject to Amendments (criteria below) ☐
(select from drop down as appropriate)

Adam Smith Business School Students to be recruited Select Option

If the applicant has been given approval subject to amendments this means they can proceed with their data collection with effect from the date of approval, however they should note the following applies to their application:

Approved Subject to Amendments without the need to submit amendments to the Supervisor	☐
Approved Subject to Amendments made to the satisfaction of the applicant's Supervisor	☒
Approved Subject to Amendments made to the satisfaction of the School Ethics Forum (SEF)	☐

The College Ethics Committee expects the applicant to act responsibly in addressing the recommended amendments.

(B) Application is Not Approved at this Time ☐

Select Option
(select from drop down as appropriate)

Please note the comments in the section below and provide further information where requested.

If you have been asked to resubmit your application in full then please send this to your local School Ethics Forum admin support staff.

Some resubmissions only need to be submitted to an applicant's supervisor. This will apply to essential items that an applicant must address prior to ethical approval being granted, however as the associated research ethics risks are considered to be low, consequently the applicant's response need only be reviewed and cleared by the applicant's supervisor before the research can properly begin. If any application is processed under this outcome the Supervisor will need to inform the School ethics admin support staff that the application has been re-submitted (and include the final outcome).

The following section is only for completion for applications that required amendments to go to SEF

(C) Select Option ☐
(select as appropriate)

This section only applies to applicants whose original application was approved but required amendments.

APPLICATION COMMENTS

Major Recommendations:

Minor Recommendations:

Participants cannot withdraw any time. For example, it is not possible to withdraw after the submission of the dissertation. Include a realistic date until which withdrawal is possible.

Full Approval Confirmation:

Ethics Application CSS/BS/PG/2017-18/006 - Fully Approved

B

Business School Ethics Application
Fri 15/06, 16:15
Jonis Mahmutllari; Paula Karlsson-Brown

Dear Jonis,

Ethics Application reference number: CSS/BS/PG/2017-18/006

Your supervisor has confirmed the appropriate amendments have been made for ethical approval.

Your application is now fully approved.

If you have any queries please do not hesitate to contact me.

Best wishes,
Business School Ethics Administrator

Acknowledgements

I would like to thank my supervisor Mrs Paula Karlsson-Brown for all her guidance and support she gave me during the entire period of planning and writing this dissertation. Her continuous prompt feedback and guidance made it possible for me to finalize this work on time.

I would also like to thank all my work colleagues for all the contribution and support they gave during this research. My colleagues were an important part of the research and have a significant contribution in findings and implementation of this action research. During this action research I consider them as "co-researchers" and the success of this research would not be possible without their dedication and support.

I must express my gratitude to my family and friends for all the encouragement, motivation and support I received during the time I wrote this dissertation as well as during my studies.

Finally, special thanks go to Mr. Mikko Rantanen for all his trust and support, giving me all the necessary resources and freedom to conduct an action research in his company and share my knowledge to improve his organisation. Moreover, I would also like to thank him for all support during my MBA studies, a support that made it possible for me to study at University of Glasgow and reach this far.

Table of Contents

Abbreviations

AR	Action Research
BMC	Business Model Canvas
DMAIC	Define, Measure, Analyse, Improve, Control´
ERP	Enterprise Resource Planning
JIT	Just in Time
KPI	Key Performance Indicator
LSS	Lean Six Sigma
MTO	Make to Order
PDCA	Plan, Do, Check, Act
SKU	Stock Keeping Unit
SLP	Systematic Layout Planning
SME	Small and Medium Enterprises
SS	Six Sigma
TPS	Toyota Production System
TQM	Total Quality Management
TOC	Theory of Constraints
WIP	Work in Progress

1 Introduction

Business is changing rapidly, globalisation has created many new opportunities for SME´s but also made the competition between businesses fiercer. Two of the most important contributors to competitive advantage are perceived as quality of products or services and the way a company creates value for its customers (Flynn et al., 1995). Flynn et al. (1995) advocate that if a company has a poor internal quality, failing to sort out defects before they reach the customer, it could result in a devastating effect on overall performance on the market. The created value for the customer and assurance of quality in products and services is directly connected with the operations and process management of a company. In all operations there is always room to make improvements, no matter how well they are designed or maintained (Slack et al., 2015).

A practical and popular approach used to develop manufacturing and operations and enable continuous improvement is to adopt and implement the lean philosophy. There are many studies advocating the benefits of lean in an organisation (Krafcik, 1988; Shingo and Dillon, 1989; Womack et al., 1990; Hines et al., 2011). Some of the benefits introduced by literature regarding implementation of lean approaches include; reducing waste, improving quality and delivery performance, increasing efficiency, increasing employee engagement, increasing customer satisfaction etc. Despite the many benefits lean offers many organisations face difficulties to design or implement lean especially in cases of SME´s, where resources are limited and often processes are complex (Achanga et al., 2006; Pearce et al., 2018).

However, the application of lean practices in SME´s has been a practice that has been around only for a short time and many important issues have been left untouched in scholarly work and business researches. From a brief research on the topic, it is evident that there are not many practical studies carried out regarding SME´s implementation of lean practices in improving their existing operations and processes. A study carried by Vamsi and Kodali (2014) concluded that there is a need of further research on practices organisation need to use to remove waste and create lean operations as there is a gap between literature and practice. Therefore, further research needs to be conducted to determine how a small organisation can adapt and implement lean practices to improve their operations process.

This study starts with literature review on lean operations management, looking at different lean operation management methodologies and how lean is implemented in SME´s. Further, lean processes are implemented in a Finnish small company using action research (AR) methodology, aiming to improve the existing operation and test the benefits of lean practices in SME´s. The distinctive characteristic of AR is that it addresses both, the task to bring change in an organisation and the ability to generate robust, actionable knowledge (Karlsson, 2016).

There is a growing incidence of managers participating in academic programmes and undertaking AR projects on their own organisation. In such cases the manager takes on the role of a researcher, and in addition to the regular organisational role the researcher can manage the project and study it simultaneously (Karlsson, 2016). The same case applies to this dissertation, were the researcher identified several issues in operation processes that needed to be improved in the organisation where the researcher has been working for over six years. Moreover, the researcher found that there is a gap between knowledge and practice on designing and implementing lean operation management practices in SME´s. Therefore, action research on this case organisation was found to be a perfect fit for a dissertation topic, aiming to give both theoretical and practical contribution.

1.1 Research Objectives

The focus of this dissertation is on designing and implementing the process of lean operations management in small and medium size organisations (SME´s). The objective of this research is to determine how SME's can design and implement lean practices to improve their operation process. During this research a small Finnish company[1] will be investigated.

The research questions that will be addressed in this study are two:

1- What are the key elements of lean operations management for operations process improvement?
2- How do lean operations management practices help in improving working practices in an SME?

[1]The action research case company is categorized under European SME´s (small and medium enterprises). SME´s are all companies with less than 250 employees and they are very important part of European economy as they represent 99 % of all businesses of the European Union. (Europa, 2018)

The researcher aims to address the first research question by conducting an extensive literature review defining the key elements of lean operations management and the available frameworks that practitioners and companies use to improve operation processes especially in SME´s.

The second research question will be answered by the empirical work that the researcher is undertaking during this study. Changes and improvements are made using action research (AR) methodology, giving the researcher the possibility to analyse and present the challenges, benefits and implications of applying lean operation practices within SME´s.

The research will give a direct academic contribution considering that literature from journals and presented practices from similar case studies will be adapted and validated by comparing the results of this study. Moreover, this study aims to fill the gap that exist on the practical implementation of lean methodology in SME´s with challenges, learning and suggestions which other SME´s could take into consideration before choosing the appropriate methodology to design and implement lean operations management.

Furthermore, the research has potential to affect directly the business performance of this case company, as it attempts to target and resolve issues that management has been facing for a long time. Using lean methodology, the researcher will educate the employees about lean practices and tools that are available to improve operations by reducing waste, eliminate errors and increase the value to customer. The direct contribution to the organisation also important considering that this is a practical development project therefore some positive results are expected at the end of this study.

To summarize, the result of this research would be significant as the number of SME´s that can consider using the findings of this research would be considerable.

1.2 Structure of the Study

Figure 1. outlines the structure of this dissertation. As shown on figure 1. the structure of this dissertation is slightly different from a traditional dissertation considering that action research was used as research methodology during this study and the structure has been adapted to support the research methodology. The study started with the introduction chapter where background information, research aims, and objectives and structure of the study are presented.

The second chapter focuses on review of lean operations management literature in the context of SME´s, presenting lean philosophy and lean tools that researcher is using to support the action research. Furthermore, the chapter describes briefly other available methodologies that are left out of scope during this study.

The third chapter presents the research approach and methods, research philosophy and research design. The chapter is followed by description of data collection process and ethical consideration.

Chapter four is focused on company overview and gives an introduction of the case company where action research is conducted. Moreover, a business analysis is conducted to create a better understanding on company's operations, strategy, business key activities and resources which are important during planning and implementation of lean processes.

The findings and analysis on this action research are divided into two chapters, number five and six; in chapter six the paper describes the research process and defines the issues found before the implementation of changes during the action research. In the next chapter the study presents the solution to the issues and describes the process of designing and implementing changes during the action research to improve the existing processes and create a lean operations management process. The decision to divide findings and analysis into two parts instead of using logical order and describe a solution after each issue is for practical reasons. The case company where this action research is conducted had several issues in existing operations process. All these issues need to be addressed simultaneously. Considering that some of the lean solutions and improvement methods target many issues at the same time, offering improvement in different areas of operations, the design and implementation of lean operations is described in a separate chapter. Moreover, further literature review will be integrated with the solution approaches and the reasoning for this approach is described in the beginning of the chapter.

After findings and analysis, in chapter seven the study will initially discuss the theoretical implications and later discuss the findings from a practical prospective. The final chapter will be the conclusion of the study, including research limitations, reflection on the process and implications for further research.

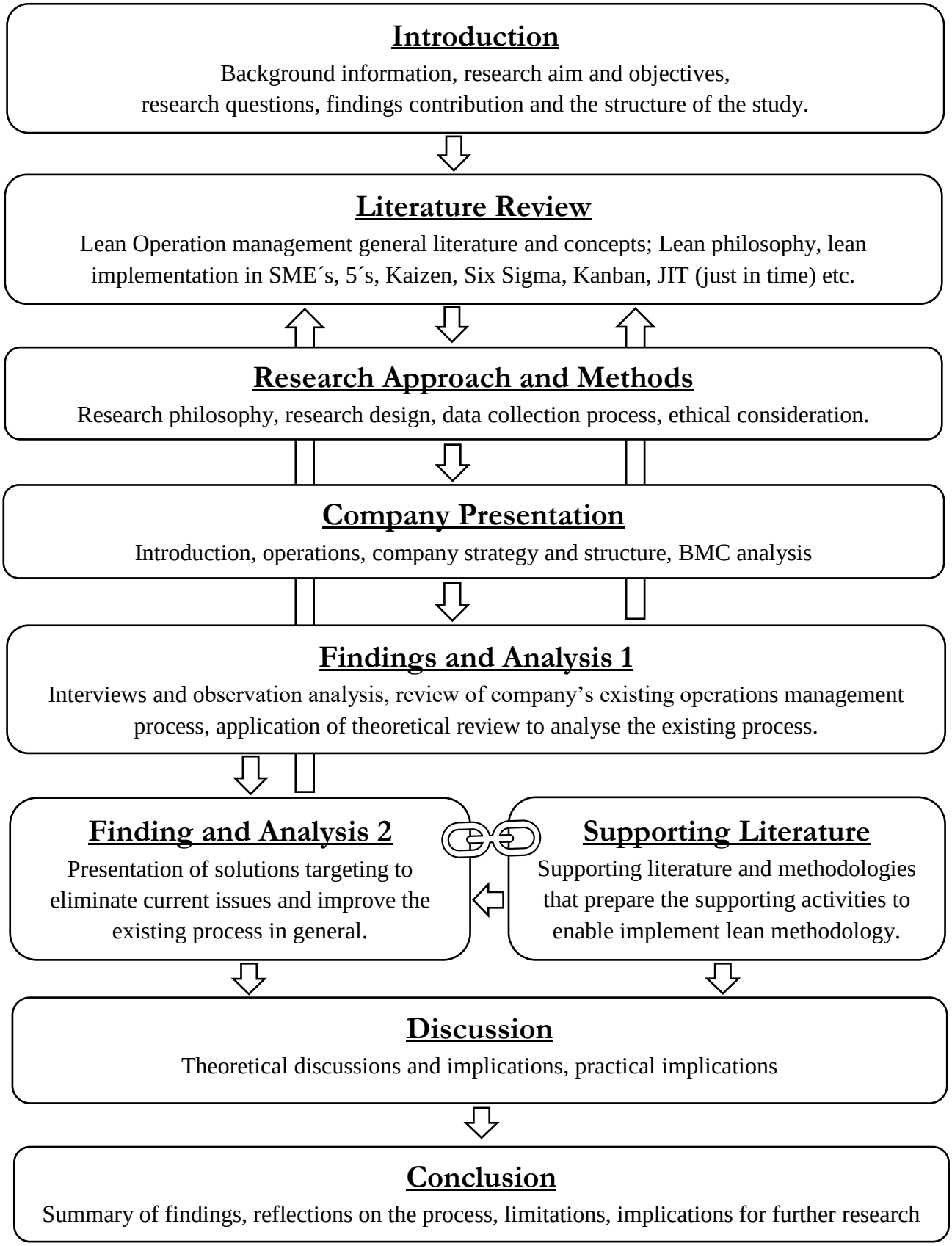


Figure 1. Structure of the study

2 Review of lean operations management literature in the context of SME´s

This section will review the literature related to lean operation management and the implementation of the methodologies in SME´s. Topics such as Lean Philosophy, Continuous improvement, 5s, Six Sigma and JIT and Kanban system will be initially introduced. Other available improvement methodologies will be discussed at the end of this chapter.

2.1 Lean Philosophy

"Lean" is a management approach which is used in many different industries and all sizes of companies including SME´s. It was firstly introduced by Toyota back in 1960´s as part of Toyota production system (TPS) and was later widely used through entire car manufacturing industry (Krafcik, 1988). The initial concept of lean had three main objectives; a) to enhance customer value, b) to eliminate waste and c) to reduce total costs (Womack et al., 1990). Hines et al., (2011) advocate that the main focus of lean is to create value for the customer. In lean philosophy the operation activities for the manufacturing process are classified in two groups; value added and non-value-added activities (Hailemariam, 2010; Melton, 2005). Non-value-added activities are all those actions or operations in the process that use time, resource and space but do not improve the production process or do not add value to the products which customer requires (Melton, 2005). The activities which do not add value for the product or the customer are considered as "waste". However often waste is an inseparable part of the process and cannot be removed completely, but in each process there is always space for improvement.

Three key areas that were introduced from TPS are used in lean to address waste; Muda (waste), Mura (unevenness) and Muri (overburden). Many often the failure of an organisation that implement but cannot sustain Lean is because they focus only in Muda (Hines et al., 2011). To address this issue Hienes et al. (2011) suggest that the practitioners of Lean should firstly understand what waste is and then they can focus in variability or unevenness. Originally, in the classical framework presented by many researchers, seven types of waste were introduced (Hines et al., 2011; Melton, 2005; Kučerová et al., 2015; Sternberg et al., 2013). Lately, some researchers have introduced "non-utilized talent" as the 8th waste type in lean (Kuori, 2011; Majava and Ojanperä, 2017). Figure 3. displays the "eight-waste" framework and is a visualisation combining all types "muda" that were introduced in lean literature.

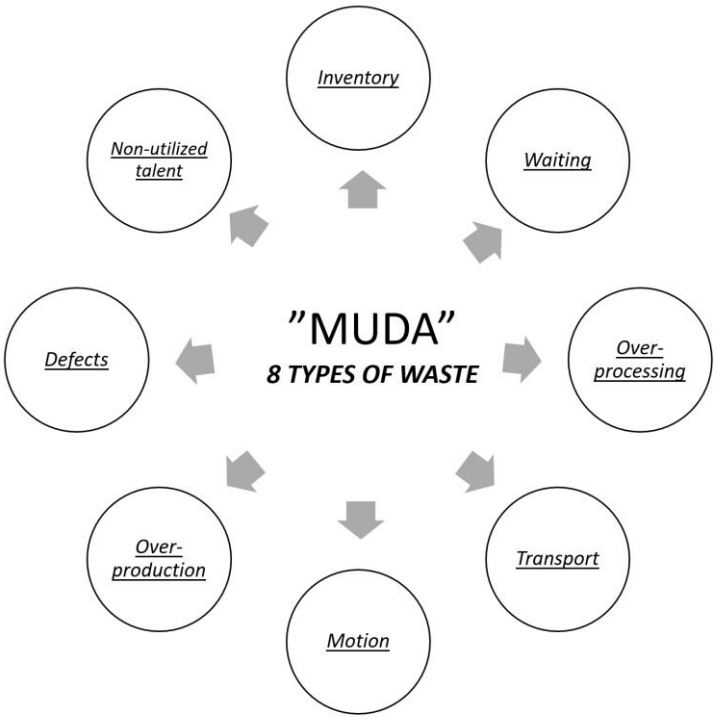


Figure 3. Eight types of waste, updated model (source: researchers´ visualisation)

Furthermore, in another study, Hines et al. (2004) argues that there exist two ways to increase customer value: a) *reduce waste* which can lead to lower cost of product or service and b) increase value adding activities while maintaining the cost of products or services unchanged. Hasle et al. (2008) reviewed 38 case studies from three different industries where lean concept was implemented. From the studied cases Hasle et al., advocate that different organisations implement lean differently, therefore the lean design and approaches can have different forms. These findings are supported further by Seppälä and Klemola (2004), who reviewed four larger organisations, concluded that the application of lean principles varied from one organisation to another and sometime differ even between different stages of the production system

2.2 Lean implementation in SME´s

Implementing lean in an SME, is easy considering that SME´s have typically simple structure and less complex systems, which can give more flexibility to change and to apply the knowledge within the organisation. (Singh et al., 2008). Moreover, Harrison (2006) advocates that when implemented correctly, lean manufacturing has proven to begin generating positive results almost immediately after implementation. Considering the time limitation during this study, but also the need of the organisation for immediate process improvement, implementing lean processes and techniques is the most feasible approach for this action research.

In lean literature is regularly presented that the management commitment is highly important when implementing lean practices. (Hines et al., 2011; Schmidt, 2011). Achanga et al. (2006) presented several critical factors that can determine the successful implementation the lean manufacturing concept within SMEs. The four most important factors presented in the research are; a.) management and leadership, b.) the organisational culture, c.) the company's skills and expertise and d.) financial capabilities.

Finally, implementing lean goes hand in hand with action research presented in chapter above. As seen in figure 4. (outer circle) lean processes are implemented in 5 stages (Melton, 2005) similarly mirroring action research which is the main methodology of this research. Melton advocates that lean approaches should be implemented in small steps. Furthermore, as the process improvements that are tested and validated during this research, the improvements are expected to continue giving results also in long term. Therefore, continuous improvement will be required by the organisation to maintain the effects of lean practices.

The continuous improvement can be achieved though "Kaizen" which is an effective process improvement methodology and the core of lean philosophy (Imai, 1986). Kaizen methodology was initially introduced in Japan after the world war II and has in its core the minimizing of waste and improvement of existing processes. Moreover, as recommended in lean processes, kaizen gives empowerment to the employees, involving them in designing, implementing and maintaining the improvements (Imai, 1986). Similarly, the kaizen process can be implemented via has 4 stage process PDCA (figure 4. inner circle) of implementation; *plan* (defining the issue), do (developing and implementing the changes), Check (compare the results) and Act (keep track of result and prepare next improvements).

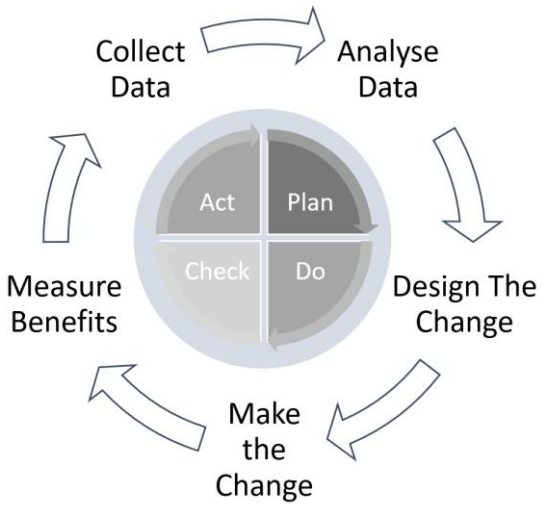


Figure 4. How to implement "lean" processes" in an SME (researchers´ visualisation)

However, it is also important to mention that there are also limitations and negative aspects mentioned in literature regarding lean implementation in SME's. For example, limited resources, include financial resources and employee capabilities. (Singh et al., 2008; Achanga et al., 2006). Alike all other productivity improvement initiatives, implementing lean is believed to be a difficult process (Denton and Hodgson, 1997; Melton, 2005). Furthermore, Melton et al., (2005) found three natural resistances that are common during implementation of change; a) Scepticism on efficiency of lean philosophy b) "we have already seen this" (p. 664), assuming that implementation of lean is just another improvement initiative, and c) lack of resources, people are "very busy" with daily tasks. Therefore, they argue that there need to be greater forces to support the application of lean. Another study from Belhadi et al., (2017) found that top five obstacles of lean implementation in SME´s are; lack of involvement from management, inadequate methodology, short-term vision, limited understanding of lean and fear or resistance to change.

2.3 5s as catalyser of lean

Another lean tool mentioned widely in literature and case studies is the *5s* methodology. *5s* is a simple yet powerful tool used to enhance system performance, reduce non-value-added processes through reduction of time, improve in product or service quality and increase productivity (Kiran, 2016). Typically, companies use 5s as lean tool as it aims to embed the values of the company, promoting neatness, clean space, standardisation and discipline. (Bayo-

Moriones et al., 2010). It originally comes from Japanese and is made of 5 components a) "seiri" *(sort)*, b) "seiton" *(set in order)*, c) "seiso*" (shine), d)* "seiketsu" *(standardize),* e) shitsuke *(sustain).* In *Figure 5.* a visualisation of 5s is presented, which provides the summarized actions to be taken in each pillar of the model and combines literature from Bayo-Moriones et al., (2010), Kiran (2016) and Omogbai and Salonitis (2017).

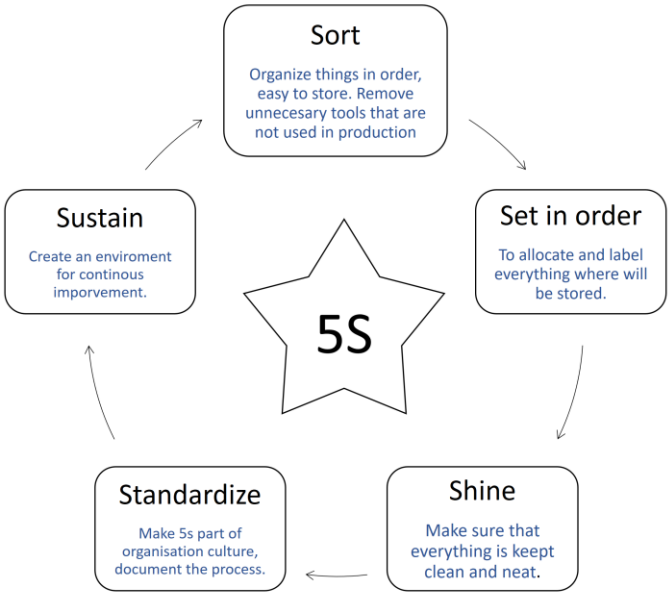


Figure 5. 5s methodology. (Source: researchers` visualisation based on literature review)

Considering the fact this research aims to improve the existing operations processes, the 5s would be a good fit as it is viewed as one of the most effective and widely used methodology in process improvement projects. (Bayo-Moriones et al., 2010; Omogbai and Salonitis 2017). Moreover, it is widely advocated that the implementation of 5s tends to give immediate results after implementation (Ho, 1998). 5s can also serve as a tool that increases knowledge in organisational level and encourages employees to learn how to reduce waste, improve working conditions, reduce in-process inventory and improve overall cost-effectiveness. (Gapp et al., 2008).

There is a concern regarding the low number of empirical studies which analyse the direct effects of 5s in manufacturing performance (Bayo-Moriones et al., 2010), however, aim of this research is to improve overall operations and not focusing only in improving manufacturing performance. Therefore, adapting and implementing this lean practice could be a feasible

option for this research. Given that literature suggests that this tool is simple (Ho, 1998; Gap et al., 2008), it is rather strange that few companies choose to implement it. Designing and implementing the changes is the easiest part but the most important and challenging part of 5S methodology is the implementation of 5th S *(shitsuke).* The success of this stage fully depends on the ability of the organisation to maintain the established lean procedures. (Bayo-Moriones et al 2010; Kiran 2016). Kiran (2016) argues that "sustaining" is the foundation of 5S, unless the discipline is not kept it shows that there is not commitment to 5S and without organisational commitment 5S and lean operations cannot be achieved.

2.4 Six sigma and Lean Six Sigma

Six Sigma (SS) is an improvement methodology that includes a series of methods and tools to manage variations that happen during a process, and that cause defects. The main goal of SS of SS methodology is to reduce defects down to 3.4 in a million (Harrison, 2006). In our case company the defects do not mean necessary tangible products, but we can use the concepts and techniques to eliminate process errors as well as service errors such as wrong product shipment or unnecessary delays in shipping products to the customers.

The methodology in which the SS uses to define the problem and reduce defects is called the DMAIC approach (Define, Measure, Analyse, Improve, and Control) and it is an evolved or more detailed version of PDCA cycle (Raisinghani et al., 2005; Dora and Gellynck, 2015) Some of the most used tools in SS methodology are; process mapping, Pareto chart, sampling and regression analysis etc. (Dora and Gellynck, 2015). Goh (2002) describes that SS is a "top-down" approach implemented by top management in project basis and yielding the results can take from few months to a year based on project type and length.

There is a strong debate weather a company should implement tools from Lean (reduce Muda) or implement tools from Six Sigma (reduce Mura). The suggestion is that both methods should be used or combined (Hines et al., 2011). Therefore, we can argue that Six Sigma is not a replacement methodology for Lean but rather a supportive methodology which can help in overall improvement of processes by eliminating waste while reducing errors. Moreover, a hybrid methodology named Lean Six Sigma is discussed in academic literature and case studies related to lean and SS. Lean Six Sigma (LSS) is rather a new concept which has been around only for the last two decades. LSS is a combination of Lean and Six Sigma approaches and

methods and is used to improve the business processes. (Antony et al., 2017). Tyler et al., (2015) advocate that LSS has found a wide usage globally in process improvement projects, with SS that focuses on the operation processes and Lean which focuses on the relationship between these processes. LSS is a methodology that is supported both by practitioners and scholars. A conceptual model for implementation of LSS was introduced by Pepper and Spedding (2010) which you can find in figure 6. of this research. The conceptual model is used to better understand the LSS implementation which will be an important concept in supporting the process improvements in our business case.

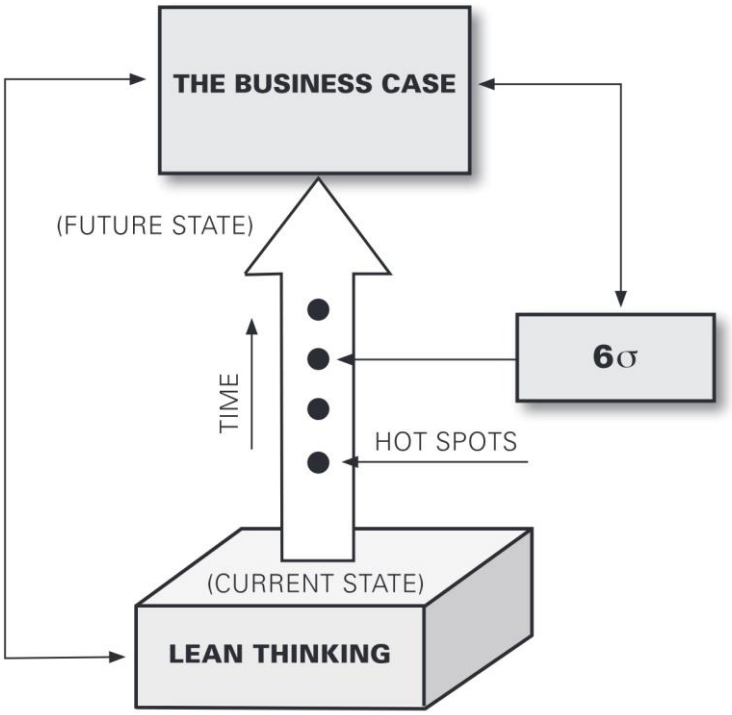


Figure 6. Conceptual model for implementation of LSS (Pepper & Spedding, 2010)

2.5 JIT approach and Kanban system

The case company is involved in both in make-to-order (MTO) and assembly-to-order(ATO) sectors where product orders are prepared or assembled after the customer places an order. According to Stevenson et al. (2005) a company that is offering MTO products and service has higher probability to choose inappropriate systems which often can be an expensive mistake. A popular approach used in MTO and ATO organisations and an important concept of Lean is the just-in-time (JIT) approach.

The JIT approach focuses in synchronising all production steps to run in same pace, reducing the need to have waiting time or buffering between the production steps. The effect of implementing JIT has been widely reported to be successfully reduce the manufacturing inventory (Harrod and Kanet, 2013) and reducing all other types of wastes (Brown and Mitchell, 1991). An important operational element of JIT approach is Kanban, which once again is originated from TPS and is an important part of JIT and Lean philosophy. Kanban is designed more as a manual system which uses employee capabilities to control each process by using a card system implemented in each phase of the system triggering a request for an action once one process is completed (Sugimori et al., 1977)

Kreig (2005) advocates that a company can fully profit from benefits of Kanban system if optimal configuration is determined and key performance measures such as inventory refill rates, inventory levels or product circulation frequency are determined. Moreover, organisational change plays an important role on the operational improvements and Kanban system alone cannot guarantee these improvements. Furthermore, Krieg describes different forms and implementations of Kanban control systems grouping them in three models; single stage, two stages and multi stage systems. This paper is not discussing in detail each Kanban system considering the research limitations, relevance of the information and the scope of this research.

To summarize, there are many tools, approaches and methodologies used in lean operations management which from the academic research prospective have been studied and presented periodically. Therefore, we focus only in tools and concepts that are relevant to our action research and directly support the implantation of planned changes in factory and process layout.

2.6 Sustaining the results of Lean approach

Hines et al., (2011) advocate that engagement of employees during a Lean implementation is very important in an organisation. Figure 7. describes the improvement performance journey over time highlighting the importance of culture change in sustaining the implantation of lean philosophy. According to Achanga et al. (2006) in SME´s the personality of the manager / owner is by default reflected in company's culture and this may lead to constrains in changes that may be undertaken during implementation of lean philosophy.

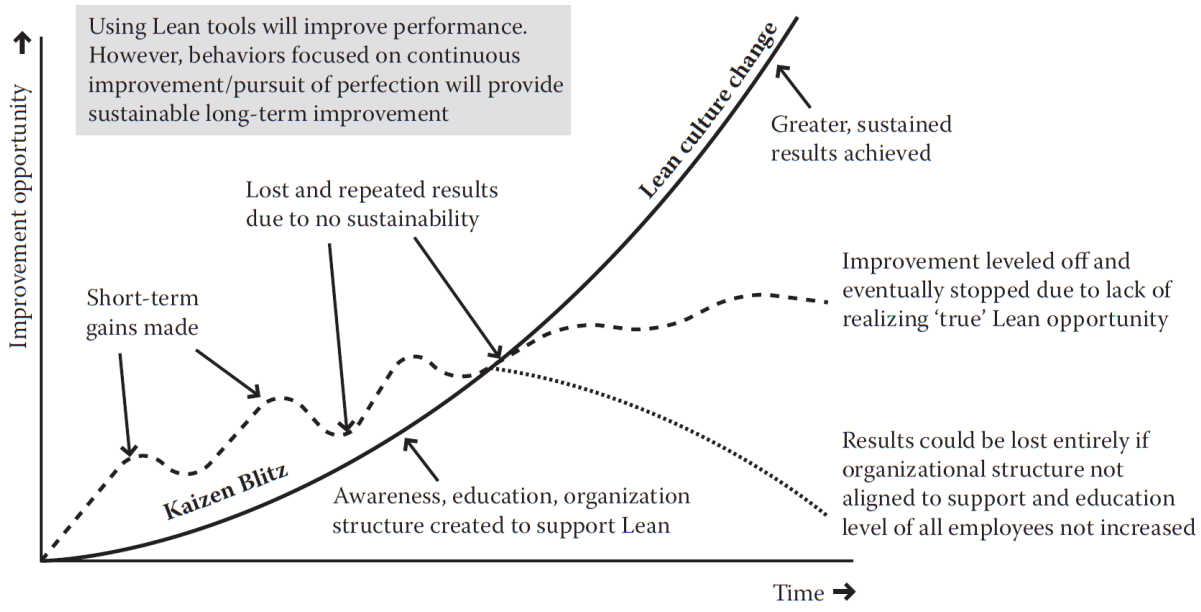


Figure 7. Improvement performance over time. (Hines et al., 2011)

As seen in figure 7. for short term gains "Kaizen Blitz" is used. According to Sheridan (1997) Kaizen Blitz is a shortened version of Kaizen, which can be implemented in one week on even two-three days targeting the improvement of one area or process. This fast action methodology is known to give very quick positive results. However, practitioners argue that the task is never really finalized but works mainly as intermediate approach to create better processes (Sheridan, 1997). Furthermore, the findings from Belhadi et al., (2017) suggest that need of management commitment, organisational training from an early stage of lean implementation, and allocation of required time and resources to allow change are very important factors that can determine the successful implementation of lean approaches in SME´s. Belhadi at al. found that key performance indicators (KPI´s) and measurement control are as much important practices that ensure the measurement of lean effectiveness and help in further improvement of existing

processes. Furthermore, Hines et al. (2011) argues that having the right tools, techniques, technology and process management is not enough to sustain a successful implementation of lean. Hines et al., have developed a model called "Lean Iceberg model" (see appendix A) where they advocate that most important factors that need to support lean are the leadership, strategy alignment and employee behaviour and engagement. Therefore, a close attention needs to be paid to these factors which are not visible during the practical implementation of lean philosophy.

2.7 Other improvement methodologies

The researcher is aware of other tools and methodologies such as TQM (Total Quality Management), TOC (Theory of Constraints), Balanced scorecard, ISO 9001 etc, however, considering the case company´s structure and processes, the research question and limitation of this research the above-mentioned methodologies are left out of scope. Although, it is important to mention that the company has planned to obtain ISO 9001 certification therefore the implementation of the system is also planned to be done by the organisation in the very near future. Furthermore, a decision has been made to use external resources to implement this process. However, it is important to mention that the lean practices are known to contribute in implementing and maintaining the quality standards required from in ISO 9001. For instance, a recent study conducted by Fonseca and Domingues (2018) in 308 companies that were ISO 9001 certified (95% of which SME´s) found that many organisations use continuous improvement methodologies (Lean, Kaizen, Six Sigma, JIT etc.,). The contributions of lean approaches are further supported by Chiarini (2011) who studied 107 companies around Europe and found that implementation of lean positively affects the quality of documentation, work instructions and procedures. Moreover, Chiarini found that tools such as 5s, lean metrics or value stream maps are used in these organisations from which some have been formalised to ISO 9001 documents. Therefore, it can be argued that the implementation of lean practices in this company can support the future processes and the long-term strategy of the company.

To summarize, there is a need to further study the implementation of lean in SME´s, especially in companies where no existing framework or structured processes are implemented. It is also important to investigate the factors that affect the implementation of lean as well as the role of management and employees on success or fail in implementing and maintaining lean practices in SME´s.

3 Research Approach and Methods

This chapter will introduce the research approach and methodology that this study is using to fulfil the research aim and objectives. The chapter is divided in four sections, starting with research philosophy, introducing the research design, describing the data collection process and finally discussing the ethical considerations.

3.1 Research Philosophy

In this research the researcher is taking a pragmatic approach. Goldkuhl (2012) advocates that pragmatism is a suitable approach for action research or design research. Pragmatism is an approach where action and change are involved, creating exchange between action and knowledge. This makes it very useful for researches where the researcher is not just observing the world but being part of the action and intervening on organisational change (Goldkuhl, 2012). Reason and Bradbury (2008) advocate that pragmatism unites the theory and praxis in a consolidated knowledge development process. The authors describe that two fundamental features are in core of pragmatism; a) the generation of knowledge through action and b) implementing participatory democracy and experimenting.

Furthermore, a pragmatic approach is considered beneficial for this research as it gives to the researcher more freedom to use different procedure, methods or techniques that are normally used in both qualitative and quantitative research. Moreover, the pragmatic approach encourages the researcher to use methods that are best suited to resolve the problem and not to focus in philosophical debates focusing on comparing which is most effective or the best approach.

3.2 Research Design

The research methodology the used in this dissertation is pragmatic action research. The initial definition, ‘action research’ is defined as a research method that enabled different theories created by social sciences to be practiced or applied in real organisations and tested based on their practical effectiveness. (Lewin, 1946). Furthermore, Waterman et al. (2001) describes action research (AR) as *“problem-focused, context specific and future-oriented”* (p.11).

Karlsson (2016) presents two types of accesses that are important to undertake AR; primary access and secondary access. The primary access is the ability of the researcher to get into operations and to agree with the organisation to undertake an action research. The secondary access is the possibility to have access to specific levels of activities and information or access to specific fields within the operations. The researcher has been working for over six years in the organisation where AR is conducted therefore both primary and secondary access is easy.

AR begins within a specific context and purpose and commences with a research question; however, the research focus may change while the research develops as the process goes through stages. Each stage of AR involves four stages starting with diagnosing the issue, moving to planning action, takin action and evaluating the effect of the action (see figure 2). This process is repeated by taking into consideration the previous circle which provides the direction for choosing the next stages (Saunders et al., 2012). AR differs from other type of research strategies as it uses different stages to explore, evaluate and trigger changes which can promote improvement in an organisation.

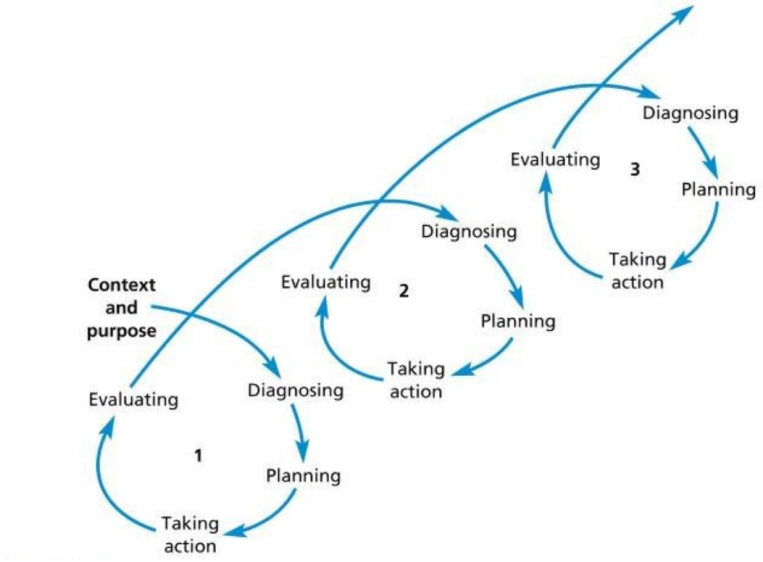


Figure 2. Action research cycles (Saunders et al,.2012; Reason & Bradbury 2008)

The most critical component of AR is participation. Greenwood and Levin (2007) present AR as a social process in which the researcher works closely with the organisation members to improve their situation and the organisation. Furthermore, is very important that organisation members cooperate with the researcher and allow the researcher to study their existing working practices and involvement of these members by being part of the research and support it by continuous collaboration in each cycle of action research (Greenwood and Levin, 2007). To comply with the principles of AR the researcher is making sure to have continuous

communication with all participants, explaining in detail not only the research objective but also passing base knowledge and capabilities to the participants.
Considering the willingness or immediate need of the organisation and employees to improve their current working processes, the implementation of AR is very viable for this study. Moreover, all participants have given full consent to participate in this research and they are crucial especially in diagnosing and implementation stage.

Other traditional research methodology such as qualitative research or quantitative research (see Saunders et al., 2012) were taken into consideration however, due to the nature of this study it was evaluated that the above methodologies would not support the research aim and objectives during this study. Mun et al. (2013) noted that traditional research methodologies normally take a passive approach to the research, analysing the collected data and drive conclusion in those data without influencing the outcome. Contrarily, AR uses an activist approach with the goal to take action that would result in change, and during this research achieving change is essential to obtain results and draw valid conclusions on the subject. Moreover, Reason & Bradbury (2008) argue that other methodologies used in social research tend to separate reflections from praxis therefore methods are segregated from application.

However, in support of the AR the researcher uses interviews in form of open ended questionnaires which would be categorized under qualitative research. Qualitative research is used when expectations are unknown, and the researcher needs to define the problem or to develop an approach to the problem. Comparing to the quantitative research, the qualitative research goes into the core of the issues and the researcher can gather more detailed information (Silverman 2005). To further support this methodology, Kemmis (1988) describes that action research has been seen more as a form of inquiry that used "qualitative research methods" rather than "quantitative research methods", that are focused more in the prospective of the actors or participants.

An important factor which was considered during this AR is the language constrains, as the case company is Finnish and conducting the study is made in English. Karlsson (2018) during a cross natural research found that conducting a research in a language other than native can be an issue during a study therefore the researcher need to consider the language barrier. Karlsson argues that business language is not necessarily same as the language used in daily

communication and transferring the academic language to a practical context can be a challenge.

Moreover, the researcher is not native-Finn and language communication in Finnish is limited, therefore the direct communication with participants of this research is done in English. However, it is important to mention that every participant during this AR has good understanding of English language and can communicate with the researcher without the need for a translator. Moreover, it is important to note that the two key supporters of this research (see table 1, participant 2 and participant 3) are native Finnish speakers and have good level of English, including academic language. Therefore, to avoid any language misunderstanding or loss in information, during the interviews with the employees many concepts and problems or issues are discussed in native language with the support of the above-mentioned participants acting as translators or conveyors if complex information is provided.

3.3 Data collection process

The data collection method which will be followed on this research is divided into two parts; "primary data" collection and "secondary data" collection.

The primary data collection includes academic theories and business cases related to lean operation management which the researcher will use to understand in depth the operations management process and find practices used by organisations to build lean operations. The author uses different reliable sources for such as books, journals, online articles and other internet reliable sources to introduce the lean management approaches or models. Some of the main key topics to be discussed are; Lean philosophy, 5´s, Kaizen (continuous improvement), Six Sigma, Kanban, JIT (just in time), layout design and inventory management.

The primary data is gathered by the researcher participating in daily work within the organisation. In addition, a qualitative research involving all research participants is conducted. The reason why the initial plan is to conduct qualitative research is because the existing issues were not clearly defined, and a qualitative research offers the possibility to go deeper into the topic and gather more detailed information regarding the company's current issues and future expectation. The reliability of the data is more significant when precise information is retrieved from in depth interviews combined with daily observation. As stated above, the role of research

participants is very important in the quality and relevance of this dissertation. The researcher shares information and evaluate the process together with the company's managers and key employees involved in the process. The involvement of all participants is necessary to get the best result when analysing the existing process, finding the key issues that need improvement and design the key actions that need to be taken to improve existing processes and achieve lean operations in the company.

Another important part of data collection is the participation of the researcher in each stage of the process where main issues are defined. This required short training or workshops from the organisation to educate the researcher with in-depth knowledge of current practices such as information sharing systems (ERP; Cloud system, email etc.), product stock and inventory system, process management, production planning etc. The gained knowledge is very important for the reliability and validity of the research but also for the researcher to understand better the operation management process in SME´s and use the learnings from the MBA programme to put the theoretical learnings into practice.

3.4 Ethical consideration

This research does not involve any sensitive topic and none of the research participants are subject to the potential risks. Moreover, the researcher is not using any methodology in which research participants personal data would be registered or disclosed. The research is focused on the business process and the researcher being employee of the company and active participant in the process focuses only on the procedures related to daily tasks. The risk is the relationship that the participants and the researcher have created while being work colleagues can interfere in application of this action research. However, the process involves all participants equally and researcher is not acting as manager but as "co-researcher", therefore future relationship has bene taken into consideration when conducting this research.

Most participants on the research do not need time commitment as the research was carried out during the normal working activities and the researcher only observes the processes that influence the participants' tasks and performance. All potential interviews with the participants were collected in form of open conversation during the process or planned interview meetings as part of organisation development process.

The research could also be beneficial for the research participants as the aim of this research is to develop new practices within the organisation that improve the employee performance and remove processes that may influence the wellbeing of the employees. The researcher would argue that it is beneficial for the employees to assist in the research as this study aims to improve their daily work. Moreover, the outcome of the research can help the organisation to increase productivity which would benefit not only the employees and the organisation but also the wider community.

There is no risk that the research would create any issue to the participants as the participants are familiar with the researcher and the researcher has the necessary information that would avoid any misunderstanding or create any issue with the people participating during the action research. Moreover, to each participant a consent form and plain language statement was given prior to the research start, giving the possibility to each of the participants to withdraw from the research at any time during this action research. Therefore, the participation in this research is voluntary and confidentiality and personal data protection is guaranteed during and after the timeframe of this research.

4 Company description and business analysis

Sovellusmestarit Oy is a Finnish company, offering contract manufacturer services for various industries (mainly oil and gas, pulp and paper, marine and offshore and mechanical engineering). The fast-growing company specializes in the fields of compressed air, instrumentation, and flow technology. In addition, the company is involved in trading products related to their core business. Effective operations are very significant for company´s success and an improvement in the existing processes could be vital for the company's future potential growth. During this research all employees involved directly with company operations have agreed to participate or to be observed during this action research. Table 1. shows each participant and their current role within the organisation. The researcher has been working for the company for the several years and has a deep knowledge in the company's current operations and business structure. Moreover, all employee levels from owner / manager of the company to the junior employees are voluntarily participating in this action research. The only employees that were not asked to participate in this study were the employees that are not involved directly on the operation processes of the organisation or participants that are not present in the organisation during the time this research is conducted.

Table 1. The research participants and their role in the organisation

Participants	Role
Participant 1	Sale Manager / Researcher
Participant 2	General manager / Owner
Participant 3	Production Manager
Participant 4	Product Manager
Participant 5	Senior employee / Assembler
Participant 6	Senior employee / Assembler
Participant 7	Senior employee / Order processing
Participant 8	Junior employee / Assembler
Participant 9	Junior employee / Assistant
Participant 10	Junior employee / Assistant
Participant 11	Junior employee / Assembler

The business model of Sovellusmestarit Oy has been mapped on Business Model Canvas (BMC) on figure 8. which is a well-known and widely used management tool used to visualise

the company's customer segments and relationship, value proposition, key resources and activities, partners, cost structure and revenue stream (Osterwalder and Pigneur, 2010). Osterwalder, et al. 2010 describe a business model as "the rationale of how an organization creates, delivers, and captures value" (p.14).

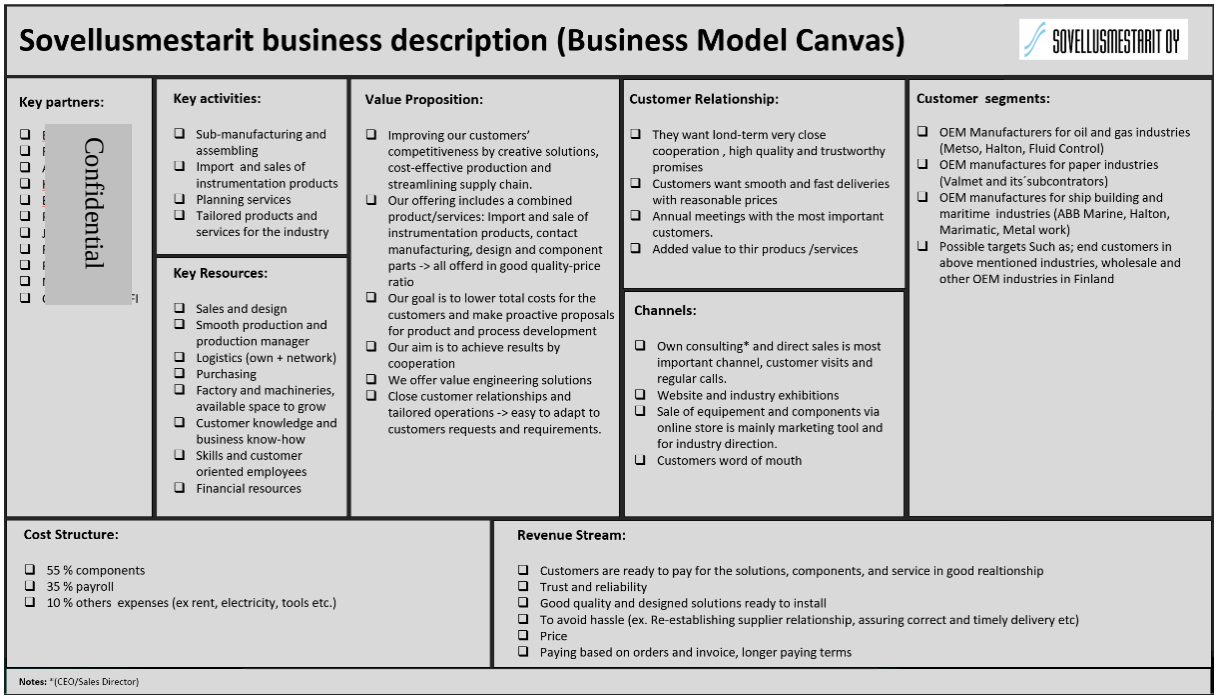


Figure 8. Company business description[2] using the BMC framework

The business model is a concept that has emerged recently and is relevant to operations strategy. Some may view the business model as widely analogous to the business strategy, but business model gives more of an idea on how the intended strategy should be achieved as well as define what the company strategy should be (Slack et al., 2015).

The business model canvas it is important for this study as it supports the research process during the analysis of operations as well as designing and implementing changes during the action research. It is important to be consistent and relate every possible change or recommendation to company's business strategy while taking into consideration the resources and capabilities of the company to implement change. Moreover, other elements such as cost structure and value proposition can help the researcher in defining the areas where the company can reduce cost via waste reduction while maintaining or adding value to customer.

[2] The business model canvas was designed together with company´s management

5 Findings and analysis 1: The organisation before action research changes

The company has already established operation processes and these processes are designed with the aim of having a smooth manufacturing and processing customer orders efficiently. It is also important to mention that manufacturing is based on customer specifications therefore custom manufacturing techniques are currently used. This chapters describes the action research process, the company´s existing operations processes and further analyse the challenges the company is facing in its daily operations.

5.1 Action research process

This action research process started on June 15th 2018 and was finalized on August 17th 2018. A total period of nine weeks was assigned to conduct the action research after the ethical approval was confirmed. However, it is difficult to separate the period when data collection started before the ethical approval, given the knowledge the researcher has of organisation as being an employee of the company for over six years. Furthermore, the review of wide literature on operations management and lean philosophy started three weeks prior to the ethical approval, in order to have a better understanding on the topic.

As seen in figure 9. this study is following action research methodology and is divided in three phases during a total of nine weeks.

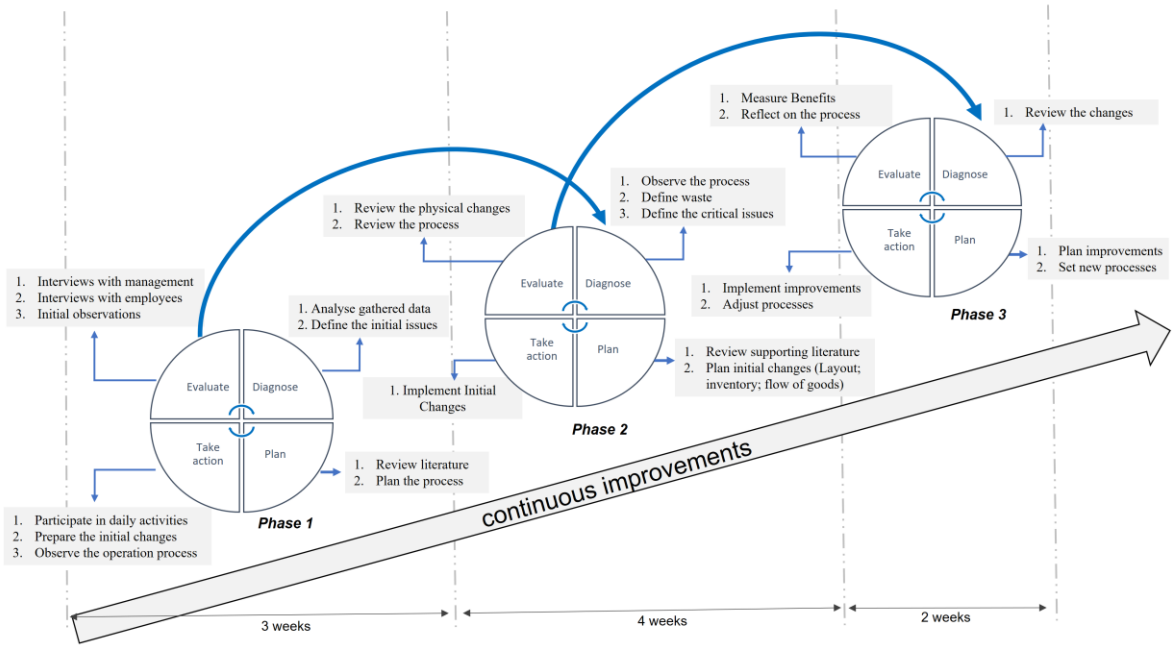


Figure 9. The action research process and timeframe

The first phase is conducted in three weeks, initially gathering data from interviews with research participants and observation of existing processes. The data then is analysed, and the initial issues that the research needed to evaluate further are defined. Simultaneously, the researcher reviews the literature on lean operations management focusing on literature that would support the improvement of defined issues. The action research and initial areas to be focused are next planned. The researcher assisted the company in daily activities to gain a better practical knowledge on all operation process management and to prepare in small steps the space for implementation of the first changes. Finally, conclusions on readiness and capability of company to implement the change are confirmed and next the research moves to the second phase.

The second phase is the longest and most intensive phase were the researcher defines all the issues found in the case company and further finds and analyses the most critical issues on the existing operations. In the next step detailed planning and allocation of resources is made and physical changes are made daily in three main areas; a) layout change, b) inventory management and c) flow of incoming / outgoing goods. Once the changes are made the process is evaluated to find out how the existing processes fit to the newly implemented physical changes and improvements and how these changes can be improved further.

The third and last phase is two weeks and starts with the review of the changes made in phase one, planning further improvements where applicable, and setting up supporting processes (or adjust existing processes) to sustain the improvements in the improved areas where further improvements are not required. Finally, the benefits are measured and recommendation for further improvements are made. It is important to note that the continuous improvement continues beyond this research considering that other processes need to be improved in order to achieve lean operations management. Moreover, employee training and "continuous improvement culture" is sent in the organisation.

5.2 Analysing current processes

The analysis of current situation started by observing the case company´s operations and daily activities as part of the researchers´ day to day work[3]. During this action research, the researcher went a step further by assisting in some of the daily activities to better understand the existing practices and experience the challenges the organisation is facing in daily basis. Moreover, continuous reporting of current issues, were brought by company owner or production manager with examples of errors or problems that needed to be resolved. During the observations a value stream map describing the operation process was created. The operations process of the company has been

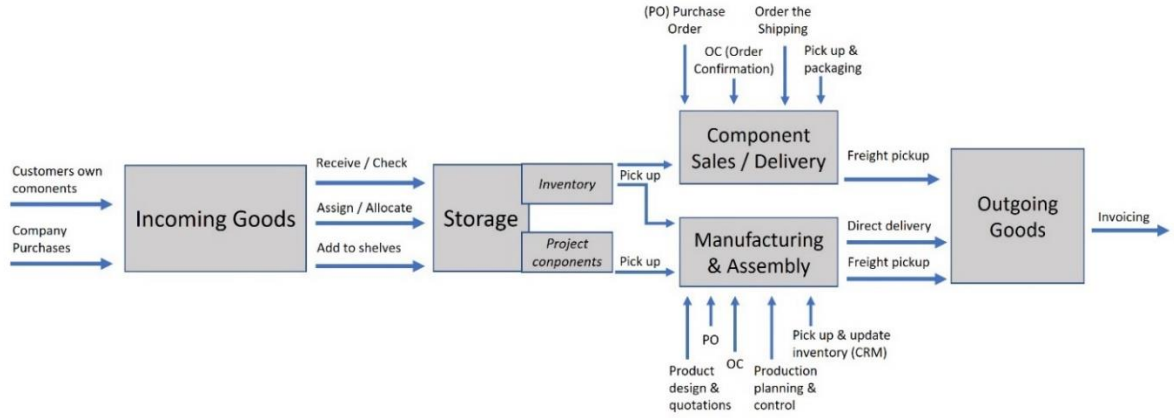


Figure 10. The overview of company's operation as process flow diagram

The operation process includes four main processes starting from the incoming of products, storage of goods in the factory, sales of components or manufacturing by order and is finalised

[3] As stated previously the researcher works for the company as Sales Manager but often involved in other activities including marketing, manufacturing, company development, planning etc.

with the delivery of goods to the customer. Each process is supported by "sub-processes" or activities that are very important in completing the entire operations process. The operations process has been mapped firstly by daily observation the company operations, secondly gathering information from interviews with employees and company middle management and thirdly reviewing the finalised map with company's managers to assure that there is no gap in the designed value stream.

Incoming goods

The incoming goods come from two different sources; a) the deliveries made by suppliers after company purchases products based on project requirements and maintenance of the inventory and b) project components that are supplied directly from the customer for assembly work. All the deliveries arrive at incoming/outgoing goods area where they wait to be assigned to the final destination. All incoming goods must be confirmed and approved, except project components arriving directly from the customers for assembly work. It is important to mention that with the current factory layout incoming and outgoing goods area is not separated and all activities are done in same area (see figure 11).

Figure 11. Existing situation incoming/outgoing area

Storage of goods

With the current system the arriving goods are divided into different categories and stored in different shelf locations situated in different areas of the factory (see figure 14).

1. The first category are goods coming weekly from main customers in MTO projects. Majority of these products are picked up from the company and arrive always in standard pallets and do not need to be checked or inspected. Other products are delivered by the customer directly.

2. Second category are all purchases company makes for MTO projects or daily operations. These products are usually allocated to the final destination only after they are checked and accepted in accordance with PO and packing list. There is no pre-allocated space for this products and deliveries are made in daily basis.

3. Third category are all products that the company keeps in stock. These products go through same procedures as second category. The difference is that for this category of products, only few products have a reserved shelf allocation. Moreover, often the stock quantity is large, and space is limited, or allocation of products is not done correctly.

Assembly and manufacturing

Assembly and manufacturing is fully manual and tailored MTO production process. The components which are used for this process come partly from the customers and partly from second and third category of products described above.

5.3 Defining the waste

Based on daily observations, interviews with the research participants and the analysis of the current existing processes this research identified several types of waste which are presented in Table 2. The waste was categorized in eight different groups as introduced in the literature review frameworks (e.g. Hines et al., 2011; Melton, 2005; Kuori, 2011).

Table 2. The eight types of waste defined during the initial situation analysis

Issue	Waste Type	Effects
1. Stock placed in wrong locations 2. Stock not marked properly	*Inventory*	Difficulty on finding and picking up the products, wrong product deliveries.
3. High amount of work in progress (WIP) 4. No backup for important processes	*Waiting*	No time for assigned employee to organize inventory, check incoming goods and process pending orders.
5. Receiving products in workshop only when needed from untrained employees. 6. Time keeping – machine does not have the necessary features.	*Over-processing*	Using time and resources consumption inefficiently, errors when updating inventory, mix up or disruption of the system. Production manager has to make hour calculations manually using working hours.
7. The existing layout design does not support the manufacturing and assembly flow. 8. Difficulty in finding tools and products.	*Transport and Motion*	Unnecessary transport of incoming goods during WIP, pile of goods in assembly area, limitation in employee motion, continuous movement of goods from one table to another, safety issues.
9. Shelf allocation of several products is separate from main storage space 10. Too many assemblers are working in limited space	*Motion*	Extra time for employees to pick up the goods, difficulty in finding correct products. Difficulty in movement of people and goods, slowdown of assembly process, safety issues.
11. There are many "low-sale" products in main inventory shelves. 12. Small deliveries allowance	*Over-production (as inventory)*	Utilizing shelf space, low profit margin. Production cost is higher than sales price = loss.
13. Wrong information from supplier / customer 14. Insufficient employee training	*Defects*	Returns, extra time for reworks, extra delivery cost
15. No professional development plan exists 16. Employees involvement in planning is low	*Non-utilized talent*	Decrease in motivation, lack of improvement suggestions (continuous improvement), difficulty in employee retention.

As it can be seen from the table 2. the issues can be found in all types of activities that are related with layout design (1,7,8,9,10), inventory management (1,2,5,9,11,12), manufacturing process (3,4, 5,10, 14), supply chain management (13), inappropriate equipment (6) and human resource management (14, 15, 16). It was found that several issues are caused from combined activities, for example the first issue (1) where stock is placed in wrong locations is caused both from layout design and the wrong inventory management system. However, due to the large number of issues and due to time limitations of this research the study will firstly focus

initially defining and improving the most critical issues that require immediate attention. This will also support the suggestions from literature where Melton (2005) advocates that optimal solution implement lean would be to make the improvements in small steps. However, a significant number of issues presented in table 2. will be improved during this action research as many lean practices effect many issues simuntaniously. The next section will present the critical issue found during further during this study.

5.4 Defining the most critical issues

During the initial three weeks of observation and after the interviews with all participants, on the start of phase two the most critical issues that disrupt the current operations were defined. Three critical issues that required immediate attention were found; inventory management, receiving of incoming goods and fulfilling the delivery time. These issues are presented and analysed in the sections below.

5.4.1 Critical issue 1: Inventory management

The first serious issue was found in the processing of purchase orders for several products especially "pressure gauges". Firstly, the product pick-up process takes too long time and many errors are done during the process. This often results in wrong delivery and customer complaint which as result leads in *financial loss* and *damaging the company reputation and customer relationship*. By investigating the route of issues that caused this difficulty, several factors were found;

1) Stock allocation is done wrong and the products were stored in several different locations with no structured labelling or coding. Moreover, one of storage rooms used for current storage of pressure gauges, had no right arrangement to be an inventory room (as it was in the condition during the research), with little space to move and much waste on the way (see appendix B, "before lean implementation").

2) There is a mix of two different product types (NPT and BSPT) which from appearance look the same creating potential for human error.

3) Products were not correctly listed in ERP system and were located in distance and separately from other stock items, creating a walking distance for the employees to pick up the goods therefore "*creating unnecessary waste"* which does not add any value to the customer.

Furthermore, similar issues at a lower level can be found on inventory management for other products in a different section. However, in this section, the inventory is more organized as improvement practices with proper product allocation and description have been attempted earlier. Therefore, the issues are minor. Furthermore, during past two years the process has been disrupted and a new intervention in restoring the process is required.

5.4.2 Critical issue 2: Receiving the incoming goods

Receiving the incoming goods and inspecting these goods is a process that is not fully aligned with other activities of operations process. Even there is an agreement that each delivery needs to be opened, inspected and allocated to a specific location the process is not smooth. During the process investigation it was found that often the packages were not open for several days after receiving them and in some cases causing late delivery to the customer who is waiting for delivery of the same goods. Moreover, the received goods were found in several locations on the floor interfering with the daily activities as well as creating potential hazards for the employees or visiting customers. The main factors found to be causing these issues were;

1) The process has been assigned to only one employees who is in charge for many other processes at the same time including production planning, purchasing, packaging and delivering the goods. The diversity of tasks and sometime high workload and urgent deliveries required by customers, creates *human errors* and no time for the products to be checked and allocated to their shelves.

2) The products are left in several places, often in the floor of manufacturing area making them "easy to forget". No shelf space is assigned for incoming goods and no track is kept on the delivery date of the goods.

3) Other employees are not trained to fulfil the process even it is a simple process. This creates a gap when main person in charge is in holiday or sick leave, creating

confusion or a situation where there is “no one’s responsibility” to pick up and inspect the incoming goods, therefore process disruptions happen often.

5.4.3 Critical issue 3: Maintaining the delivery time

Delivery date is often different from order acknowledgment. An initial investigation found that the root of the problem starts from the initial offer which according to company management “often it is too optimistic” or is not aligned with production planning and available resources. Further research found that other issues which need to be considered exist;

1) An issue was found with information sharing system and communication flow between sales, engineering, production planning and manufacturing. Considering that company is small, direct communication or email was used to confirm and process each order. However very often in the communication chain many messages or information was not shared with all involved employees, creating situations where order processing was neglected or forgotten, creating delays. For instance, in documented example case X when a late delivery was confirmed, it was found that customer has asked for an early delivery which it was confirmed but production manager was not informed for the change therefore production plan was not updated.

2) The calculated working hours for a given product are based on estimating the man hours required to produce the goods and number of available workforce. Other factors that need to included have not been given the right importance when making order acknowledgment. Such factors include; a) unplanned absence of employees due to illness, b) all employees work in different phase and speed and most of work is manual work c) there is a large amount of work in progress (WIP) and employees work in several projects simultaneously d) some employees do not have necessary skills, knowledge or training to assist in projects, e) direct component purchases and order processing can interfere with production planning and assembly work.

Other issues concerned with manufacturing space and layout, ergonomics at work, access to the ERP were defined and recorder, however due to time and space limitations of this research they will be studied in second stage through research continuation[4].

To summarize the issues found during process observation in figure 12. the sub processes that create disruptions and as result need immediate improvements have been marked in red.

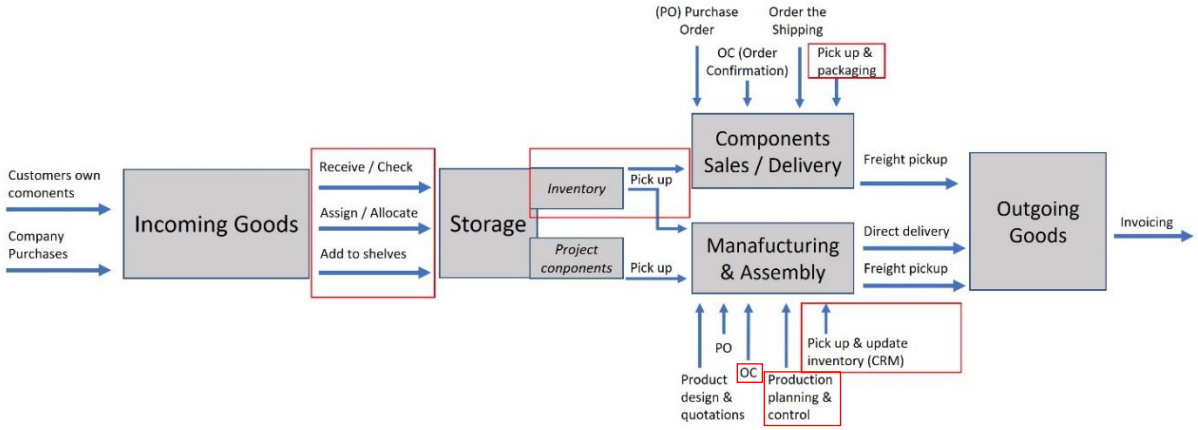


Figure 12. Defined critical issues in company's operation process

As it can be seen on figure 12. in the value stream the major issues are currently after the good have arrived in the factory and are affected by inappropriate process design, high amount of WIP and poor management of time and resources. Moreover, layout design and tolerant procedures contribute in accumulation of issues and continuous creation of waste.

[4] The researcher plans to continue the research to a second stage and expand the study to other areas of improvement

6 Findings and analysis 2: Design and implementation of lean operations

This chapter will introduce with solution approaches which the researcher is introducing to the organisation after defining the waste and critical issues. A combination of lean tools (defining MUDA) and DMAIC approach was used to define the current issues and offer feasible solutions. It is important to mention that the engagement with key literature continues further during this chapter. The reason why this method is used is due to the nature of the research and the type of the issues that were found in the organisation after the initial analysing phase.
For instance, issues in current layout design and inventory management were defined. To implement and establish lean tools such as 5S, Kanban or LSS, many process improvements require the right environment, space or tools in order to enable the implementation of lean philosophy. Therefore, supporting frameworks and methodologies are necessary at this stage of the action research and would contribute in a better implementation of lean philosophy. These methodologies and frameworks will be described and introduced in each paragraph before every proposed or/and implemented problem solution.

6.1 Lean layout Design

The factory layout is very important decision as it influences the daily operations. The ideal factory layout should assure the optimal relationship between the input, manufacturing process and floor space. An effective factory layout enhances the production process, minimizes transportation, reduces time and cost, allows flexible operations, improves utilisation of space and manpower, increases employee's safety and working conditions (Tak and Yadav, 2012).

A popular procedural solution used to design or improve the layout design problem is the Systematic Layout Planning known differently as SLP (Muther, 1973) and is one of the most used facility design approach up today. Muther´s approach is based in three main fundamentals; a) the relationship between the processes and activities, b) assigned space for each activity and c) planning efficiently by adjusting the activity relationship and space. By following the three fundamentals listed above the planner can achieve better layout and a smooth process. (Richard Muther & Associates, 2005). Considering that effective factory layout reduces waste and improves the efficient utilisation of resources it provides the possibility of application of lean

tools such as 5s, JIT, Kanban, Kaizen etc. (Naqvi et al., 2016). Figure 13. Is a visualisation of SLP framework presented by Tompkins et al. (2010) which separate the approach in three phases; analysis, search and selection. As you can see from the diagram flow of material, analysis of space (required vs available) and the relationship between activities are some of most important aspects of designing process.

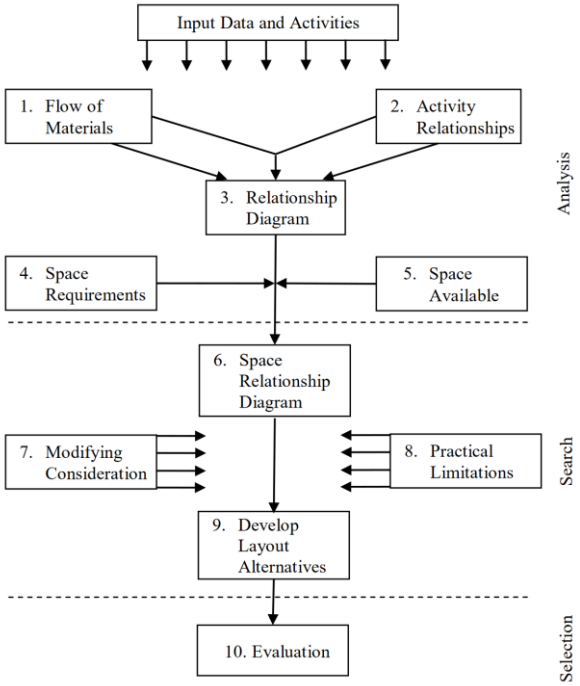


Figure 13. Systematic Layout Planning methodology (Tompkins et al., 2010)

To plan the layout improvements, the procedural SLP methodology was used during this action research. The decision to use SLP is because it is a framework that allows the implementer to make improvements via visualisation and relationship of ongoing activities. Considering the scale of operations in a small organisation, would be rather difficult to use other algorithm-based models and methodologies (Heragu and Kusiak, 1991) which often are difficult to implement.

6.1.1 Review of the existing layout design

To improve the existing processes a floor plan was initially mapped showing the allocation of storage space, product inventory, the manufacturing and assembly area and other spaces which

can be utilized in the future for further expansion as “green field” project. The existing factory layout is shown in figure 14.

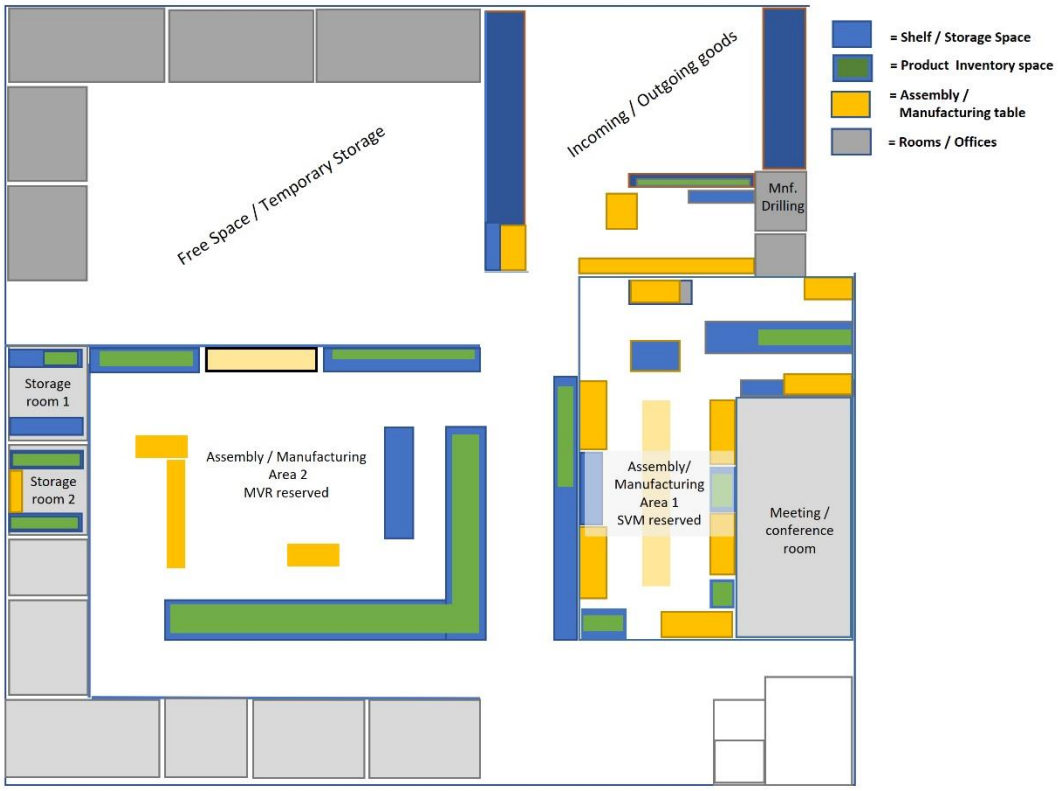


Figure 14. Existing factory layout

A seen in the current factory layout the factory consists is three main areas; incoming/outgoing, inventory and manufacturing.

Incoming/Outgoing area where all incoming products are left after delivered from the freight companies or company employees. In addition, all goods waiting to be delivered are temporarily stored in the same area. This layout planning often creates several issues such as; space limitations where free movement of goods is constrained, forcing employees to temporary move the goods on side to free space for operations to take place. This movement is considered as unnecessary waste. This problem was discovered from daily observations as well as mentioned during interviews with the employees. The main factor which creates these issues is the fact that there are no separate assigned locations for incoming and outgoing goods even the space on this area is large to implement such structure.

As shown in figure 14. product inventory space can be found in several different areas. The designing of shelf allocation has been planned while taking into consideration the distance from manufacturing area and the available free space. However, the system of storing the inventory has many errors which often result in creating unnecessary waste and disrupting the manufacturing and delivery process as presented above.

Assembly and manufacturing area is where all daily activities happen and is one the most important part of daily operations. The current design of the manufacturing area is U-cell based on lean manufacturing where each process starts from "working table" 1 and is finalized in "working table" 6. However, it was found that this design does not fit to the daily production process, considering that several different products are manufactured simultaneously, and different working tables are used for different products.

Taking into consideration the existing critical issues presented in chapter 5.2, and the review of the current layout, the researcher argues that the processes can be improved by updating the existing layout.[5] Moreover, lean practices starting with 5S methodology (Bayo-Moriones et al., 2010) should be incorporated in parallel with the layout changes.

6.1.2 Planning the new layout

The planning and design of the new layout is made by taking into consideration the improvement procedures that researcher is implementing during this action research and the needs of the existing assembly and manufacturing processes. Therefore a process relationship analysis was made.

In the context of operations management and effective manufacturing environment, the layout design is extremely important in making daily activities more efficient. A good layout design is equality important to the implementation of the manufacturing activities as much as it is important to daily operations (Gomes et al.,2000). Due to the complex nature of layout factory problem and many variables that need to be taken into consideration, many heuristics procedures have been developed during last decades, all with the aim to obtain good or close

5 The manufacturing area layout improvement will be left out of scope considering the time required to apply changes and the limitations of this action research. The findings and recommendations will be used for the next improvement stage.

to optimal results (de Alvarenga and Negreiros-Gomes, 2000). Kusiak and Heragu (1987) classified these procedures into two separate methods a) construction methods and b) improvement methods. Construction methods are mainly "green field" projects starting from a free empty space and constructing the facility in stages. The improvement methods introduce an initial solution and improvements are made continuously until near optimal results are achieved. As this action research is improving the existing processes, planning a completely new layout would be costly and would use many resources therefore improvement method is applied. Moreover, the benefits of improvement methods are supported also by Tam (1992) who argues that better quality layouts are often the result of improvement methods when compared to construction procedures.

To target all the combined issues simultaneously, reduce the probability of some processes shadowing the benefits of the main improvements, we focus the improvement of current layout in six different areas (see figure 15). This will assure that all new established processes support each other, and a completed process is designed in accordance with lean principles and therefore aiming to significantly improve the entire operations process.

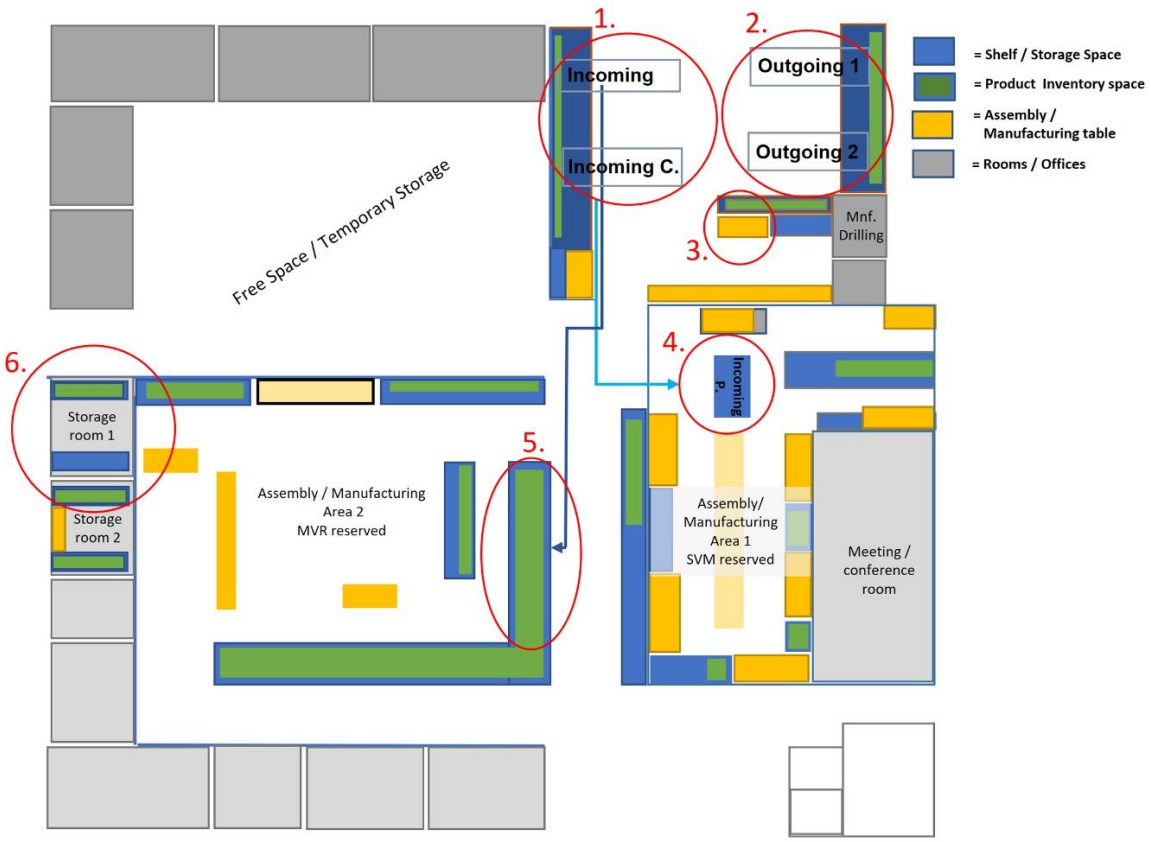


Figure 15. Adjusted factory layout to support the new lean processes

Firstly, the Incoming/outgoing area where all products were mixed together is redesigned and the existing space is divided in two separate areas; Incoming goods and outgoing goods (see fig. 15; nr.1 and 2).

Secondly, to free more space and reduce waste by crating free movement of goods, working table (fig 15. nr. 3) is repositioned and rearranged using 5S methodology. This change is made to support the manufacturing activity and allow smooth operation on other supporting activities that take place in the same area.

Next, a forward area is created close to the assembly area where incoming goods used in MTO projects are picked and stored using a Kanban visual system where products required to the next project are transported from incoming goods storage area to the assembly area (fig 15. nr. 4). Once again, this process aims to reduce the traveling distance that assemblers need to do in order to pick up the goods from different locations.

Finally, the storage of inventory goods is allocated in two different areas (fig 15; nr. 5 and 6). Considering that inventory management was a critical issue for the case company, redesigning the inventory of stock items was one major change which is further discussed in chapter 6.3.

6.2 Receiving and storage of materials

As presented above the receiving and storage of goods had many flaws and several processes or delayed practices created unnecessary waste or critical errors. One of the problems found during the research was fact that there were no assigned location where incoming goods were left temporarily before they were checked, confirmed and allocated to the shelves. Both temporary location for incoming goods and storage inventory for each product was determined to eliminate the above issues.

Bartholdi and Hackman (2009) view the location of products stored very important as this location can determine the speed and the cost of the process involved in retrieving these products. Moreover, other studies have shown that among different activities that take place in a warehouse, order picking process takes more than half of the costs (Berg et al., 1998). One of the strategies used to reduce the "waste" associated during the process of storing the products

and order picking is to divide the warehouse into two parts; *forward area* and *reserve area.* The forward area serves to increase efficiency during the pick-up of the good while the reserve is used to store the bulk products (Berg et al., 1998; Bartholdi and Hackman, 2008).

In another study Bartholdi and Hackman (2008) explain the concept of "forward pick area" which is an assigned area designed to function as "warehouse within the warehouse". The idea is that most used Stock keeping units (SKUs) should be stored in small quantities, so the order picking process is made within a small area. This reduces the travel time required to pick up the products and enables a better supervision. However, there is a trade-off considering that the forward pick area should be levelled continuously from the reserve storage. The main challenge on this system is to determine the exact volume used in the forward pick area.

6.2.1 Improving the incoming process

The improvement process was divided in two phases; layout improvement and process improvement.

In the first phase the incoming / outgoing area is rearranged as described in the previous section. On the new layout design the incoming goods are separated in four sections as shown in figure 16. The first two sections are reserved for all goods coming directly from the customer x for MTO projects. These goods once picked by the company can be delivered and kept in the reserved space until the products are required for MTO assembly process. As described in chapter 5. the goods received directly from the customer do not require further inspection or confirmation. These products can be directly stored and ready to be used once assemblers start the manufacturing process following the daily production plan. The next two sections are reserved for all incoming goods which company orders for specific MTO projects or inventory. All these product orders are fulfilled by the purchasing department and need to be checked and confirmed before they are allocated. The new layout design was implemented by support of the 5S methodology described in literature review (e.g., Bayo-Moriones et al., 2010, Kiran, 2016).

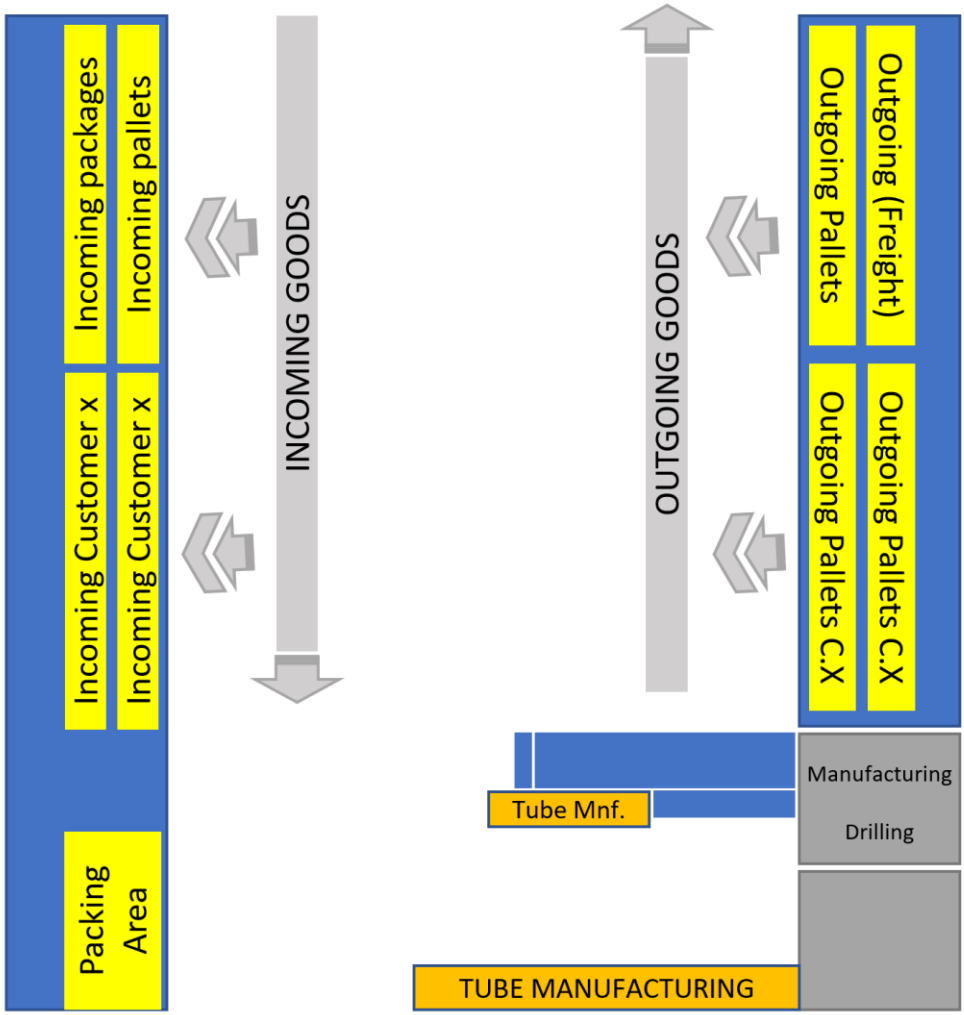


Figure 16. New lean layout for incoming and outgoing goods

In the second phase new supporting processes were implemented. The incoming goods that need to be checked will not be delivered and left at a random location but in the specific assigned space (Figure 16. incoming pallets and packages). These goods need to be checked in daily basis from an assigned trained employee within 24 hours from the arrival of the product. Furthermore, proper training is given to a second employee which will act as “back up” in situations when the assigned main employee is not present or is not able to fulfil the process. The implementation of lean practices on the receiving area aims to eliminate the first critical issue presented in subchapter 5.4.2 and reduce waste from other sections presented in table 2. (issues 1,7,8,9,10).

Figure 17. shows the transformation of the incoming area after successful implementation of lean using 5S methodology. As seen from the photos the results are positive, resulting in more order and organized process that supports the improvement of operations management process.

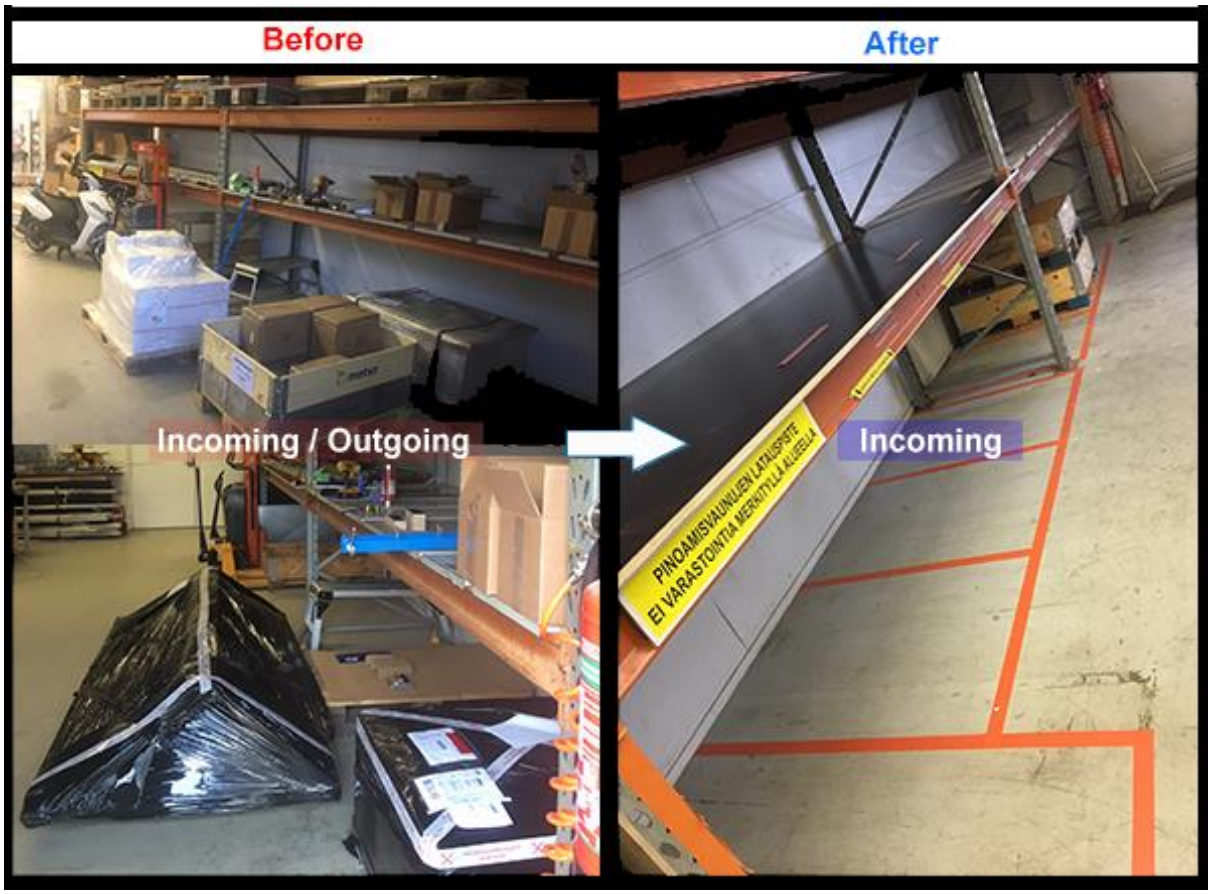


Figure 17. Improvement of receiving process, before and after lean implementation

6.2.2 Improving the outgoing process

During the planning of the new area for the outgoing process same logic and methodology as incoming process was used. In the previous layout design there was no assigned space for the outgoing goods except a small area next to manufacturing that was used for the shipment of goods (freight delivery). The packages were left in floor and often created difficulty for the assemblers during the manufacturing process. Moreover, outgoing goods in large packages or pallets were left in the entrance area, often being mixed with the incoming goods.

In the new layout design, four new shelf spaces were assigned only for the outgoing goods (see figure 16). This space is divided into two sections; Section one is reserved for the outgoing products that are shipped using freight delivery and are picked up directly from freight company. Section two is reserved for all finished goods from MTO projects that are ready to be delivered to the customer by employees in the agreed delivery date. This new arrangement aims to help the manufacturing process by making more space in the manufacturing area to store the half-finished goods and to allow better movement for the employees.

Figure 18. shows the transformation outgoing area after successful implementation of lean using 5S methodology. Once again it can be clearly seen that the improvement is significant, and the utilisation of space is optimised.

Figure 18. Improvement of outgoing process, before and after lean implementation

6.3 Lean inventory design and management

Even it was found that many products are "slow moving products" and take unnecessary storage space after a more in-depth analysis taking into consideration the key activities and value proposition described via the BMC model (Osterwalder and Pigneur, 2010) in chapter 4, the high range of products from A to Z is necessary to maintain in certain quantity.

Furthermore, the importance of inventory is also discussed in inventory management literature. Pepper and Spedding, (2010) advocate that reducing inventory levels is not a process that can be enforced in volatile environments. They argue that such practice can lead to increase in variability and even greater exposure to risk. Therefore, Pepper and Spedding suggest that company need to adapt a systematic approach which will optimise the whole system and focus in the appropriate strategies in the correct places.

Melton (2005) advocates that a well-organized process layout combined with efficient storage solution will result in reduction of distance and as result save time. In sections above, we offered solutions to improve the existing processes, and as part of the solutions there were a set of activities that needed to be implement. The activities include the *rearrangement of inventory location* and *organizing the products accordingly*. The improvement is aiming to reduce the wastes presented in table 2 (issues 1,2,5,9,11,12). and especially eliminating the first critical issue on inventory management presented in subchapter 5.4.1. All changes are interrelated with each other and the researcher would argue that one change separately may not give optimal or desirable effect if other related activities or procedures are not supporting the change.

Lee and Elsayed (2005) developed an approach where dedicated storage is used to achieve optimal capacity. The approach suggests that SKU´s need to need to be separated based on ratio of available storage space and expected activity, placing most active SKU´s at the preferred slots and least active in least preferred ones. A popular method used in inventory management for separation of SKU´s is the ABC System. The system uses statistical data (product sales) to divide the products into three categories. ABC system is based on 80/20 principle or differently known as Pareto[6] that is also an LSS practice (Slack et al., 2015).

[6] In operation principle, Pareto rule is that 80% of sales is generated from sales of 20% of all stocked items

6.3.1 Improving the inventory

With aim to eliminate the issue of product allocation and build a process where employees can easily find and pick up the goods a new approach was designed and tested. The improvement was tested initially in one product category aiming to resolve the issues with inventory management that were analysed and presented back on chapter 5.3. The improvement process was implemented in four phases;

1- Phase One: Allocating the inventory space and location

Taking into consideration the activity relationship, the distance from closest available shelf location (the time an employee need to travel to pick up the products) and the number of SKU´s in inventory the new locations were defined and introduced in figure 15. (nr. 5 and 6).

2- Phase two: Categorizing the products

A total of 53 products groups and over 1500 order lines were analysed using the data retrieved from the enterprise resource planning (ERP) system showing the monthly product flow in last two years (sales statistics) and available SKU´s in stock. the products were initially categorized into two different categories (based on Pareto principle); *a) fast moving products* and *b) slow moving products*. The location of "slow moving goods" was decided to be in separate available storage (area 6. figure 15.). The "fast moving products" are placed in the main inventory shelves, close to the manufacturing area. Furthermore, using ABC analysis the fast-moving products were categorized in three group in order to decide the shelf level placement with most frequent used products to central level (easy and fast to pick). A semi-logical arrangement of product was also used based on product type and size.

3- Phase three: Arranging the products

For Each shelf location a separate position was assigned. Each box or product space was labelled accordingly using unique colour code for each product group. Moreover, the design of the labels includes product description, picture and SKU code from the ERP system. Furthermore, a list of customer unique purchase code for each product was placed in each shelf. Finally, the ERP system was updated adding information for shelf allocation of each product.

4- Phase four: Designing new processes

To support the changes and create a sustainable lean operations management, two new process flow charts were designed during this action research. The flow charts are shared with all employee's or research participants and serves as guide for people involved in the process of product picking; first flow chart was created for all orders that require direct shipping from inventory (see appendix C) and second flow chart for all products that are used inhouse during manufacturing or assembly of MTO products (see appendix D).

The process of inventory improvement was one of the most challenging improvements considering that all products were mixed, and product codes found in each package were different from the registered code in the ERP system. Therefore, each product had to be inspected, assigned to the correct group and updated in the ERP system. This was a labour-intensive process which required many working hours and human resources. The implementation of the entire process gave results immediately (see appendix B). The products were organized and easy to be found. Moreover, the ERP system is updated with correct product information reducing the risk of making wrong deliveries. Furthermore, more space was dedicated for incoming new inventory allowing the company to have an increase in capacity as well as reduce waste.

6.3.2 Sustaining lean procedures

As mentioned in the literature (e.g., Bayo-Moriones et al 2010; Kiran 2016) the most critical part of successful lean implementation is the ability of the organisation to implement correctly the 5th S from the 5S model "SHITSUKE" which means to make lean part of organisation´s culture and maintain or optimise the achieved improvements. To make sure that the implemented changes are effective a set of rules were agreed to maintain inventory;

1) The lean 5S will be maintained through all the process and everyone involved in the process will have the proper training both for lean practices and process flow. Moreover, a 5S checklist was created (see appendix E) which assigned employees should use weekly to inspect the factory and find areas that need to be improved using lean 5S methodology.
2) Only assigned employees with proper product knowledge can pick up the goods from stock.

3) A “backup system” is put into place. Two additional employees are trained to pick up the goods and serve as back up when first assigned employee is missing.
4) Only a person at time is assigned to pick up the goods for projects or deliveries.
5) End year inventory inspection will be done only from production manager
6) Inventory activity/status will be a topic of each weekly meetings.

The set of six rules aims to support in sustaining the new designed lean practices and to encourage continuous improvement within the organisation. Further training in continuous improvement practices will be kept regularly from the management of the company with the support of the researcher.

6.4 Implementing Kanban systems

To target the third critical issue presented in subchapter 5.4.3 Kanban system (Sugimori et al., 1977) was designed and implemented. The Kanban system is based on JIT approach and was introduced in lean literature (see Harrod and Kanet, 2013; Brown and Mitchell, 1991). The Kanban system during this action research is designed in two different forms (see appendix F).

The first one is an excel form (see section a, Appendix F) build during the action research and is shared via cloud system with all departments. The Kanban system displays all product orders, brief information and their status. This system gives access to receive and update information by all involved employees including sales managers, design and engineering team, and production manager. Each update can be seen by all departments in real time without the need to ask for information continuously on open orders or delivery status. This leads to reduction in unnecessary waste and most importantly eliminates the possibility of neglecting orders and possible delays due to miscommunication or lost information due to many communication channels. Furthermore, this system assists the production planning and sales managers to prioritise important orders and control the manufacturing capacity before a promise is made to the customer. To maintain the process, responsibilities for updating the Kanban system were assigned to specific departments, each responsible for a given process.

The second form of Kanban was a copy of the above system displayed in a Kanban board (see section b, Appendix F). This visual system is created for employees working in manufacturing and assembly and is a mirroring of the information provided in excel file, only that this will be

updated in weekly basis. Considering that work in manufacturing area is physical and information need to be visible all the time, the Kanban board is the most feasible tool to share the information with the employees working in the workshop. The product manager will be responsible to update the board in weekly basis.

The Kanban system is initially implemented in a one area of manufacturing initially in order to test the effectiveness on the daily manufacturing process and after the concept is proven to be effective, it will be adjusted and implemented in the second area of manufacturing.

7 Discussion

This study analysed and presented the outcomes of the improvement project undertaken by the case company, aiming to improve the operation processes by implementing lean philosophy. A literature review on lean operations management and implementation of lean methodologies in SME´s was conducted to provide the necessary background for the empirical study. Topics such as Lean Philosophy (Krafcik, 1988; Womack et al., 1990; Hailemariam, 2010), Continuous improvement (Imai, 1986), 5s methodology (Bayo-Moriones et al., 2010), Six Sigma (Harrison, 2006), Lean Six Sigma (Dora and Gellynck, 2015; Goh, 2002), JIT (Brown and Mitchell, 1991; Harrod and Kanet, 2013) and Kanban (Sugimori et al., 1977) were initially introduced.

The action research started with analysis of the existing processes, defining the main issues, recommending changes or improvements and assisting the company to implement the recommendations. The principles presented in the literature review were followed to locate the issues and plan the necessary changes that would improve the existing operations and create lean practices in daily operations of the case company.

The purpose of this chapter is to discuss the findings of this research by initially discussing the theoretical implications and later discuss the study from a practical prospective.

7.1 Theoretical discussions and implications

This study supports Harrison (2006) and Ho (1998) who advocate that lean manufacturing starts to generate positive result almost immediately after being implemented correctly. During the action research the improvements, were evident immediately after the first week of implementation. The new implemented processes made handling of incoming and outgoing of goods much easier and the inventory management simple to handle therefore the waste reduction was significant. Moreover, the changes made created greater benefits in knowledge sharing and employee training. For instance, implementation of structured shelf management system and LSS, including labels with detailed product info, colour coding and ERP system synchronisation have contributed in reducing the possibility of making errors. Therefore, the management can delegate the task of processing order to less experienced employees which

can fulfil this process with *basic training* when before implementation of lean, only very experienced employees could locate and find some of the products.

Achanga (2006) and Singh et al. (2008) presented financial resources of an organisation as an important factor which can determine the successful implementation of lean. The experience from this study shows that financial resources are not a determinant in implementation of lean. However, it is important to note that the case company had already invested in required materials and tools (e.g., shelfs, tables, working tools, ERP system, label printers etc.,) that were required during the implementation of lean practices, therefore the implementation of lean was primary focused in process improvement and better utilisation of existing resources. The implementation of lean in this case company required more human resources rather than financial resources. The limitation on human resources was one of the biggest challenges in designing and implementing lean processes during this study. The difficulties that SME´s often face during the design and implementation of lean due to limited resources was also mentioned in the literature (e.g., Pearce et al., 2018; Achanga et al., 2006). A learning derived from this study and that could apply to other SME´s is that companies need to estimate and plan the resources required in each process before the implementation phase starts. Moreover, the implementation process should be divided into smaller stages, a process that would allow smaller organisations to use less resources during the implementation phase of lean processes.

Furthermore, this study found that the availability of human resources also depends on many other factors. During this action research four main factors were uncovered; timing, human resource capabilities, work in progress and existing state and nature of processes that need to be improved.

Timing

Timing is an important factor for sourcing the necessary human resources to implement lean especially on SME´s. For instance, during this study most employees of the case company had summer holidays for four weeks, at the same time when the action research was conducted therefore the implementation of lean approach was delayed. In Finland, maintain healthy work-life balance is an important part of Finnish society and companies often have summer office shutdown during summer which can last up to five weeks (Yle News, 2018). However,

other countries may have different system on summer breaks or other holidays periods, therefore each case may depend on the country where the company is located. It is difficult to find a universal approach to determine the right time as this factor depends on many other variables and each company needs to be analysed separately to determine what is the right timing to implement lean or any other improvement or change approach.

Human Resource Capabilities

Human resource capabilities are other important factors that determine the required resources to design and implement lean operations. There are many processes that require certain knowledge level and not everyone in organisation can be involved in the process. Therefore, it can be argued that the dependability of implementing lean will not be only on available number of employees that can support the process but rather the availability of employees with the right capability or knowledge in each specific process. Outsourcing the process can be another option however when it comes to SME´s the financial resources are often critical and in such case the findings from Achanga (2006) and Singh et al. (2008) regarding limitations in financial resources in SME would be valid. Moreover, it can be argued that some internal problems or processes need to be addressed and resolved internally. The literature defines that in core of lean philosophy the involvement employees in designing, implementing and maintaining the improvement processes (Imai, 1986). This gives more importance to internal resources meaning that smaller and more complex the organisation is, more challenging would be to obtain the required resources. Therefore, the study supports the idea that employee involvement should be prioritized during the implementation of lean.

Work in progress

Work in progress (WIP) can influence the implementation of any change where human resources are required, especially in SME´s where these resources are limited. What was found from this action research was that when manufacturing workload is high, and employees are busy with daily tasks the implementation of lean need to be planned carefully to ensure that it does not disrupt the existing WIP. Moreover, when WIP is high and customer orders need to be fulfilled less available resources would available to implement lean. Therefore, the optimal solution would be to implement lean in small steps as Melton (2005) advocated and target to plan the process changes or improvements in periods when WIP is low. Once again, the

learning from this action research is that each company need to be evaluated separately as there is not a fit solution for every organisation.

The state and nature of existing processes

The state and nature of existing processes can determine both human and financial resources required to design and implement lean operations. Depending on how complex or developed the existing operations management process is, the improvement process can require different approach thus the resources required will vary in each process separately. For instance, in the studied company, during the implementation of 5S approach model adapted from Bayo-Moriones et al. (2010), Kiran (2016) and Omogbai and Salonitis (2017) the involvement of all employees was required especially during the first three S´s (sort, set in order, shine) where physical action is required. Moreover, Gapp et al. argued that 5S lean approach serves as a tool that increases knowledge in organisational level and through involvement during planning and implementation process employees learn how to reduce waste, improve working conditions and understand the importance and overall benefits of lean. Other lean processes such as statistical analysis used in Lean Six Sigma to define the design and distribution of inventory or design the new layout can be done from the senior management or the person in charge of managing the implementation of lean approach.

The findings from this study support at some extent other studies such as Hines et al. (2011) or Schmidt (2011) who argued that management commitment is highly important in implementation of lean. Moreover, the findings from Belhadi et al., (2017) suggested that need of management commitment is important from an early stage of lean implementation. During this study it was found that the role of the management is important in allowing lean initiatives within the organisation, or even supporting the process directly by contributing during the implementation of processes. The direct contribution during this AR was offered in form of; process knowledge, experience, innovative ideas, training or managerial support in the aspect of change management.

However, the involvement of upper management during the implementation process can cause difficulties in SME´s when typically, the manager / owner is making the final decision for most of changes happening in organisation. In the start of this AR, it was found that often these decisions are not supporting the main objectives of Lean and can be unproductive, sometime

risking to vanish the benefits gained during implementation of lean approaches. This argument was briefly mentioned in the study of Achanga et al. (2006) who argued that the personality of owner/manager is by default reflected in the culture of an SME, therefore constrains in making changes often exist.

This research takes the argument a step further, presnting a different approach or method that was used during this action research to deal with the challenge. Considering that the initiative of process improvement using lean philosophy came as bottom-up development, in which the researcher[7] was the initiator of the process, the educational process started from the manager. Firstly, it was explained broadly how the company can benefit from implementation of lean and how existing issues could be eliminated by using these tools. It was found that the first resistance to deal with is the management of the company, and in an SME, this is extremely important considering the decision power of manager / owner. Melton et al. (2005) introduced three natural forces contribution in resistance to lean implementation, therefore eliminating this forces in this company action research was done in two steps; firstly by initially educating the management on lean approaches and how the organisation could benefit from the improvement initiative, and secondly giving case examples showing that this is not "just a fad" or only just a short term improvement attempt..

Therefore, in the context of SME´s environment the study supports the importance of management role as it is clearly important. However, the learnings from this study is that company owner / manager should have more supporting and educational role and less involvement in planning and implementing process. This would avoid biased decisions and reduce the risk of employees being more reserved when it comes to expressing concern in existing real issues or contributing in improvement ideas.

The second important part of implementing the improvements was to receive further support within the organisation. Melton (2005) pointed out that senior management support is very important part during implementation of lean. In this study, the support was gained from the production manager[8] and this was also achieved by following same educational approach as

[7] As mentioned in the company description the researcher is an employee of the company
[8] As described in company description the production manager was a participant of this action research and a key support in implementing the change

with upper management, however this time additional details were discussed. These details include;

a) the available approaches that should be implemented,

b) the role of the subject in the improvement process,

c) the possible challenges that management could face during the implementation stage,

d) the contribute and dedication that is required to support in achieving results.

It is important to mention that the managerial structure in small organisations is often less complex than large organisations for example, smaller the company is, less managerial levels are in the business, therefore the receiving support is easier in SME´s. Implementing the changes as well is more simple process as there are only few key players involved in the change process. Furthermore, it can be argued that in SME´s, sharing knowledge and attempting cultural change is an easier process which with the right educational approach can be successfully implemented in a short period of time. However, as the challenge is to sustain the changes in a long run (Hines et al., 2011) the focus in educational process and organisational cultural where manager encourages employees to be part of continuous improvement is very important to create a lean organisation and lean operation management processes.

7.2 Practical discussions and Implications

Applying lean approaches can bring many benefits for SME´s. The results from this study show that lean practices can be used to achieve immediate positive effects in daily operations as well as increase efficiency of manufacturing and delivery processes. In this study lean approaches were implemented in several processes simultaneously, starting from the receiving of goods, inventory management, manufacturing planning and finalising to outgoing and delivery of the finished products.

As presented under chapter 6.3 the LSS approaches that were described in literature (Dora and Gellynck, 2015; Harrison, 2006) such as process mapping and statistical data analysis combined with 5s approach (Bayo-Moriones et al., 2010) were used to organize the design and implementation of the improved inventory management system. During the first weeks of implementation, using visual control, benefits such as clean and tidy warehouse, organized products and reduced time during pick up process were identified immediately during and after implementation process. These benefits were achieved as result of implementing lean

methodologie, achieving the first aim which was waste reduction. However, the second aim targeting to reduce or eliminate errors cannot be analysed is such short time considering the limitation of this research. Furthermore Goh (2002) described that implementation of SS approaches can take few months up to a year to yield results. This depends also in project type and considering the case company operations, one year would be the expected time to validate the data by recording each potential error made during the process. To obtain exact statistical data will be a challenge as in our case company there are no documented records in exact errors, except general data that gathered during the interviews with research participants and observation process.

This study further supports Singh et al. (2008) advocating that Lean implementation in SME´s is easy considering that SME´s have simple structure and less complex system. As discussed above, the key to implement lean was to receive the organisational support, which in this study was the management of the company. Once the process was initiated the challenges were mainly due to limited resources and timing. Moreover, in contrast to Denton and Hodgson (1997) or Melton (2005) the implementation process during this action research was easy as the organisation employees embraced the improvement initiatives by using lean approaches. However, it can be argued that results from implementation can vary from one SME to another as many other factors. For instance, an SME by definition can have between 10 and 250 employees therefore the managing change in in an organisation of 15 employees would not have same difficulty level as in organisation of over 100 employees. Therefore, the exact number of employees could play a role in the difficulty level of implementing change. Other factors such as company culture, management structure, immediate need for improvement, state of the existing processes and type of industry in which company operates can influence the difficulty level.

Furthermore, measuring the exact benefits of implementing lean approaches in an SME can be very challenging process due to lack of data or any records on attempted changes that were used to improve the existing process. Therefore, this study supports Belhadi at al. (2017) who gave importance to measurement control system and defined KPI´s as practices used to ensure the measurement of lean effectiveness. These practices will allow the organisation to keep track in all changes that are done in relation to activities that may influence directly or indirectly the operations management process.

The implementation of lean philosophy in the case company was viewed as a positive approach in all levels of organisation. For instance, the Kanban system is helping in improving the operations by improving the information sharing system.

"The Kanban system improved our internal information to move more fluently, people in our organisation are now better informed on what to do next." says Product manager - (AR, Participant 4)

Furthermore, from the employee perspective, a lean layout and process flow helps in reducing unnecessary waste as well as creating a better working processes.

"The new layout and process looks great! It is easier for us to know where to store the products after we have them ready. Also, is helps us to find all components we need, we don't need to search everywhere like before" says Senior Assembler – (AR, Participant 5).

Moreover, lean methodologies help in improving the production process creating a lean operation management process. The production manager who was also an important component of this action research sees lean methodologies very positive for the company and necessary for further development of lean operations management processes.

"The improvement process using action research and lean methodologies has been very beneficial for our company. Everything is more organized, and we have set fixed processes that help us to have better operation management process. We should continue further what we have started and expand the improvements in all areas by following the same approach" says Production Manager – (AR, Participant 3)

In this study it was also presented the support that lean operation management gives to other improving methodologies that lead to certification such as ISO 9001 (e.g. Fonseca and Domingues 2018; Chiarini (2011). Many SME´s need to receive such certification as requirement from the existing or potential customers. And lean operations management can support an organisation to reduce costs and ease the application process in receiving a quality certification. From this case company the study found that the applied lean practices will support the implementation of ISO 9001 as many requirements to obtain the certification can

be easily adapted from the newly established lean processes that were implemented during this action research. Therefore, it can be argued that side benefits of designing lean operation processes have positive effect daily operations but can also support the organisation in overall improvement of the business.

8 Conclusion

This dissertation focused on designing and implementing processes of lean operations management in SME´s. During this study, pragmatic approach using action research methodology was conducted to improve operation processes in a Finnish SME. The results from this study offered important insights on how SME's can design and implement lean practices to improve their operation process.

The study answered the first research question by introducing key elements of element of lean philosophy that practitioners and SME´s use to improve the operations processes. Popular methodologies such as Kaizen and 5s, Lean Six Sigma, JIT and Kanban system were introduced. Other improvement methodologies that SME´s implement to improve their operations were briefly mentioned. Supporting frameworks such as SSL (Muther, 1973) and inventory management (e.g., Lee and Elsayed 2005; Bartholdi and Hackman, 2009) practices that were not directly lean literature but supported the design and implementation of lean operations were introduced during this action research. These supporting methodologies and practices were necessary and viable to implement lean methodologies and create lean operations management processes on the case company.

The second research question was answered by analysing the empirical work conducted during this action research. During this research the design of a "lean layout" created the necessary conditions and supported the implementation of lean methodologies. Lean methodologies such as 5S helped in defining the problems and reducing unnecessary waste. Lean Six Sigma approach helped to resolve problems and improve the existing processes and Kanban system was used to standardise the processes and improve the information sharing processes. The validity of results derived from this action research were also supported by the research participants. Both managers and employees of the company highlighted the positive effects of lean practices in an SME. The main challenges that were found during the implementation of Lean in SME´s were related to availability of human resources. During this research four main factors were uncovered and discussed; timing, human resource capabilities, work in progress and existing state and nature of processes that need to be improved.

The research gives a direct academic contribution to literature, closing the gap between knowledge and practice on designing and implementing lean operation management practices

in SME´s. Moreover, this study contributes in filling the gap that exist on the practical implementation of lean methodology in SME´s with benefits, challenges and learnings which other SME´s managers could take into consideration before choosing the appropriate methodology to design and implement lean operations management.

8.1 Reflections on the process

This dissertation was a challenging but exciting process which gave a significant contribution in my personal development by increasing my academic knowledge while enhanced my professional development. Choosing action research as research methodology gave me the possibility to interact and exchange knowledge with the organisation. This approach allowed me to take control on the processes and make a positive impact to the company via significant daily improvements. At the same time, I gained more business knowledge and a wide understanding on operations management process.

During the research I took full responsibility in designing and implementing lean operations. This gave me more flexibility to test new practices and use own judgement on which would be the best practices that a small organisation can implement to improve the operation processes. It is important to note that the flexibility during the research was a merit of company´s owner who allowed me to act independently and utilise all necessary resources within the company to improve the existing processes and at same time achieve the objectives of this study. Moreover, I received a great support within the organisation from both production manager and employees of the company who contributed in implementing the change through the entire process. In exchange, I had the possibility to share information and educate my work colleagues on importance and benefits of lean philosophy and how this philosophy can help them in day to day work.

However, with all the responsibility came also the challenges. The challenges during this research were both internal and external pressure to achieve results.

The external pressure was the fact that there is a time restriction from Glasgow University in which this research needed to be finalized. Moreover, the academic requirement restricted somehow the structuring of the study as both space and content limitations were set. This

created a challenge to maintain a balance between a good academic study and an efficient practical research. I would argue that in normal situation without strong organisational support this research would be impossible to be implemented, especially in an SME where key resources are limited. Moreover, lean implementation is not a process that can be done by a single person and involvement of the entire organisation is required. If there is no commitment from the organisation the entire process would risk failing and no gains would be made. The importance of organisational and management commitment was also discussed during this research (e.g. Kiran 2016; Hines et al., 2011, Schmidt 2011) which was also one direct learning from my experience on this journey. The major challenge as mentioned above was the timeframe of this research. Considering that there was a deadline to be met but at the same time not enough resources available in the company to implement lean (due to summer holidays) forced me to re-design the entire research structure and data gathering process. This pushed me to make all the necessary planning and preparations that would allow me to target the improvement of several processes at the same time after all employees would be back from summer break.

The internal pressure came from within the organisation. The management of the company had given me the trust in this process therefore positive results were expected considering that considerable resources were utilised during the research. This research was not just an experiment but a real development process in which high responsibility was given to me to resolve the existing issues and improve the operation management process. Furthermore, as this project could be also categorized under "change management" I had to take into consideration the possible resistance or potential sabotage during the implementation of the project. As people that were influenced directly from the changes during this action research have worked many years in the company and I as work colleague would have to change "the way things are done around" resistance would be a logical risk to be taken into consideration. Moreover, from literature review resistance during change in SME is seen as a very common barrier during implementation of lean (e.g., Melton et al., 2005; Belhadi et al., 2017). However, in this study this issue was not present, in the contrary the organisation embraced the idea of improvement. I believe that there were three major factors that contributed in this positive response: a) the close relationship I have created with the employees during six years of working with the company, therefore the employees were familiar with me and not seen me as an outsider trying to make changes. Moreover, the employees understood that this process was important to my studies, b) the immediate need for improvement in many processes which

often influenced directly day to day activities, therefore everyone in the organisation agreed that there is a need for improvement, c) all employees were informed and educated regarding the benefits of lean and d) all employees were invited to participate in designing and implementing the new processes. This created the team work environment where everyone had a chance to give his or her own contribution on the process. I strongly believe that involvement of all people is a key to the successful implementation of lean.

To conclude, for me personally this was a big achieving as I managed to resolve several issues that have been existing for a long time. It is an individual fulfilment knowing that I could use my learnings and knowledge gained during my MBA studies to benefit the organisation where I work. Moreover, the success of this project gives me more confidence to continue the improvement process even in other areas, contributing not only in the organisation development but also on my own professional development.

8.2 Research Limitation

This research had some limitations that have restricted the research to provide more generalist conclusion . Firstly, the study has relied on data from one single organisation, which is a very small sample of all SME´s. Secondly, the timeframe of this research was very limited, considering that to the researcher was given only nine weeks' time to conduct the research and at the same time implement lean practices within the organisation. The short timeframe created limitation to gather statistical data that are required to measure all benefits of implementing lean practices in SME´s. Moreover, the holidays of all employees may have limited the implementation of some planned processes during the research, narrowing the focus of this study and targeting only to the critical issues. Finally, the improvements done during this action research could be expanded in other areas of operation management processes but due to time and resource limitations the improvements need to be carried out at a later stage.

8.3 Implications for further research

This research has provided authentic insights into the application of lean methodologies in SME´s in designing and implementing lean operation management. Whereas the study gave a general description methodologies and available tools, only few of these tools were implemented during this action research.

One further area of research that is recommended would be the importance on the number of people an SME is employing during the implementation of lean approach and the effects this number plays. There are many researches conducted on large organisations and fewer in SME´s but none of these researches is grouping the SME´s by number of employees. This study results showed than in a small organisation of 14 employees is easier to introduce lean concept, but results of this study cannot validate the role that size of the company plays in designing and implementing lean practices within SME´s. Therefore, further research in this area should be considered.

Management commitment versus management direct involvement in implementation of lean practice in SME´s was an important discussion of this study. Many studies (e.g. Hines et al., 2011; Schmidt 2011; Kiran 2016; Belhadi et al., 2017) advocate the importance of management commitment during implementation of lean but there are no validated studies which would analyse the effect caused by direct involvement of management / owner during implementation of lean. Moreover, it can be argued the managers leadership style could also play a role in this process. For instance, it can be argued that an autocratic manager can hinder the implementation of lean by enforcing own ideas or creating fear for employees to express their ideas, but a collaborative manager can support the team to implement lean and encourage employees to contribute in the research. A further research on this topic should be conducted, especially for SME´s where manager / owner of the company has important role in decision making for each activity or change that the company undertakes.

Finally, this research was limited due to the short timeframe in which it was conducted. Some of lean processes require half to one year to yield results. Further research on the long-term effects and sustainability of lean processes integrated in designing and implementing lean operation management process need to be conducted for SME´s that implement lean approaches to quickly resolve the critical issues.

8.4 Further recommendations for the organisation

The improvements during this AR were done is different areas of operations management, improving processes in layout design, inventory management and manufacturing process. However, the improvements in these areas are not fully optimised, even they resolve the

existing issues. As discussed in chapter 2.6 regarding the importance of sustaining the results of lean approaches, continuous improvement need to be applied beyond this research. Moreover, during this action research, other types of waste were found (see table 2.). Due to limitation of this study, important processes such as human resource management, supply chain management and investment in new technology or equipment were the areas that improvements were not attempted during this AR. Therefore, these areas will need immediate attention and improvement from company´s management. The improvement can be achieved by following the same approach and methodology as in this AR, but always keeping in mind that the already improved processes will need to be sustained. Even "self-sustaining" procedures are put into place (e.g., process design presented in appendixes C and D) the management of company need to use regular control, and this can be achieved via a measurement control procedure as presented also in literature (Belhadi at al., 2017). Moreover, continuous training and education of the employees need to be maintained and extended.

To conclude, I would like to repeat the statement as in the introduction of this study, rephrased from Slack et al., (2015); In all operations there is always room to make improvements, no matter how well they are designed or maintained. Therefore, the improvements in the company should be done continuously in order to maintain competitive advantage and support the growth of an SME.

References

Achanga, P., Shehab, E., Roy, R. and Nelder, G., 2006. Critical success factors for lean implementation within SMEs. *Journal of Manufacturing Technology Management*, *17*(4), pp.460-471.

Antony, J., Snee, R. & Hoerl, R. 2017, "Lean Six Sigma: yesterday, today and tomorrow", *International Journal of Quality & Reliability Management,* vol. 34, no. 7, pp. 1073-1093

Bartholdi, J.J. & Hackman, S.T. 2009, "Allocating space in a forward pick area of a distribution center for small parts", *IIE Transactions,* vol. 40, no. 11, pp. 1046-1053.

Bartholdi, J.J. and Hackman, S.T., 2008. *Warehouse & Distribution Science:* Supply Chain and Logistics Institute.

Bayo-Moriones, A., Bello-Pintado, A. & Merino-Díaz de Cerio, J. 2010, "*5S use in manufacturing plants: contextual factors and impact on operating performance*", International Journal of Quality & Reliability Management, vol. 27, no. 2, pp. 217-230.

Belhadi, A., Touriki, F.E. & El fezazi, S. 2017, "Prioritizing the solutions of lean implementation in SMEs to overcome its barriers: An integrated fuzzy AHP-TOPSIS approach", *Journal of Manufacturing Technology Management,* vol. 28, no. 8, pp. 1115-1139.

Brown, K.A. & Mitchell, T.R. 1991, "A Comparison of Just-in-Time and Batch Manufacturing: The Role of Performance Obstacles", *The Academy of Management Journal*, vol. 34, no. 4, pp. 906-917.

Chiarini, A., 2011. Integrating lean thinking into ISO 9001: a first guideline. *International Journal of Lean Six Sigma*, *2*(2), pp.96-117.

de Alvarenga, A.G. and Negreiros-Gomes, F.J., 2000. Metaheuristic methods for a class of the facility layout problem. *Journal of intelligent manufacturing*, *11*(4), pp.421-430.

Denton, P.D. and Hodgson, A., 1997. *Implementing strategy-led BPR in a small manufacturing company.* Paper presented at the Fifth International Conference on FACTORY 2000 – The Technology Exploitation Process Conference Publication No. 435, pp. 1-8.

Dora, M. & Gellynck, X. 2015, "Lean Six Sigma Implementation in a Food Processing SME: A Case Study: Lean Six Sigma in a Food SME", *Quality and Reliability Engineering International*, vol. 31, no. 7, pp. 1151-1159.

Europa, 2018. ec.europa.eu. *What is an SME?* [Online] Available at: http://ec.europa.eu/growth/smes/business-friendly-environment/sme-definition_en

Fonseca, L.M. & Domingues, J.P. 2018, "The best of both worlds? Use of Kaizen and other continuous improvement methodologies within Portuguese ISO 9001 certified organizations", *The TQM Journal*, vol. 30, no. 4, pp. 321-334.

Flynn, B.B., Schroeder, R.G. & Sakakibara, S. 1995, "The Impact of Quality Management Practices on Performance and Competitive Advantage", *Decision Sciences*, vol. 26, no. 5, pp. 659-691.

Goh, T.N. 2002, "A strategic assessment of six sigma", *Quality and Reliability Engineering International*, vol. 18, no. 5, pp. 403-410.

Goldkuhl, G., VITS - Laboratoriet för verksamhetsinriktad systemutveckling, Linköpings universitet, Filosofiska fakulteten & Institutionen för ekonomisk och industriell utveckling 2012, *"Pragmatism vs interpretivism in qualitative information systems research"*, European Journal of Information Systems, vol. 21, no. 2, pp. 135-146.

Gapp, R., Fisher, R. & Kobayashi, K. 2008, "*Implementing 5S within a Japanese context: an integrated management system*", Management Decision, vol. 46, no. 4, pp. 565-579.

Gomes de Alvarenga, A., Negreiros-Gomes, F.J. & Mestria, M. 2000, "*Metaheuristic methods for a class of the facility layout problem"*, Journal of Intelligent Manufacturing, vol. 11, no. 4, pp. 421-430

Greenwood, D.J. and Levin. M. 2007. *Introduction to Action Research* 2nd edition. Sage Publications Ltd. London

Haiemariam, D.A. 2010, *Redesign of the Layout and the materials flow of a production Plant.,* University of Twente, Enschede, the Netherlands

Harrod, S. & Kanet, J.J. 2013, "Applying work flow control in make-to-order job shops", *International Journal of Production Economics,* vol. 143, no. 2, pp. 620-626.

Harrison, J. 2006, *Six Sigma vs. Lean Manufacturing: which is right for your company?*, Penton Media, Inc., Penton Business Media, Inc. and their subsidiaries, Cleveland

Hasle, P., Bojesen, A., Langaa Jensen, P. & Bramming, P. 2012, "Lean and the working environment: a review of the literature", *International Journal of Operations & Production Management,* vol. 32, no. 7, pp. 829-849.

Heragu, S.S. & Kusiak, A. 1991, "Efficient models for the facility layout problem", *European Journal of Operational Research,* vol. 53, no. 1, pp. 1-13.

Heragu, S.S. & Alfa, A.S. 1992, "Experimental analysis of simulated annealing-based algorithms for the layout problem", *European Journal of Operational Research,* vol. 57, no. 2, pp. 190-202.

Hines, P., Found, P., Griffiths, G. and Harrison, R., 2011. *Staying Lean: thriving, not just surviving*. 2nd edn, CRC Press, London

Hines, P., Holweg, M. & Rich, N. 2004, *"Learning to evolve: A review of contemporary lean thinking",* International Journal of Operations & Production Management, vol. 24, no. 10, pp. 994-1011.

Ho, S.K. (1998), *"5S practice: a new tool for industrial management", Industrial Management & Data Systems,* Vol. 98 No. 2, pp. 55-62.

Imai.M., 1986. Kaizen: *The Key to Japan's Competitive Success*. MacGraw-Hill, New York

Karlsson, C. & Taylor & Francis Group 2016, *Research methods for operations management*, Second edn, Routledge, Abingdon, Oxon.

Karlsson, P. S. (2018) Comparative cross-national case study research – the 'stuff' research methods books don't tell you. In: *SAGE Research Methods Cases.* SAGE.

Kemmis, S. 1988. *Action Research*, in: J. P. Keeves (ed.) Educational Research, Methodology and Measurement: An International Handbook (Oxford, Pergamon Press)

Kiran, D.R. 2016, *Total Quality Management: Key Concepts and Case Studies*, Elsevier Ltd, Chapter 23-*5.* pp 334-342.

Krieg, G.N. 2005, *Kanban-controlled manufacturing systems*, Springer, New York; Berlin.

Kuori, I. 2011. *Lean management in a nutshell. Teknologiainfo Teknova Oy.* Finland.

Kučerová, M., MÍkva, M., Sablik, J. & Gejguš, M. 2015, *"Eliminating waste in the production process using tools and methods of industrial engineering"*, Production Engineering Archives, vol. 9, pp. 30-34.

Kusiak, A. and Heragu, S.S., 1987. The facility layout problem. *European Journal of operational research*, *29*(3), pp.229-251.

Lee, M.-. & Elsayed, E.A. 2005, "Optimization of warehouse storage capacity under a dedicated storage policy", *International Journal of Production Research*, vol. 43, no. 9, pp. 1785-1805.

Lewin, K. 1946 *Action Research and Minority Problems.* Journal of Social Issues, 2.4

Majava, J. and Ojanperä, T., 2017. *Lean production development in SMEs: a case study.* Management and Production Engineering Review, *8*(2), pp.42

McNiff, J. & Whitehead, J. 2013. *Action research: principles and practice*, 3rd edn, Routledge, London.

Melton, T. 2005, "The Benefits of Lean Manufacturing", *Chemical Engineering Research and Design*, vol. 83, no. 6, pp. 662-673.

Munn, Z., Pearson, A. & Ovid Technologies, I. 2013, *Implementing evidence using an action research framework*, 1st edn, Wolters Kluwer/Lippincott Williams & Wilkins, Philadelphia.
Muther, R., 1973. *Systematic Layout Planning*, Cahners Books.

Naqvi, S.A., Fahad, M., Atir, M., Zubair, M. and Shehzad, M.M., 2016. Productivity improvement of a manufacturing facility using systematic layout planning. *Cogent Engineering*, *3*(1), p.1207296

Omogbai, O. & Salonitis, K. 2017, "*The Implementation of 5S Lean Tool Using System Dynamics Approach*", Procedia CIRP, vol. 60, pp. 380-385.

Osterwalder, A. and Pigneur, Y., 2010. *Business model generation: a handbook for visionaries, game changers, and challengers*. John Wiley & Sons.

Osterwalder, A., Pigneur, Y., Smith, A., Clark, T., Pijl, P.v.d. & Ebooks Corporation Limited 2010, *Business model generation: a handbook for visionaries, game changers, and challengers*, John Wiley & Sons, Inc, Hoboken, New Jersey.

Pearce, A., Pons, D. & Neitzert, T. 2018, "Implementing lean—Outcomes from SME case studies", *Operations Research Perspectives*, vol. 5, pp. 94-104.

Pepper, M.P.J. & Spedding, T.A. 2010, "The evolution of lean Six Sigma", *International Journal of Quality & Reliability Management*, vol. 27, no. 2, pp. 138-155.

Raisinghani, M.S., Ette, H., Pierce, R., Cannon, G. & Daripaly, P. 2005, "Six Sigma: concepts, tools, and applications", *Industrial Management & Data Systems*, vol. 105, no. 4, pp. 491-505.

Reason, P. & Bradbury, H. 2008. *The Sage Handbook of Action Research: Participative Inquiry and Practice*. 2nd edition. Sage Publications Ltd. London.

Richard Muther and Associates., 2005. Overview of Systematic Layout Planning (SLP). *Manufacturing Plant Example*

Saunders, M.N.K., Lewis, P., Thornhill, A. & Dawson Books 2012, *Research methods for business students*, 6th edn, Pearson, Harlow, Essex.

Schmidt, S., 2011. *From hype to ignorance-a review of 30 years of lean production.* World Academy of Science, Engineering and Technology, 73, pp.1021-1024.

Seppälä, P. and Klemola, S. (2004), "*How do employees perceive their organization and job when companies adopt principles of lean production?*", *Human Factors and Ergonomics in Manufacturing*, Vol. 14 No. 2, pp. 157-180.

Sheridan, J.H. 1997, "Kaizen blitz", *Industry Week*, [Online], vol. 246, no. 16, pp. 18

Shingo, S. and Dillon, A.P., 1989. *A study of the Toyota production system: From an Industrial Engineering Viewpoint*. CRC Press.

Silverman, D. 2005. Doing Qualitative Research: A Practical Handbook. 2nd edition. Sage Publications Ltd. London

Singh, R.K., Garg, S.K. and Deshmukh, S.G., 2008. Strategy development by SMEs for competitiveness: a review. *Benchmarking: An International Journal*, *15*(5), pp.525-547.

Slack, N., Brandon-Jones, A., Johnston, R. & Betts, A. 2015, *Operations and process management: principles and practice for strategic impact*, Fourth edn, Pearson Education Limited, Harlow, Essex.

Sternberg, H., Stefansson, G., Westernberg, E., Boije af Gennäs, R., Allenström, E., Linger Nauska, M., Teknisk logistik, Lund University, Engineering Logistics & Lunds universitet 2012;2013;, "*Applying a lean approach to identify waste in motor carrier operations"*, International Journal of Productivity and Performance Management, vol. 62, no. 1, pp. 47-65

Stevenson, M., Hendry, L.C. & Kingsman †, B.G. 2005, "A review of production planning and control: the applicability of key concepts to the make-to-order industry", *International Journal of Production Research*, vol. 43, no. 5, pp. 869-898.

Sugimori, Y., Kusunoki, K., Cho, F. and Uchikawa, S., 1977. Toyota production system and kanban system materialization of just-in-time and respect-for-human system. *The International Journal of Production Research*, *15*(6), pp.553-564

Tak, C.S. and Yadav, L., 2012. Improvement in Layout Design using SLP of a small size manufacturing unit: A case study. *IOSR Journal of Engineering*, *2*(10), pp.1-7.

Tam, K.Y. 1992, "Genetic algorithms, function optimization, and facility layout design", *European Journal of Operational Research*, vol. 63, no. 2, pp. 322-346.

Tompkins, J.A., White, J.A., Bozer, Y.A. and Tanchoco, J.M.A., 2010. *Facilities planning*. John Wiley & Sons. pp. 299

Taylor, J., Sinn, J., Ulmer, J.M. & Badar, M.A. 2015, "Proposed Progression of Lean Six Sigma", *Journal of Technology Studies*, vol. 41, no. 1, pp. 2-8.

Yle News (2018). *Out of Office: Finland's traditional summer shutdown*. [online] Yle Uutiset. Available at: https://yle.fi/uutiset/osasto/news/out_of_office_finlands_traditional_summer_shutdown/10291712 [Accessed 20 Aug. 2018].

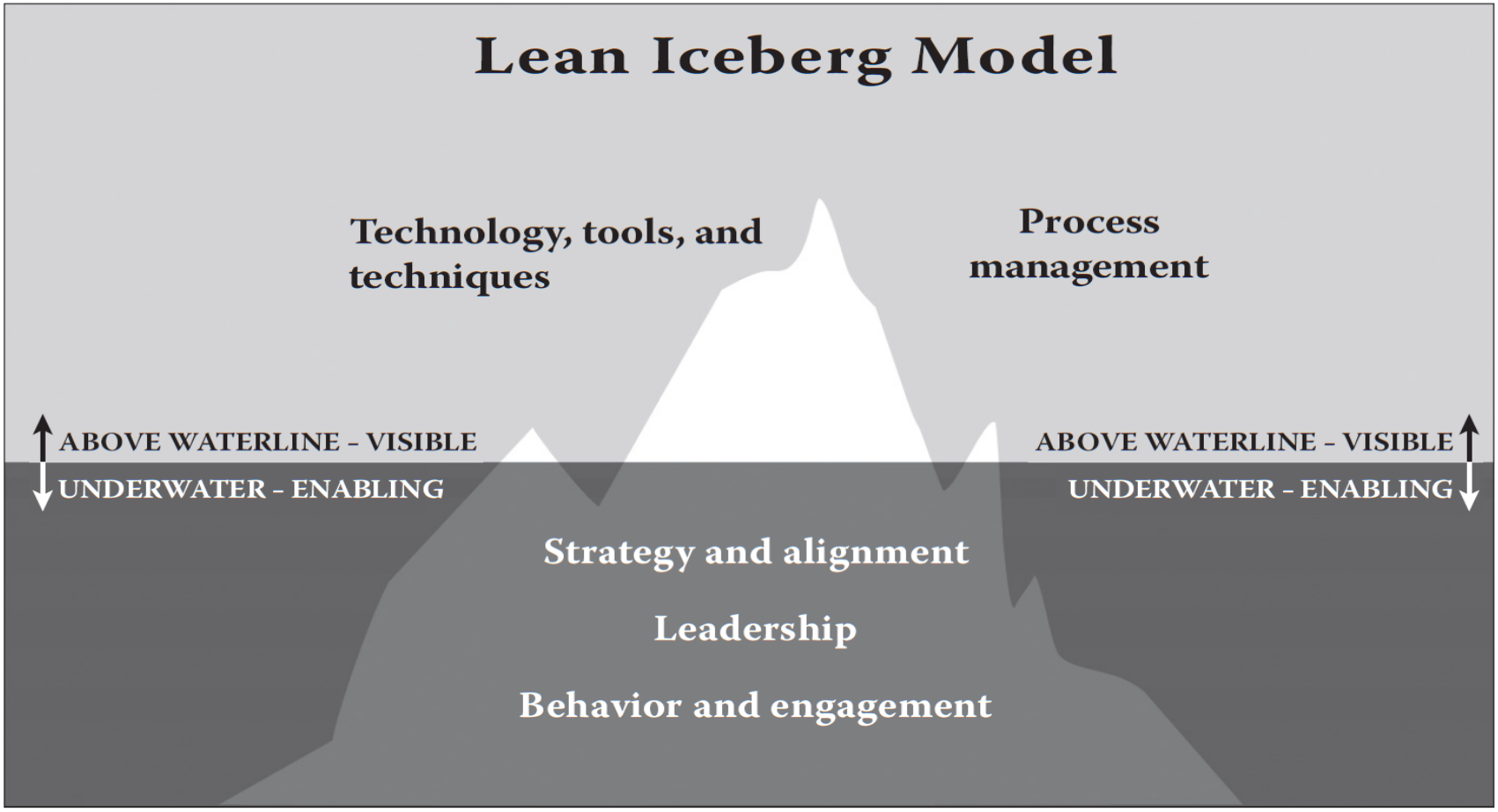
van den Berg, Jeroen P, Sharp, G.P., Gademann, A.J.R.M. & Pochet, Y. 1998, "Forward-reserve allocation in a warehouse with unit-load replenishments", *European Journal of Operational Research*, vol. 111, no. 1, pp. 98-113.

Waterman, H., Tillen, D., Dickson, R. & de Koning, K. 2001, "Action research: a systematic review and guidance for assessment", *Health technology assessment (Winchester, England)*, vol. 5, no. 23, pp.11.

Womack, J.P., Jones, D.T., Roos, D. & Massachusetts Institute of Technology 1990, *The machine that changed the world*, Rawson Associates, Oxford;New York, N.Y;.

Vamsi Krishna Jasti, N. & Kodali, R. 2014, *"A literature review of empirical research methodology in lean manufacturing"*, *International Journal of Operations & Production Management*, vol. 34, no. 8, pp. 10

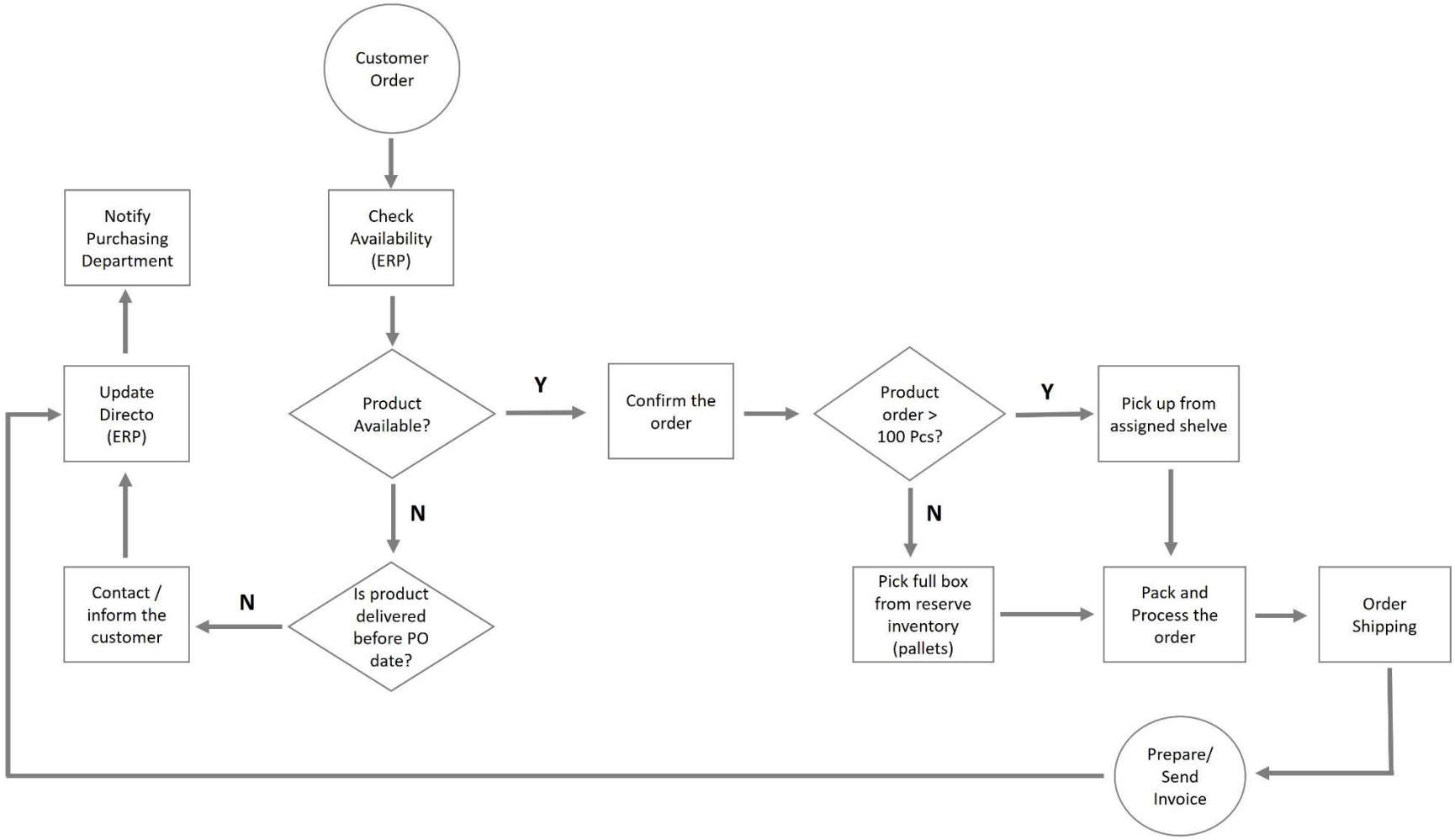
Appendix A. The sustainable lean iceberg mode



Source: Hines et al. (2011)

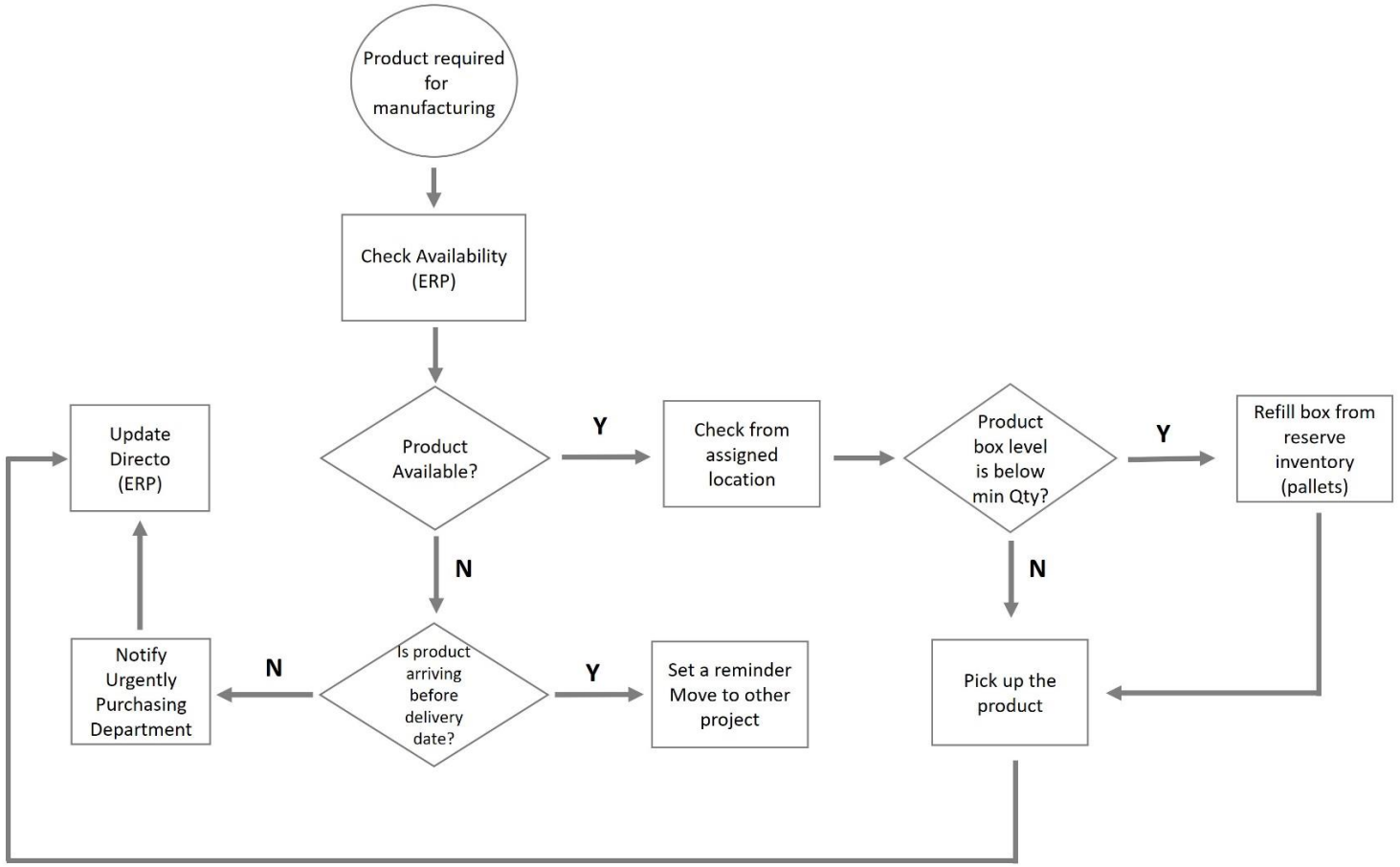
Appendix B. Product inventory before and after lean implementation

Appendix C. New process design (pick up for manufacturing)



Inventory Management: New process design for inventory products order picking (Product sales)

Appendix D. New process design (direct sales of components)



Inventory Management: New process design for inventory products order picking (Required products for manufacturing (MTO)

Appendix E. The 5´s Checklist

5´s Checklist				
Date	5s Step	Problem Found	Suggested Action	Rating
	SORT			
	SET IN ORDER			
	SHINE			
	STANDARDIZE			
	SUSTAIN			

Lean tool: 5S checklist used to implement and sustain lean operations processes

Appendix F. Designed and implemented Kanban system

a) Orders and production control Excel format Kanban system shared via cloud system

	1	2	3	4	5	6	7	8
1								
2	**Order Nr.**	**Customer**	**Product**	**Qty**	**Delivery Date**	**Status**		
3								
4	4502757242	Name / Country	Product Code / Name	1	dd/mm/yy	Not Started		
5	4502757243							
6	4502757244							
7								
8								
9								

Not Started
Waiting Components
In Progress
Ready
Shipped

b) Orders and production control Kanban board implemented in manufacturing area